










Mandai Park Holdings
Environmental Impact Assessment

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

26th September 2016

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ERM

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Client	Project No
Mandai Park Holdings	0292668

Project Summary

Mandai Park Holdings (MPH) proposes to develop an integrated wildlife and nature heritage area for recreational use, adjacent to the existing Wildlife Reserves Singapore attractions in the Mandai area of Singapore.

MPH commissioned ERM to undertake an environmental impact assessment (EIA) relating to the construction and operation activities associated with the development.

This document presents the EIA Report for the development. Information and the assessment presented is based on the masterplan concept for the development; secondary data available at the time of writing; and environmental baseline data collected during field surveys between March 2015 and December 2015.

Date
26th September 2016

Approved by

Piers Touzel
Partner in Charge

Revision	Description	By	Checked	Approved	Date
003	FINAL ENVIRONMENTAL IMPACT ASSESSMENT REPORT	ERM TEAM	RF/DN	PT	26.09.16
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Distribution

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ANNEXES

ACRONYMS AND ABBREVIATIONS

Acronym/ Abbreviation	Definition
µg	Microgram
˚C	Degree Celsius
µm	Micrometer
AADT	Annual average daily traffic
ALARP	As low as reasonably practicable
AOI	Area of Influence
ASEAN	Association of Southeast Asian Nations
asl	Above sea level
ASMC	ASEAN Specialised Meteorological Centre
ASR	Air sensitive receptor
AVA	Agri-Food and Veterinary Authority
AYE	Ayer Rajah Expressway
AZE	Alliance for Zero Extinction
bgl	Below ground level
BKE	Bukit Timah Expressway
BOD_5	5-day Biochemical Oxygen Demand
BOH	Back of House
BTNR	Bukit Timah Nature Reserve
btop	Below top of pipe
CBD	Convention on Biological Diversity
CCNR	Central Catchment Nature Reserve
CFU	Colony-forming unit
Chl-a	Chlorophyll-a
CITES	Convention on International Trade in Endangered Species
Cl	Chloride
cm	Centimeters
cmd	Cubic meters per day
CO	Carbon monoxide
CO_2	Carbon dioxide
COD	Chemical Oxygen Demand
CP	Code of Practice
CR	Critical
dB	Decibel
dB(A)	Decibel A
DBH	Diameter at Breast Height
DD	Data Deficient
DIV	Intervention Value
DO	Dissolved Oxygen
DTV	Target Value

Acronym/ Abbreviation	Definition
EHS	Environmental, Health & Safety
EIA	Environmental Impact Assessment
EMA	Energy Market Authority
EMMP	Environmental Management and Monitoring Plan
EN	Endangered
EPM	Environmental Protection and Management
EPMA	Environmental Protection and Management Act
ERM	Environmental Resources Management
EU	European Union
F&B	Food and Beverage
FHWA	Federal Highway Administration
GHG	Greenhouse gas
GISD	Global Invasive Species Database
ha	Hectares
HDV	Heavy duty vehicle
hm^3	Cubic hectometers
hr	Hour
IA	Impact assessment
IAQM	Institute of Air Quality Management
IBA	Important Bird Areas
IFC	International Finance Corporation
IPA	Important Plant Area
IUCN	International Union for Conservation of Nature and Natural Resources
KBA	Key Biodiversity Areas
kg	Kilograms
km	Kilometer
km^2	Square kilometers
k_p	Scaling factor dependent on soil type
kph	Kilometers per hour
kt	Kiloton
k_v	Scaling factor
KVA	1000 volt amps
kW	Kilowatt
L	Liters
LC	Least Concern
LDV	Light duty vehicle
LED	Light Emitting Diode
LiDAR	Light Detection And Ranging
LOR	Limit of reporting
LTA	Land Transport Authority
m	Meter

Acronym/ Abbreviation	Definition
m^2	Square meter
m^3	Cubic meter
masl	Meters above sea level
MEWR	Ministry of the Environment and Water Resources
mg	Milligram
ml	Milliliter
MLW	Maximum laden weight
mm	Millimeter
MND	Ministry of National Development
MPa	Megapascals
MPN	Most probable number
MRT	Mass Rapid Transit
msl	Mean sea level
MPH	Mandai Park Holdings
MSS	Meteorological Service Singapore
MTI	Ministry of Trade and Industry
N	Total Nitrogen
NBSAP	National Biodiversity Strategy Action Plan
NCMP	Nature Conservation Master Plan
NE	Nationally Extinct
NE	Northeast
NEA	National Environment Agency
NGO	Non-governmental organization
NH_3	Ammonia
NO_2	Nitrogen dioxide
NO_{3-}	Nitrate
NO_x	Oxides of nitrogen
NParks	National Parks Board
NSR	Noise sensitive receptors
NSS	Nature Society (Singapore)
NSSF	Nee Soon Swamp Forest
NT	Near threatened
NTU	Nephelometric Turbidity Units
P	Total Phosphorous
PAH	Polynuclear Aromatic Hydrocarbon
PCN	Park Connector Network
PM	Particulate matter
PM_{10}	Airborne particulate matter less than 10 µm in diameter
$PM_{2.5}$	Airborne particulate matter less than 2.5 µm in diameter
PMS	People Mover System
ppb	Parts per billion

Acronym/ Abbreviation	Definition
ppm	Parts per million
PPV	Peak particle velocity
PSI	Pollutant Standards Index
R	Rediscovered species erroneously thought to be nationally extinct
r	Distance between the pile toe and receptor location
s	Second
SCDF	Singapore Civil Defense Force
SI	Soil Investigation
SLA	Singapore Land Authority
SO_2	Sulphur dioxide
sqm	Square meters
SRDB	Singapore Red Data Book
SS	Singapore Standard
SSB	Sustainable Singapore Blueprint
SSC	Species Specialist Group
STB	Singapore Tourism Board
TP	Treatment Plant
SW	Southwest
TAQMMS	Telemetric Air Quality Monitoring and Management System
TDS	Total Dissolved Solids
TIW	Toxic Industrial Waste
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorous
TPH	Total petroleum hydrocarbon
TSI	Trophic status indices
TSP	Total Suspended Particulate
TSS	Total Suspended Solids
UK	United Kingdom
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
URA	Urban Redevelopment Authority
US	United States
USEPA	United States Environmental Protection Agency
UVI	Ultraviolet Index
UXO	Unexploded ordnance
v_{res}	Resultant peak particle velocity
VU	Vulnerable
W	Watt
W	Nominal hammer energy
WAZA	World Association of Zoos and Aquariums

Acronym/ Abbreviation	Definition
WCPA	World Commission on Protection Areas
WHO	World Health Organisation
WHO AQG	World Health Organisation Air Quality Guidelines
WMO	World Meteorological Organisation
WRS	Wildlife Reserves Singapore
WSUD	Water Sensitive Urban Design
WTP	Wastewater Treatment Plant
WWF	World Wildlife Fund
x	Horizontal distance between the pile and receptor location
∂	Scaling factor dependent on the mode of operation of the vibratory hammer

GLOSSARY OF TERMS

Terminology	Definition
Administrative Framework	The compendium of requirements with which the Project is required to, and/or has chosen to, comply.
Area of Influence	The primary Project site(s) and related facilities that Mandai Park Holdings develops or controls and the additional areas in which aspects of the environment could conceivably experience significant impacts, such as: • associated facilities that are not developed and funded as part of the Project but are essential for the Project and without which the Project cannot proceed, and the associated additional areas in which aspects of the environment could conceivably experience significant impacts; • areas potentially affected by cumulative impacts resulting from other developments known at the time of the IA, further planned phases of the Project or any other existing circumstances; and • areas potentially affected by impacts from predictable (but unplanned) developments as a result of the Project (i.e., induced activities), occurring at a later stage or at a different location.
Baseline	The physical, biological, cultural and human conditions that will prevail in the absence of the Project, including interactions amongst them. The Baseline includes information on all receptors and resources that were identified during scoping (or at a later stage in the IA Process) as having the potential to be significantly affected by the Project.
Committed Development	A development which is underway and is considered as part of the Project **baseline**. Note, if there are other developments in the Study Area which are in preparation or envisaged, but are committed at the time of writing, they are not considered to be part of the **baseline**.
Cumulative Impact	An **impact** that arises as a result of an **impact** from the **Project** interacting with an **impact** from another activity to create an additional **impact**.
Effect	The specific consequence (to a **resource/ receptor**) arising from an alteration of existing conditions caused by the **Project**.
Embedded Controls	Physical or procedural controls that are planned as part of the **Project** design (i.e., not added solely based on a mitigation need identified by the **impact** significance assignment process). These are described from the very start of the **IA Process** as part of the **Project** (i.e., in the Project Description and Administrative Framework chapters).
IA Process	A systematic process that predicts the **impacts** of the **Project** and evaluates the resulting **effects** it is likely to have on elements of the physical, biological, cultural and human environment. It identifies measures that the **Project** will take to avoid, reduce, abate, remedy or compensate for adverse **impacts/effects**, and to enhance positive **impacts/effects**.
Impact	Any alteration of existing conditions, adverse or beneficial, caused directly or indirectly by the **Project**.

Terminology	Definition
L_{A90}	The percentile sound pressure level exceeded for 90% of the measurement period with 'A' frequency weighting calculated by statistical analysis.
$L_{Aeq,T}$	Equivalent continuous sound pressure level with 'A' frequency weighting. Signifies the value of the sound pressure level of a continuous steady noise that, over a measurement interval of time (t), has the same mean square sound pressure as the sound under consideration whose level varies with time.
Mitigation Hierarchy	The types (in order of preference) of mitigation that can be applied to address an impact. The **Mitigation Hierarchy** is as follows: • **Avoid at Source:** avoiding through the design of the Project (e.g., avoiding by siting or re-routing activity away from sensitive areas). • **Reduce at Source:** reducing at source through the design of the Project (e.g., by restricting the working area or changing the time of the activity). • **Abate on Site:** add something to the design to abate the impact (e.g., pollution control equipment, traffic controls, perimeter screening and landscaping). • **Abate at Receptor:** if an impact cannot be abated on-site then control measures can be implemented off-site (e.g., noise barriers to reduce noise impact at a nearby residence or fencing to prevent animals straying onto the site). • **Repair or Remedy***:* some impacts involve unavoidable damage to a resource (e.g. agricultural land and forestry due to creating access, work camps or materials storage areas) and these impacts can be addressed through repair, restoration or reinstatement measures. • **Compensate in Kind; Compensate Through Other Means:** where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate (e.g., planting to replace damaged vegetation, • financial compensation for damaged crops or providing community facilities for loss of fisheries access, recreation and amenity space).
Mitigation Measure	A feature, procedure or other action that the **Project** commits to implement to avoid or reduce the magnitude of an adverse **impact**, or to enhance the magnitude of a positive **impact**.
Project	The features and activities that are a necessary part of the Project Proponent's development, including all associated facilities without which the Project cannot proceed.
Project Activities	Activities that are planned as part of the Project, including all phases.

Terminology	Definition
Project Alternative	A particular approach for the **Project** (e.g., concept level alternatives, such as site location, technology, etc or detailed alternatives, such as geotechnical investigation method) that could potentially be employed.
Project Footprint	The area that may reasonably be expected to be physically touched by **Project** activities, across all phases. The **Project Footprint** includes land used on a temporary basis such as construction lay down areas or maintenance areas.
Project Site	The (future) primary operational area for the **Project** activities, e.g. the attractions.
Project Vicinity	For assessment of impacts to biodiversity, the **Project Vicinity** refers to the refuge areas identified and the CCNR area immediately adjacent to the **Project Footprint**
Receptor	Humans and other animals which can be impacted by **Project** activities.
Resource	An element of the physical, biological, cultural or human environment which is not a human or other animal (these are referred to as **receptors**) which can be impacted by the **Project** activities. Typical **resources** include, but are not necessarily limited to: • In the physical environment: geological resources; sediments; land; water quality; water supply; air quality; noise level; vibration levels; light. • In the biological environment: terrestrial, freshwater and marine habitats; flora; biodiversity at the community, species and genetic levels; protected areas; ecosystem services. • In the human or cultural environment: subsistence resources; community health, welfare, amenity and safety; employment and incomes; business and economic activity; land use; traffic; sites and features of archaeological, historic, traditional, cultural or aesthetic interest.
Study Area	The area that needs to be studied in order to adequately understand and describe the **Baseline** likely to be affected by the **Project**. At a minimum, the **Study Area** will encompass the **Project Footprint** and the **Area of Influence**, and in some cases it may extend farther to further establish the context for the **Baseline**.
Unplanned Event	A reasonably foreseeable event that is not planned to occur as part of the **Project**, but which may conceivably occur as a result of **Project** activities (e.g., accidents), even with a low probability.

1 INTRODUCTION

1.1 BACKGROUND

In 2008, the Singapore Tourism Board (STB) identified the Mandai precinct as an opportunity to develop a world class nature themed destination for Singaporeans and visitors to enjoy and appreciate nature.

Since the idea was first mooted, STB reached out to various potential partners to explore suitable concepts for the site. Temasek, the majority shareholder of Wildlife Reserves Singapore (WRS) which operates the existing Mandai attractions and Jurong Bird Park, responded to STB's invitation to explore concepts and established Mandai Park Holdings (MPH) to oversee the concept development for the rejuvenation of Mandai into an integrated wildlife and nature heritage space.

After three years of concept development, MPH is proposing to augment the existing gated attractions at Mandai with two main attractions – a revamped Bird Park and a new Rainforest Park – as well as two smaller attractions – Planet Explorer and Sri Seletar Point. Other facilities such as lodges, retail outlets, non-gated public amenities and infrastructure, will also be introduced. Development of these new attractions will require modifications to existing facilities and infrastructure such as parking areas, drainage and upgrade works to the existing road.

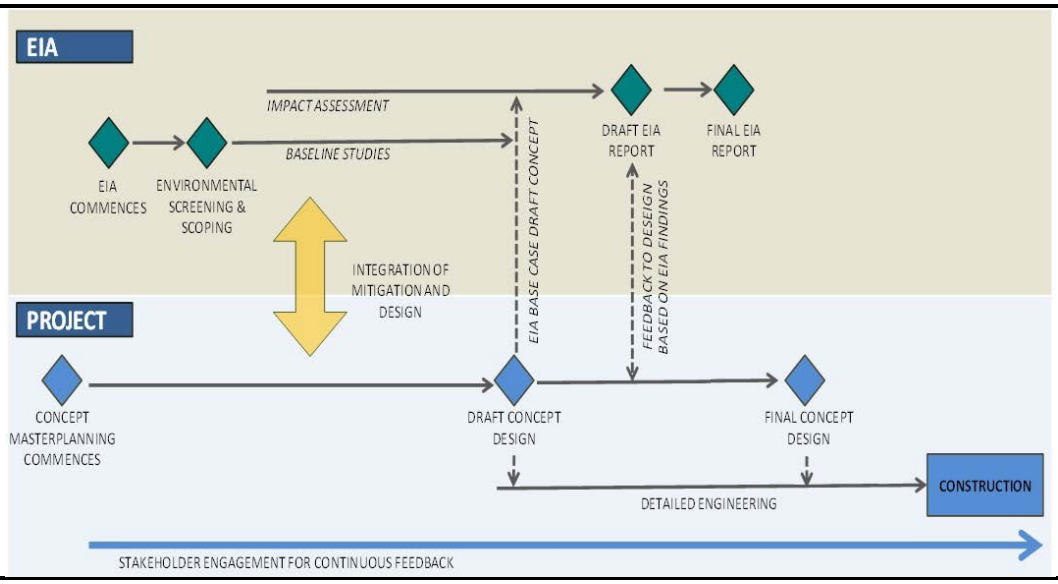
From the earliest stages of concept development, agencies provided the following "Guiding Principles" for the development:

Guiding Principles for Concept Design

- The development footprint will not encroach on the Central Catchment Nature Reserve (CCNR).
- There are opportunities through sensitive design to strengthen and restore connectivity of the nature reserves.
- There will be no pollution discharge into the Upper Seletar Reservoir from the development.
- Mitigation measures will be developed through the Environmental Impact Assessment (EIA) to minimise the impact to the CCNR during construction and operation of the development.

The Project is currently at the conceptual design stage with masterplan under preparation as illustrated on *Figure 1.1*. As part of the conceptual design process, MPH commissioned Environmental Resources Management (ERM) to conduct an EIA for the Project. This report presents the EIA for the concept design of the Project.

Figure 1.1: Pre-Construction Project and EIA Flow



Note: Commencement of construction will be subject to relevant authority approval of the Final EIA Report and Final Concept Design

1.2 OBJECTIVES

The specific objectives of the EIA are to:

- Document the baseline environment conditions of the Project area that may be affected by the Project construction and operational activities;
- Define the potential sources of environmental impact; receptors to the impacts; and magnitude of the impacts;
- Determine the impact significance and mitigation measures to reduce impacts identified and/or enhancement measures; and
- Develop an Environmental Management and Monitoring Plan (EMMP) that can be taken forward for consideration during the detailed design and construction planning, and implementation and operation of the Project.

1.3 REPORT STRUCTURE

The structure of the EIA report is shown in *Table 1.1*.

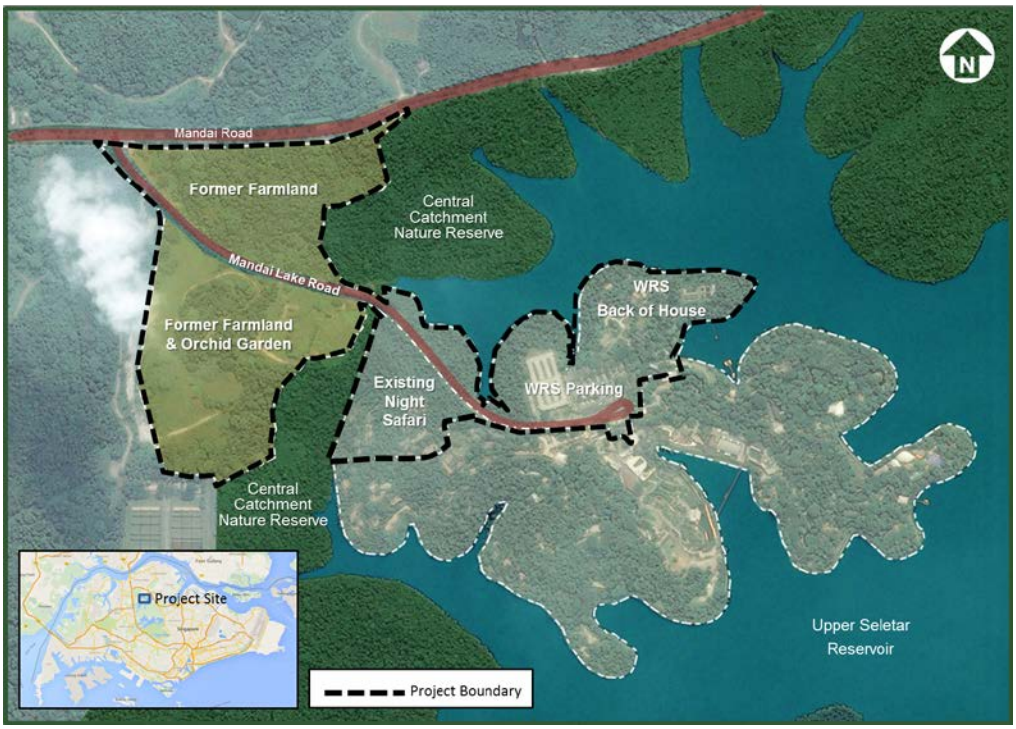
Table 1.1: EIA Report Structure

Chapter	Title	Content
1.0	Introduction	Overview of the Project and objectives.
2.0	Project Description	Outline of the conceptual design of the Project and alternatives considered.
3.0	Administrative Framework	Legislation governing the protection of the environment in Singapore.
4.0	Impact Assessment Methodology	Process and criteria used for the impact assessment including the criteria used to determine significance.
5.0	Screening and Scoping	Details of the Project activities and environmental aspects likely to have a significant interaction and therefore "*scoped*" into the impact assessment.
6.0	Baseline	Current environmental conditions in the Project area.
7.0	Stakeholder Engagement	Engagement process, consultation and key comments received.
8.0	Construction Phase Impact Assessment	Assessment of environmental impacts during construction.
9.0	Operation Phase Impact Assessment	Assessment of environmental impacts during operations.
10.0	Environmental Management and Monitoring Plan	Recommended mitigation measures, roles, responsibilities, implementation strategies and timing, to manage and reduce the impacts identified.
11.0	Impact Assessment Summary	Summary of the EIA findings.

2 PROJECT DESCRIPTION

The Project involves the development of approximately 35.4 hectares (ha) of land to the west of the existing WRS operated Zoo, along Mandai Lake Road in the north of Singapore. Historically, the area included a village, farmland and the former Mandai orchid farm. In addition to the two plots of land to the north and south of Mandai Lake Road, there will also be redevelopment of the 'Back of House' area, redevelopment of a portion of the current Night Safari, and some infrastructure upgrades within the WRS operated area. The total Project area, including existing WRS areas which will be redeveloped, is 63.94 ha. The Project will not encroach on the Central Catchment Nature Reserve (CCNR). The location of the Project is illustrated in *Figure 2.1.*

Figure 2.1: Mandai Park Holdings Project Location



Source: MPH, May 2016

MPH and the Masterplanning team embarked upon developing a concept design for the Project in 2013. From the outset, the guiding principles for developing the concept design included the following to apply to all Project components:

- Areas of high biodiversity value, including disturbed primary forests, mature secondary forests, native dominated Critically Endangered, Endangered and Vulnerable tree species listed in the Singapore Red Data Book (SRDB) and the existing Alstonia trees along Mandai Lake Road (which provide connections for arboreal fauna) will be avoided as a first priority. Clearing footprint will be minimized by developing in areas already disturbed or consisting of low value habitats, and retaining existing forested areas within attractions. Habitat features (such as existing large trees; hollow bearing trees; ground habitats; and riparian zones) will be protected and retained, wherever possible.

- Water use and runoff within the Project area will be managed through the use of water efficient design, such as permeable pavements and water collection systems. Water from potentially contaminated areas will be captured such that it does not enter forested areas and aquatic habitats, and will be treated to reduce the risk of pollution to surface water bodies. Natural flow regimes will be maintained to provide habitat for aquatic flora and fauna.

- Design measures will be used to reduce edge effects on adjacent habitats. This includes the use of building and enclosure designs that reduces heat and light reflection into adjacent habitats, hence minimizing resultant heat / light edge effects. Enclosure structures that reduce shading of tree canopies will be used to limit shadow edge effects. Rooftop gardens can be established to provide continuous vegetative cover that will maintain moisture differentials between buildings and habitats so as to reduce edge impacts. Suitable colour palettes will be used for buildings to reduce absorption by building surfaces and heat reflection into adjacent to habitats. Permanent lighting will be directed away from forested areas / habitats to reduce nocturnal impacts on species.

- Attractions will be designed to prevent potential breaches and subsequent escapees. This includes the use of design features to guard against localised tree falls caused by potential microburst storm events, the selection of appropriate mesh sizes to reduce the risk of breaches and escapees, and the use of anchoring points built into the land surface to avoid incursion by native predatory fauna.

- Appropriate planting of vegetation and landscaping will be carried out to maintain moisture differentials and connectivity within surrounding forested areas and to reduce edge effects. The use of natural habitat features (such as fallen logs / rough bed and banks) within the design will be considered to provide areas that can potentially be used by wildlife.

- Noise-attenuating features will be incorporated into the design to absorb and direct noise from the Road and *Arrival Nodes* away from forested areas / habitats. This includes avoiding direct line of sight of noise sources with forested areas. Noise generating facilities / equipment (such as air conditioners etc.) should be placed away from forested areas, situated underground or sound insulated to reduce noise disturbance and minimize the displacement of fauna.

- Waste will be managed to minimise opportunities for animals to forage on waste from garbage disposal sites.

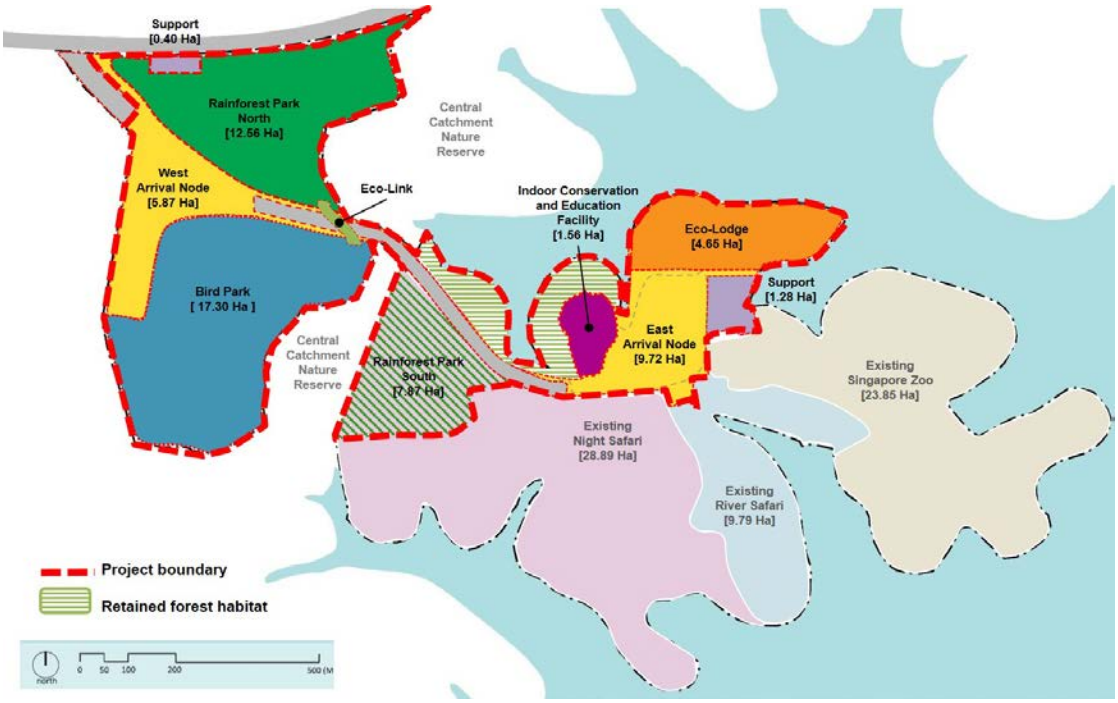
- Air discharges from *Arrival Nodes* (including kitchens / toilets) will be directed away from natural areas / habitats to reduce the potential impacts of air discharges to vegetation. Where possible, low emission / electric vehicles will be used on site to reduce potential impacts on vegetation from exhaust gases.

- Required corridors will be established within the design to facilitate wildlife connectivity, particularly at the canopy level.

- Landscaping features will be used to discourage habitat incursion by humans.

Owing to the nature of the Project and the ecological sensitivity of the Mandai environment, ERM considers avoidance and minimisation of biodiversity impacts through spatial planning and consideration of Project alternatives, coupled with the improved connectivity between currently fragmented sections of the CCNR, will have a higher reduction in impact over the medium to long term as compared to other procedural or operational measures taken during the construction or operation of the new attractions. Consequently, during the masterplanning stage, experts worked collaboratively with MPH and the Masterplanning team to develop a concept design which incorporates environmental impact minimisation measures following the mitigation hierarchy of "avoid, minimise, manage, and compensate". The concept Masterplan used as the basis of the impact assessment is illustrated in *Figure 2.2*.

Figure 2.2: Mandai Park Holdings Concept Masterplan



Source: MPH, June 2016

The following subsections provide further detail on each of the Project components illustrated in *Figure 2.2*; how the concept for each area evolved; and the key environmental sensitivities and design principles which were taken into consideration during development of the concept design.

2.1 RAINFOREST PARK NORTH

2.1.1 Rainforest Park North Masterplanning

The masterplan concept for *Rainforest Park North* is to create a rainforest-themed experience incorporating elements of wildlife and adventure to inspire conservation. The *Rainforest Park North* design seeks to preserve existing vegetation, especially the mature native trees of conservation significance that have been identified in the arboriculture survey, which can also enhance the overall rainforest experience of the park. The peak day visitorship for both *Rainforest Park North* and *Rainforest Park South* is projected to be approximately 19,000; 80% (i.e. 15,200) of which are assumed to enter from the *West Arrival Node* to *Rainforest Park North*, and the other 20% (i.e. 3,800) are assumed to enter the *Rainforest Park South* from the *East Arrival Node*.

During the early masterplanning phase, the *Rainforest Park North* was intended to be located in the former orchid farm area to the south of Mandai Lake Road. In recognition however, that the area to the north of Mandai Lake Road was better suited to a rainforest park style attraction given the existing secondary forest, the site of the *Rainforest Park North* was relocated there.

Environmental sensitivities of the proposed *Rainforest Park North* location were subsequently identified during development of the baseline (full details of the baseline environment of the entire Project area are detailed in *Chapter 6)*. In consultation with the Masterplanning and MPH teams, design principles were then developed to minimise potential impacts associated with the sensitivities identified. The key sensitivities identified and corresponding design principles integrated into the concept design of *Rainforest Park North* are as follows:

- The area comprises disturbed secondary forest (native dominated), mature secondary forest (native dominated) to the east, disturbed secondary forest (exotic dominated) and scrubland forest types with habitat values for Critically Endangered flora and fauna. The design principle developed therefore involved the protection of key existing forested areas by integrating them into the design of future attractions;

- Forest values along the eastern boundary of the location, immediately adjacent to the CCNR, are higher with mature secondary forest, dominated with native flora. A 45 to 50 m wide buffer from the CCNR will be maintained along the eastern boundary, to reduce potential edge effects and disturbance;

- There are Critically Endangered, Endangered and Vulnerable SRDB-listed flora species, including a single large and mature individual of *Ficus stricta* (SRDB CR) and 1 species (*Nephelium ramboutan-ake*) identified as extinct (see *Section 6.6.4*). The design principle therefore involved placing the footprint of structures in locations that will avoid native Critically Endangered, Endangered and Vulnerable (SRDB) flora species and those previously thought to be Extinct where possible. Where removal of threatened flora is necessary, a separate approval will be sought from NParks;

- The area plays host to important fauna species listed as Critically Endangered or Endangered under the SRDB, including the Lesser Mousedeer (*Tragulus kanchil)*. Forest

dependent birds also exist within this area. Given the presence of such species, attraction opening hours will be limited to daytime only with minimal lighting, thereby reducing disturbance and displacement of species; and

- The area is part of a connection corridor between land to the west of the *Rainforest Park North* location, the CCNR and forested areas on the northern side of Mandai Road and south of Mandai Lake Road. The currently unrestricted movement of fauna between these areas will be partially blocked by the development. An *Eco-Link* will connect the CCNR across Mandai Lake Road to allow the safe passage of fauna and design features such as berms, bunds and fences have been integrated into the design along Mandai Lake Road to reduce the risk of vehicle strikes.

The environmental sensitivities and design principles outlined above, together with stakeholder inputs, were taken into consideration during the masterplanning phase in order to develop the concept design used as the base case in the Project EIA. The following sub-section details the concept design for *Rainforest Park North*.

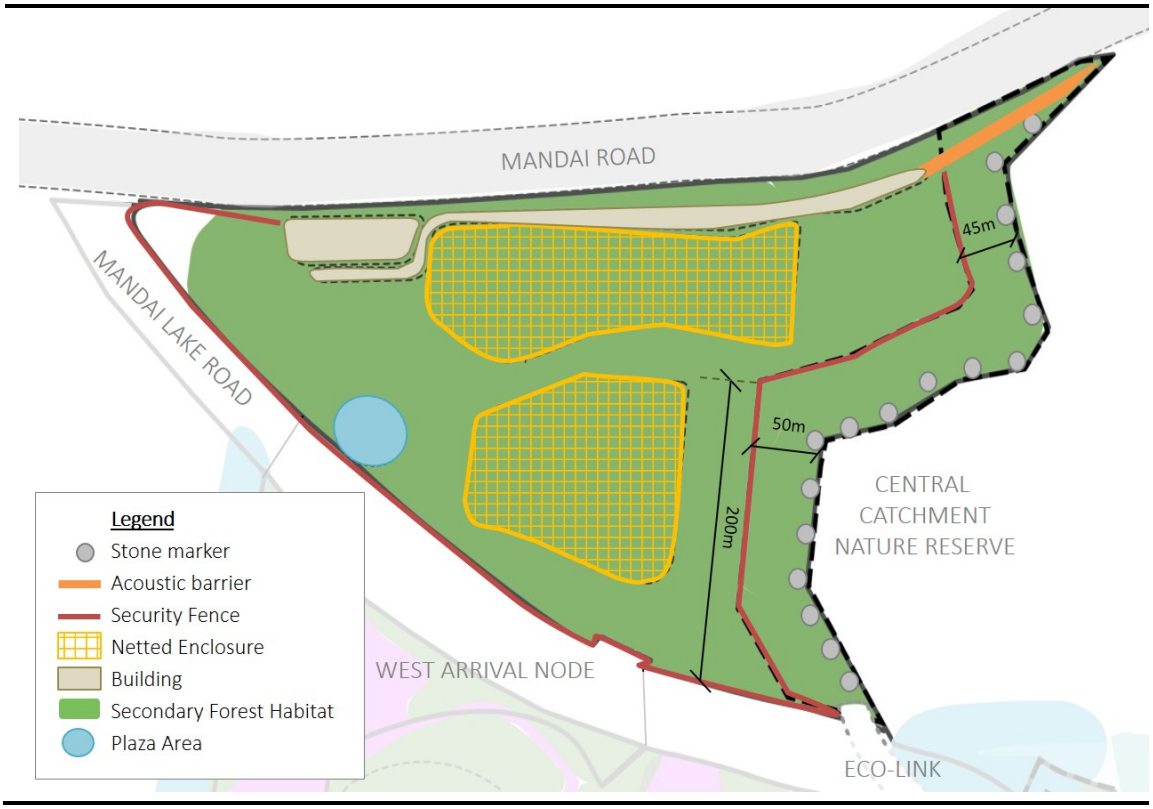
2.1.2 Concept Design of Rainforest Park North

The concept design developed for the *Rainforest Park North* covers an area of approximately 12.56 ha as illustrated in *Figure 2.3*. Built structures will generally be limited to impacted areas or running along the edge of the Park adjacent to Mandai Road. The area will include animal enclosures, and adventure components, such as rope courses, climbing structures and trails. There will be a main circulation spine linking the 2 large netted enclosures. Within each netted enclosure, it is proposed to retain and use existing vegetation to create the rainforest experience. There will be a 2 storey building in the north of the park along Mandai Road, and permanent acoustic panels erected to the north east of *Rainforest Park North* along Mandai Road. The building along Mandai Road will house smaller exhibits / terrariums. The footprint and height of this building will be designed to respect the sensitivities of the site and will be integrated with the surrounding landscape. The concept has been developed with a view to being operational from 07.00 to 19.00 daily, with occasional night time activities situated away from the CCNR. Occasional night time activities will comprise overnight camps for small groups (approximately 40 people) similar to overnight education camps currently undertaken in the WRS operated areas.

The buffer zone between *Rainforest Park North* and the CCNR will be free from any structures and activities. There will be no clearance of vegetation in the buffer except for the purpose of constructing the *Eco-Link* detailed in *Section 2.5*. Within the first 200 m north of Mandai Lake Road, where the width of the adjacent CCNR is narrower, the buffer will be 50 m in width. Just south of Mandai Road, where the width of the adjacent CCNR is wider, the buffer will be 45 m in width. For the stretch that abuts Mandai Road, green acoustic panels will be erected, as a continuation of the building along the northern edge of *Rainforest Park North*, to screen traffic noise. The height of these acoustic panels will be designed to respect the sensitivities of the site and will be integrated with the surrounding landscape. There will be a security fence around the attraction area that will serve to restrict unauthorised human access and prevent ground dwelling fauna within the attraction escaping into the CCNR. The security fence will also exclude ground dwelling fauna in the CCNR from entering the attraction area. Stone markers, which can be installed manually without vehicular entry and

the use of heavy machinery or equipment, will be used to demarcate the boundary between the buffer zone and CCNR.

Figure 2.3: Rainforest Park North Concept Design



Source: MPH, June 2016

2.2 BIRD PARK

2.2.1 Bird Park Masterplanning

The existing Jurong Bird Park, located at Jurong Hill along the Ayer Rajah Expressway (AYE), will be relocated to the Project area. The masterplan concept for the *Bird Park* is to create immersive and authentic habitats throughout the park where there will be opportunities to interact with bird keepers and feed some of the birds within the attractions. The peak day visitorship for the *Bird Park* is projected to be approximately 14,300.

During the early masterplanning phase, the location of the *Bird Park* was intended to be located north of Mandai Lake Road. As outlined in *Section 2.1.1*, this area is more suited for a rainforest park attraction given the existing forest values, while the south of Mandai Lake Road is predominately cleared and consists of grassland habitats. Given that greater disturbance will arise from the development of the *Bird Park* due to the construction of aviaries, the *Bird Park* was switched to the south of Mandai Lake Road as illustrated in *Figure 2.2*.

Environmental sensitivities of the proposed *Bird Park* location were subsequently identified during the baseline studies (full details of the baseline environment of the entire Project area are detailed in *Chapter 6)*. In consultation with the Masterplanning and MPH teams, design

principles were then developed to minimise potential impacts associated with the sensitivities identified. The key sensitivities identified and corresponding design principles integrated into the concept design of the *Bird Park* are as follows:

- The area is predominately grassland with patches of mature secondary forest adjacent to the CCNR, young secondary forest (exotic dominated) and scrubland forest types with habitat values for critically endangered flora and fauna. The design principle developed incorporates the protection of key existing habitat features where possible and integration of existing forested areas into attraction designs;

- Similar to the design requirements for the *Rainforest Park North*, important forest values along the eastern boundary immediately adjacent to the CCNR are higher with mature secondary forest, dominated with native flora. A 45 to 50 m wide buffer will therefore be maintained along the eastern boundary, to reduce potential edge effects and disturbance of the CCNR. There will be no clearance of vegetation in the buffer except for the purpose of constructing the *Eco-Link* detailed in *Section 2.5*;

- There are Critically Endangered, Endangered and Vulnerable SRDB-listed flora species, including 1 species (*Rourea acutipetala* spp. *Acutipetala*) previously listed as Extinct (see *Section 6.6.4*). The design principles adopted including minimising the footprint of structures that would require clearing to retain native Critically Endangered, Endangered and Vulnerable (SRDB) flora species and those previously thought to be Extinct;

- Important fauna species listed in the SRDB, including the Sunda Pangolin (*Manis javanica*) as well as birds and bats frequent this area. Given the presence of such species, attraction opening hours will be limited to daytime only with minimal lighting, thereby reducing disturbance and displacement of species. Retention of suitable vegetated areas for use by birds and bats within the development area will also be incorporated;

- The area is part of a connection corridor between land to the west of the *Rainforest Park North* location, the CCNR and forested areas to the south and west of the development area. The currently unrestricted movement of fauna between these areas will be partially blocked by the development. An *Eco-Link* will connect the CCNR across Mandai Lake Road to allow the safe passage of fauna and design features such as berms, bunds and fences have been integrated into the design along Mandai Lake Road to reduce the risk of vehicle strikes; and

- Species that may interact with visitors and bird enclosures such as the Sambar Deer (*Rusa unicolor*) and Wild Boar (*Sus scrofa*) will be prevented from entering the *Bird Park* through appropriately designed fencing.

Similar to the *Rainforest Park North*, the environmental sensitivities and design principles outlined, along with stakeholder inputs, were taken into consideration during the masterplanning phase in order to develop the concept design used as the base case in the Project EIA. The following sub-section details the concept design for *Bird Park*.

2.2.2 *Bird Park Concept Design*

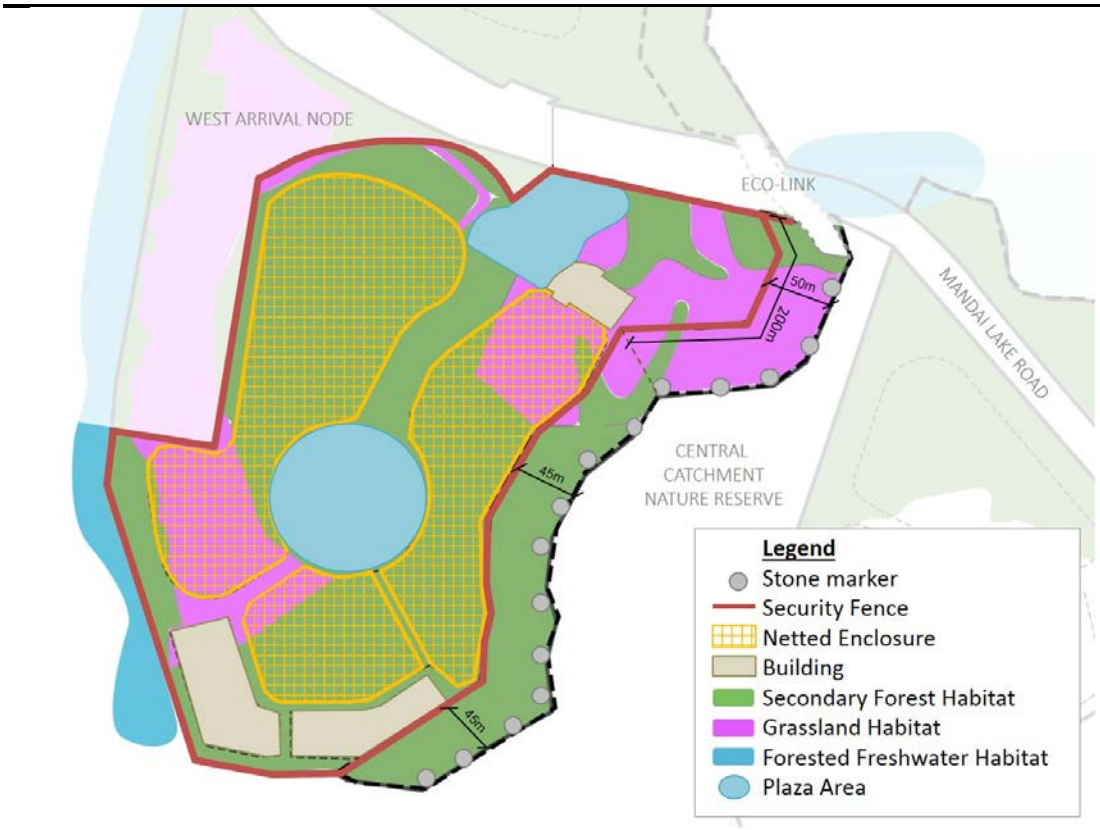
The concept design developed for the *Bird Park* covers an area of approximately 17.3 ha and is illustrated in *Figure 2.4a*. The new *Bird Park* comprises 9 walk-in aviaries, 1 netted amphitheatre, an indoor exhibit area, smaller individual aviaries and Back of House facilities to support the operations of the park. Each aviary will contain a different themed habitat. There will be a main circulation thoroughfare through the centre of the *Bird Park*, providing a landscaped pedestrian boulevard with an in-park transportation service on paved area. There will also be retail and F&B options located along the thoroughfare.

The *Bird Park* will be open from 09.00 to 18.00 daily with occasional night time activities situated away from the CCNR. Occasional night time activities will comprise overnight camps for small groups (approximately 40 people) similar to overnight education camps currently undertaken in the WRS operated areas.

With reference to *Figure 2.4b*, the design of the central landscaped pedestrian boulevard as well as passageways between aviaries takes into consideration the movement of birds through the *Bird Park* site to the adjacent forest habitats in the west and to the CCNR. The connection for birds will be achieved through the retention of existing trees of conservation significance and supplemented by additional planting of native tree species along these corridors to provide continuous tree lines and encourage bird movement.

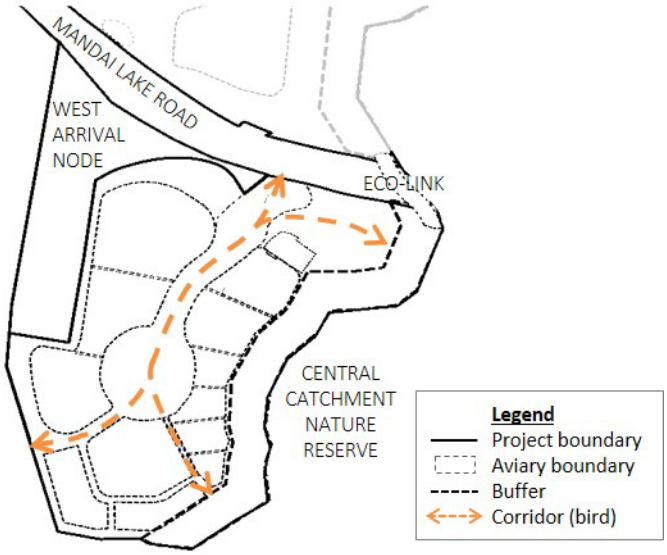
The buffer zone between the *Bird Park* and the CCNR will be free from any structures and activities. Within the first 200 m south of Mandai Lake Road, where the width of the adjacent CCNR is narrower, the buffer will be 50 m in width. At the southern end of the *Bird Park,* where the adjacent CCNR is wider, the buffer will be 45 m in width.

Figure 2.4a: Bird Park Concept Design



Source: MPH, June 2016

Figure 2.4b: Movement Corridors for Wild Birds



There will be a security fence around the attraction area that will serve to restrict unauthorised human access and prevent ground dwelling fauna within the attraction escaping into the CCNR. The security fence will also exclude ground dwelling fauna in the CCNR from entering the attraction area. Stone markers, which can be installed manually without vehicular entry and the use of heavy machinery or equipment, will be used to demarcate the boundary between the buffer zone and CCNR.

2.3 RAINFOREST PARK SOUTH

2.3.1 Rainforest Park South Masterplanning

The development of the *Rainforest Park South* (see *Figure 2.5*) entails the repurposing of the western portion of the existing WRS operated *Night Safari* area.

Similar to the *Rainforest Park North*, the masterplan concept for *Rainforest Park South* is to create a rainforest-themed experience incorporating elements of wildlife and adventure to inspire conservation. The peak day visitorship for both *Rainforest Park North* and *Rainforest Park South* is projected to be approximately 19,000; 20% (i.e. 3,800) of which are assumed to enter from the *East Arrival Node* to *Rainforest Park South*, while 80% (i.e. 15,200) are assumed to enter the *Rainforest Park North* from the *West Arrival Node*.

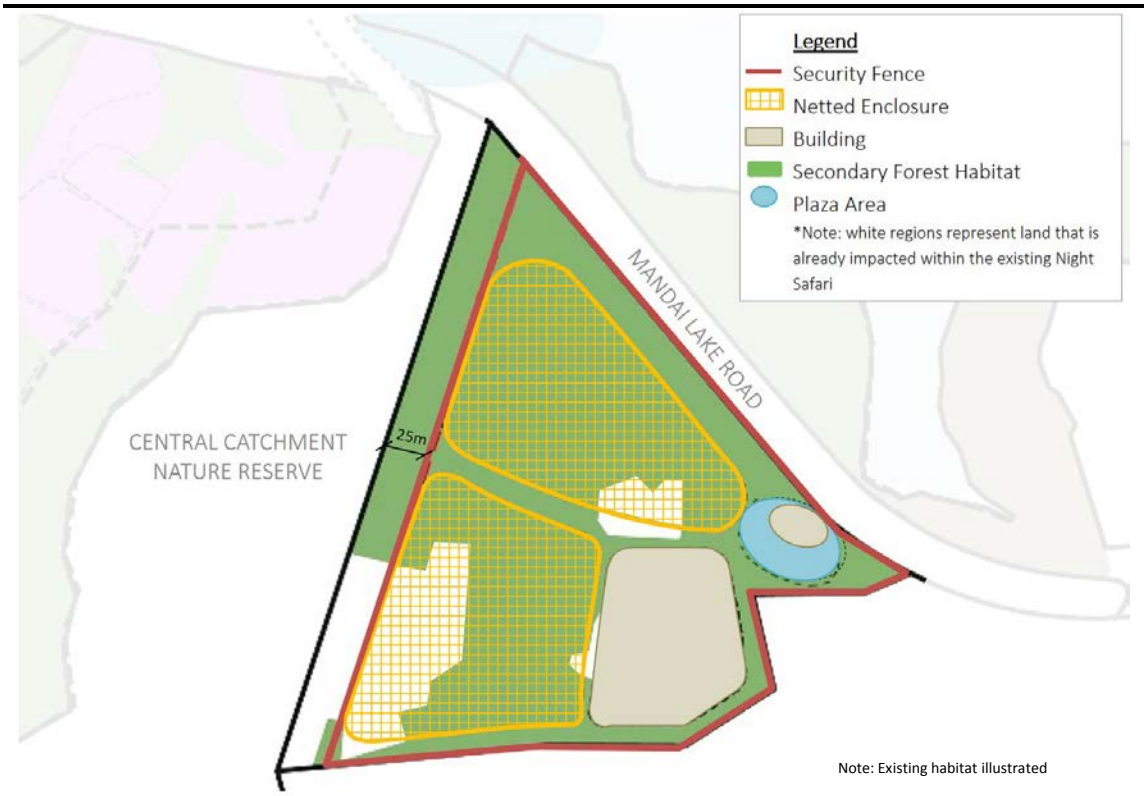
2.3.2 Rainforest Park South Concept Design

There will be a separate entrance that leads from the *East Arrival Node* to this part of the Park. The entrance plaza will house a pavilion-like building with retail and F&B offerings. There will be 2 large habitats within netted enclosures in the *Rainforest Park South*. It is proposed to retain patches of existing dense forest and trees of conservation significance.

Light structures such as boardwalks are proposed in this part of the Park to help maintain the integrity of the existing green areas by preventing soil erosion.

All buildings and structures will be set back 25 m from the boundary of the CCNR. As the existing *Night Safari* borders a relatively narrow bottleneck at the CCNR, consideration was given to widen the forested areas available for use by wildlife within the vicinity of this bottleneck, as part of the proposed repurposing of the *Night Safari*. In addition, this 25 m setback will protect buildings and structures within the *Rainforest Park South* from the possibility of treefall from the nature reserve. This zone will be planted with native trees. There will be a security fence around the attraction area that will serve to restrict unauthorised human access and prevent ground dwelling fauna within the attraction escaping into the CCNR. The security fence will also exclude ground dwelling fauna in the CCNR from entering the attraction area.

Figure 2.5: Rainforest Park South Concept Design



Source: MPH, June 2016

2.4 ARRIVAL NODES

2.4.1 Arrival Nodes Masterplanning

The masterplan concept for *Arrival Nodes* is to provide a welcoming arrival experience and create a landscaped public space for congregation and wayfinding for visitors before they disperse into the parks. The projected peak day visitorship for the public areas around the *West Arrival Node and East Arrival Node* is approximately 10,200 for each node. Commercial facilities at the *Arrival Nodes* are expected to be open from between 06.00 and 19.00 daily at the *West Arrival Node* and 06.00 to 24.00 at the *East Arrival Node*.

The preliminary arrival node location consisted of one centralised area adjacent to the CCNR. However, given the biodiversity sensitivity of the proposed site, this plan was subsequently changed to include two *Arrival Nodes* as illustrated on *Figure 2.2*, to reduce the operational intensity adjacent to the CCNR. Key environmental sensitivities identified and corresponding design principles integrated into the concept design of the A*rrival Nodes* are as follows:

- High biodiversity values exist within the adjacent areas (*Rainforest Park North*, *Bird Park* and CCNR) that contain disturbed primary, and native dominated secondary forests. Therefore, two *Arrival Nodes* were designed to be located away from the CCNR and remnant forested areas. The location selected for the *East Arrival Node* is currently existing structures and a car park, while the location of the *West Arrival Node* is currently grassland and scrubland habitat. The locations selected enable a 45 m to 50 m buffer

area to be established adjacent to the CCNR at these locations, which will receive a large number of visitors at any one time;

- An unnamed freshwater stream is located external but adjacent to the western boundary of the *West Arrival Node*. The distance between the freshwater stream and the boundary line of the *West Arrival Node* ranges from 7.5 m to 19 m. Buildings within the *West Arrival Node* will be setback by a minimum of 5 m from the boundary line.

- Landscaping will use fast growing pioneer species followed by successional species to maximise habitat value of the arrival nodes and reduce the time for re-establishing connectivity. Lighting for public safety will be kept to a minimum lux level and directed away from the CCNR, thereby reducing disturbance and displacement of nocturnal species. The use of fencing and vegetative barriers will assist in reducing conflicts between humans and Project components with fauna. Landscaping within the *Arrival Nodes* will provide opportunity for use by birds and bats;

- Overland water flow at the arrival nodes has the potential to increase runoff. Managing overland water flow within the deck has been a key design principle. This has included the use of grassed swales that will enable temporary inundation during high intensity rainfall events; and

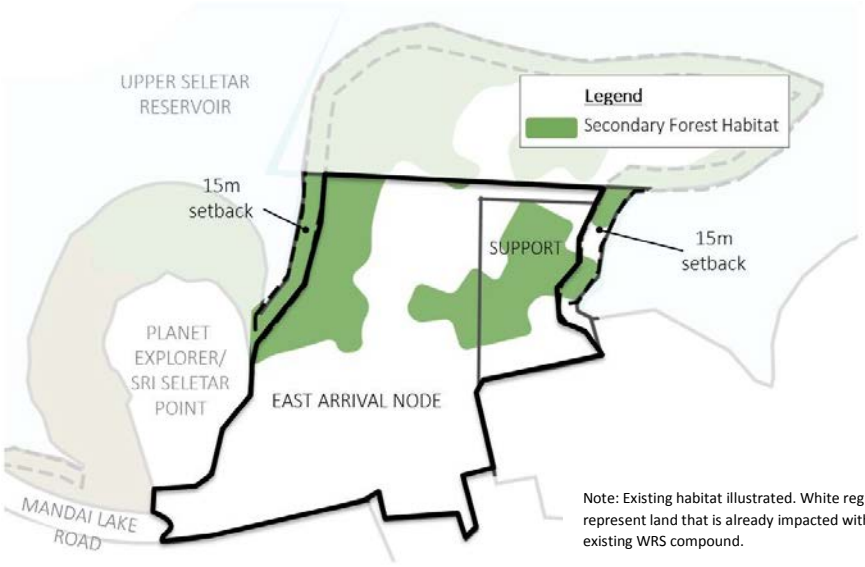
- Species that may negatively interact with visitors such as the Sambar Deer (*Rusa unicolor*) and Wild Boar (*Sus scrofa*) will be prevented from entering the *Arrival Nodes* by using appropriate design features.

2.4.2 Arrival Nodes Concept Design

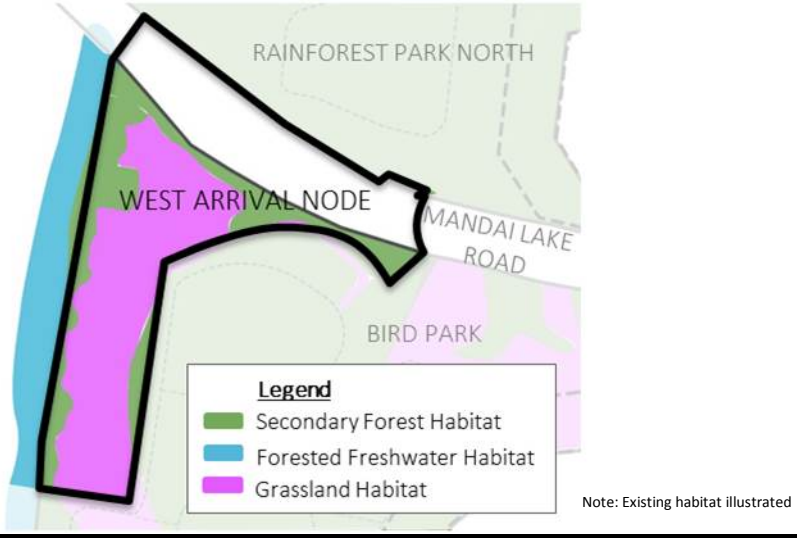
The concept design developed for the two *Arrival Nodes* is illustrated in *Figure 2.6*. The *West Arrival Node,* called the *Forest Gateway*, will serve the new *Bird Park* and *Rainforest Park North* attractions. The *East Arrival Node*, called the *Forest Courtyard*, will be the main point of arrival for visitors to the existing *Singapore Zoo*, *Night Safari*, *River Safari*, and the new *Rainforest Park South*, *Planet Explorer / Sri Seletar Point* and the *Eco-Lodge*.

Figure 2.6: Arrival Nodes Concept Design

East Arrival Node



West Arrival Node



Source: MPH, June 2016

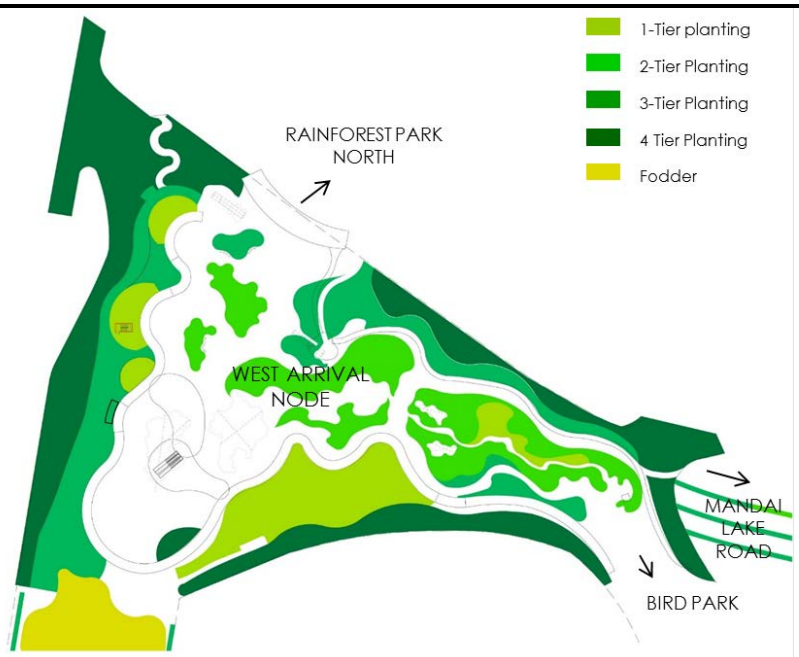
The *West Arrival Node* (*Forest Gateway*) will consist of a large landscaped deck built across the existing Mandai Lake Road to connect the *Bird Park* and *Rainforest Park North*. The *West Arrival Node* will include a central arrival area constructed in the form of a cavern, which serves as an arrival point into the Mandai precinct as well as a form of vertical transportation from the basement level to the top of the deck. The landscape deck will include recreated forest patches, open grass areas and an artificial stream and waterfall flowing down to the skylight cut-out. Other amenities to be developed at the *West Arrival Node* include:

- Ticketing Areas;
- Food Court;
- F&B Spaces;

- Play Areas; and
- Sanitary facilities.

The landscape planting strategy for the deck at *Forest Gateway* seeks to incorporate and recreate a range of the feature elements found in the tropical rainforest as illustrated in *Figure 2.7*. With guidance from the Forest Restoration Plan (*Annex 15*), multi-tiered planting will be used to allow for gradual transition from the existing surrounding forest to be retained, promoting opportunity for eco-connectivity across the deck. The 3- and 4-tier planting along the edges of the deck serves as a buffer to these adjacent forests to reduce edge effects and discourage high human activity in those areas. Trees will be planted in clusters with minimum edge to area ratio to maintain quality of microhabitats. Elements such as overlapping tree canopies, arboreal ropes, water features and green rooftop plantings will be provided.

Figure 2.7: Landscape Planting Strategy for West Arrival Node



Source: MPH, May 2016

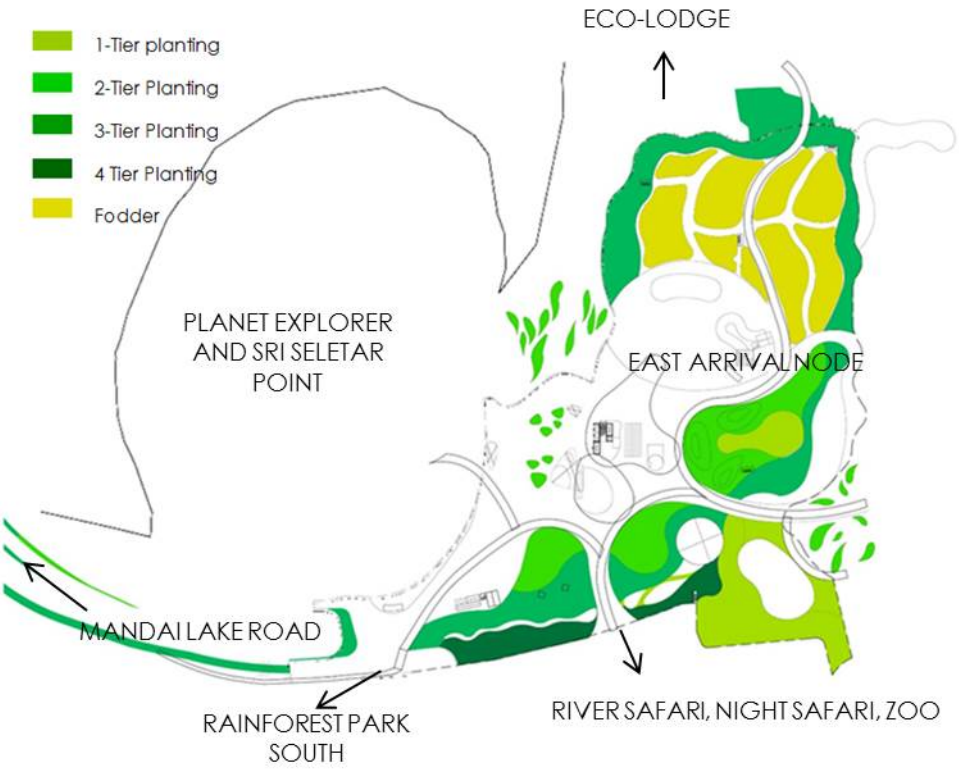
The *East Arrival Node* (*Forest Courtyard*) will consist of a garden deck over a new basement car park. Visitor amenities at the *East Arrival Node* will include:

- Ticketing and membership areas;
- F&B facilities;
- Landscape areas – gardens, terraces and lawn areas;
- Event space;
- Play areas;
- Sanitary areas; and
- Fodder areas.

The landscaping strategy for the *Forest Gateway* is similarly applied to the *Forest Courtyard* as illustrated in *Figure 2.8.* With guidance from the Forest Restoration Plan (*Annex 15*), multi-

tiered planting will be used to allow for gradual transition from the existing surrounding forest to be retained, promoting opportunity for eco-connectivity across the deck. The 4-tier planting along the southern edge of the deck serves as a buffer to these adjacent existing mature secondary forests to reduce edge effects and discourage high human activity in those areas. Trees will be planted in clusters with a minimum edge to area ratio to maintain quality of microhabitats. The stretch of 3-tier plantings consisting of canopy tree species on the deck extends along the boundary of the existing attractions, connecting to the existing mature secondary forest and can potentially serve as a green corridor.

Figure 2.8: Landscape Planting Strategy for East Arrival Node



Source: MPH, June 2016

2.5 *ECO-LINK*

2.5.1 *Eco-Link Masterplanning*

The main philosophy behind the *Eco-Link* is to restore connectivity of the CCNR across the two areas currently separated by Mandai Lake Road (*Figure 2.1*) and reduce impacts from fauna mortality from vehicle strike along Mandai Lake Road. The *Eco-Link* will provide a long term benefit for fauna and flora by enabling movement between habitats thereby providing native fauna with greater access to resources and improving genetic flows.

Following consultation with external stakeholders, the alignment of the *Eco-Link* was designed such that it optimises use of the buffer zone and does not infringe upon the CCNR.

Other key environmental sensitivities identified and design principles integrated into the concept design of the *Eco-Link* are as follows:

- The *Eco-Link* design includes requirements to limit gradients and deck curvature to ensure fauna are able to utilise the deck. The width of the *Eco-Link* has been set at a minimum of 30 m at the ends. The *Eco-Link* will be fenced on both sides and integrated with the overall fencing strategy to ensure fauna do not enter Mandai Lake Road; and

- Forest establishment on the *Eco-Link* is designed to facilitate movement of ground dwelling and arboreal species. Native trees will be planted and planting will be guided by the Forest Restoration Plan (*Annex 15*). Trees will be placed at suitable distances to enable species, such as the Malayan Colugo (*Galeopterus variegatus*), to be able to glide between trees. A multi-layered forest structure will be implemented to facilitate connection and fauna movement.

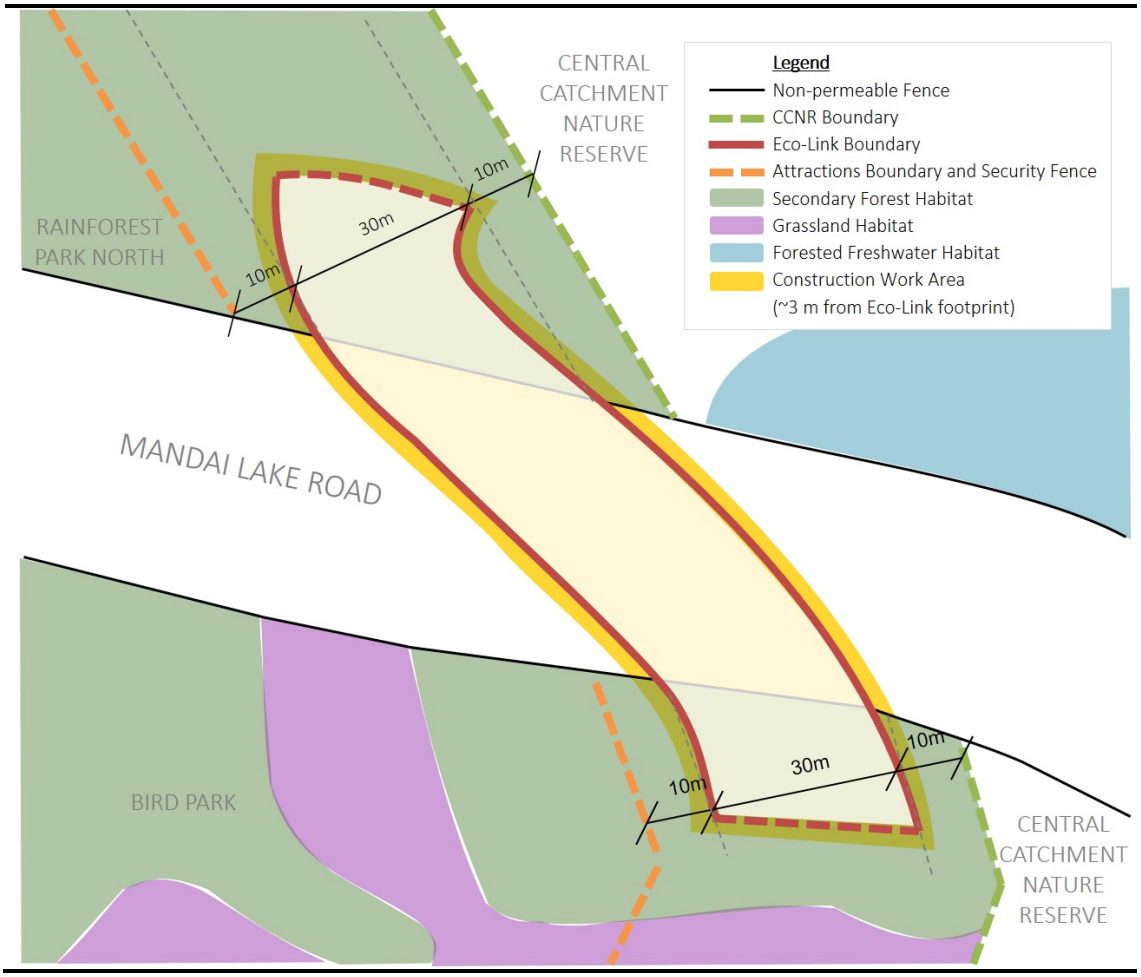
2.5.2 Eco-Link Concept Design

The proposed *Eco-Link* (*Figure 2.9*) connects the north and south side of the CCNR, over Mandai Lake Road, in an alignment that optimises the use of the buffer zones to avoid encroaching on the CCNR. There will be no clearance of vegetation in the buffer except for a construction work area of approximately 3 m from the *Eco-Link* footprint. In consultation with the technical agencies, it is recommended that a setback of 10 m from the *Eco-Link* be maintained from the CCNR to the east in order to minimise construction impacts on the CCNR, and a similar 10 m setback be maintained from the attractions to the west to provide sufficient distance from the attractions during operations so as to minimise noise disturbance on the *Eco-Link*. Given this, the resultant width of the *Eco-Link* will be 30 m at a minimum.

As outlined in *Section 2.5.1*, the planting strategy for the *Eco-Link* will be carefully developed with the aim to provide a conducive and safe passageway for use by aerial, arboreal and terrestrial fauna.

With regards to construction methods for the *Eco-Link*, the use of a reinforced concrete retaining wall on the north side will be less intensive due to the elevated terrain profile, thus reducing the length of the north side landing. Earth cutting of terrain on the southern side of the *Eco-Link* will be necessary for the construction of a retaining wall. Earth cutting works will not encroach on the CCNR. The elevated terrain allows for a gentle slope landing without the need for a heavy structural retaining system. The detailed design of the *Eco-Link* is subject to further studies. As the detailed design of the *Eco-Link* develops, MPH will work with the technical agencies to study how the width of the *Eco-Link* could be further widened. MPH will also work with the relevant authorities to demarcate CCNR boundaries on site prior to construction and ensure that works and activities associated with the *Eco-Link* construction will not encroach into the CCNR.

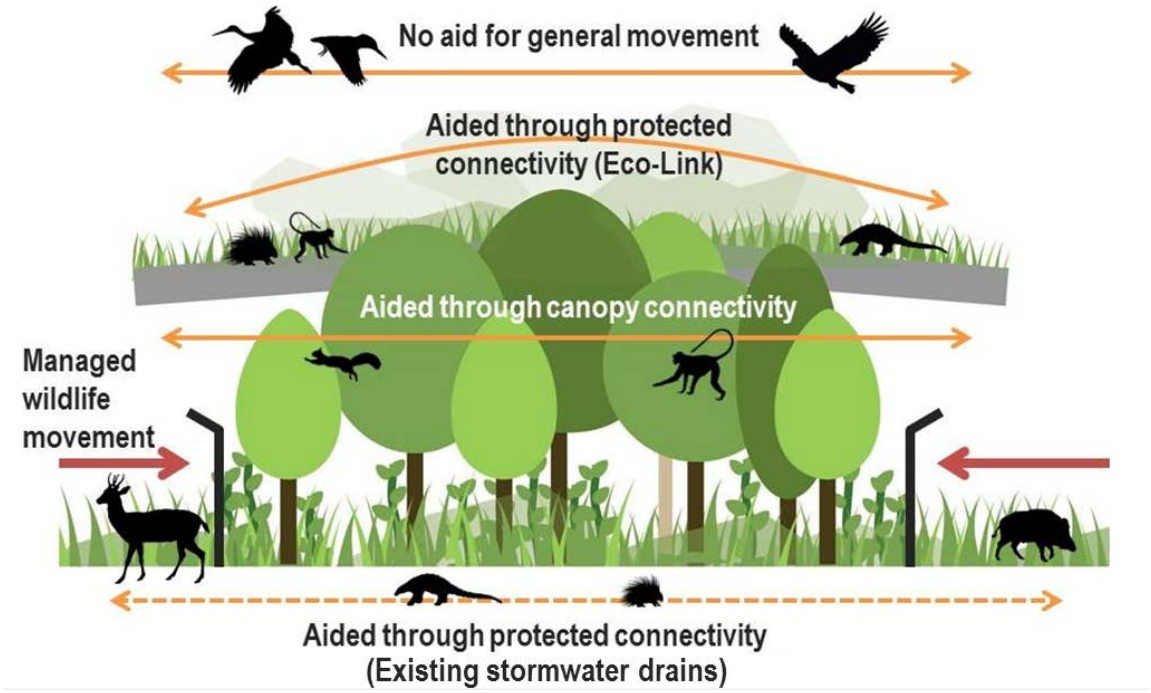
Figure 2.9: Eco-Link Concept Design



Source: MPH, July 2016

To supplement the connectivity provided by the *Eco-Link* (*Figure 2.10*), the Project will include rope bridges across Mandai Lake Road and roadside planting along Mandai Lake Road for arboreal animals. Existing stormwater drains along Mandai Lake Road which cater for the movement of fauna under the road will be maintained.

Figure 2.10: Provisions for Eco-connectivity



Source: MPH, June 2016

2.6 ECO-LODGE

2.6.1 Eco-Lodge Masterplanning

The masterplan concept for *Eco-Lodge* is to provide an environmentally-friendly, short-stay and immersive experience for visitors to the attractions.

Key environmental sensitivities identified and corresponding design principles integrated into the concept design of the *Eco-Lodge* are as follows:

- High biodiversity values exist within the adjacent areas (Upper Seletar Reservoir and remnant forest patches within the forest footprint) that contain native dominated secondary forest patches within the existing WRS development. Individual flora species listed as Critically Endangered, Endangered or Vulnerable (SRDB) will be protected within the development footprint where possible;

- The maximum height of the *Eco-Lodge* will be the same as surrounding tree heights to limit shading and edge effects on surrounding forested areas. This translates to around 4 storeys;

- Landscaping will use fast growing pioneer species followed by successional species to maximise habitat value surrounding the *Eco-Lodge*. The use of fencing and vegetative barriers will assist in reducing conflicts between humans and fauna; and

- Species that may negatively interact with visitors such as the Sambar Deer (*Rusa unicolor*) and Wild Boar (*Sus scrofa*) will be prevented from entering the *Eco-Lodge* area by using appropriately designed fencing.

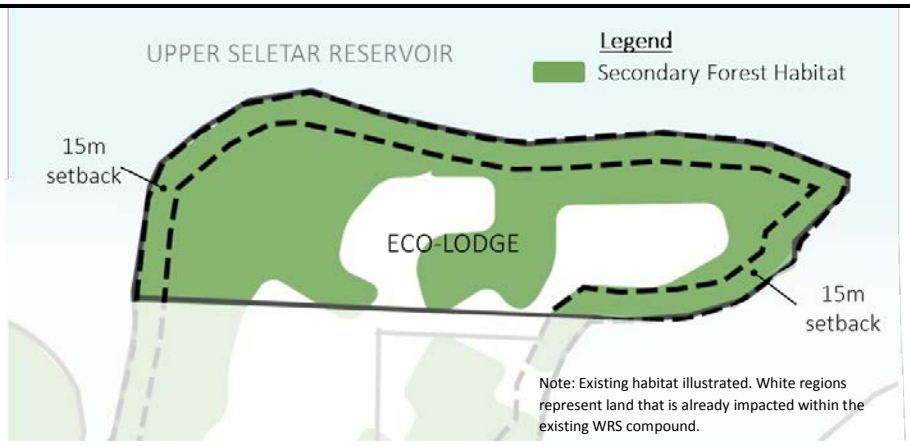
2.6.2 *Eco-Lodge Concept Design*

The *Eco-Lodge* will occupy an estimated 4.65 ha site located adjacent to the Upper Seletar Reservoir within the existing 'Back of House' area of the Singapore Zoo, currently being used as staff quarters, animal holding areas, quarantine and the Wastewater Treatment Plant (WTP). At the time of writing, the *Eco-Lodge* had not been designed and the construction footprint within the site boundary is underdetermined. As details regarding the *Eco-Lodge* are not ready, technical agencies and nature groups will be consulted during the conceptualisation process of the *Eco-Lodge*. This includes seeking approval for the detailed *Eco-Lodge* plan from technical agencies prior to construction. The boundary for the *Eco-Lodge* site is provided in *Figure 2.11*.

The development is envisaged to be built sensitively around existing vegetation, with the goal of preserving and retaining as many of the existing mature trees as possible. The overall building form and height will be low-rise, respecting existing tree lines and well-integrated with the surrounding landscape. A 15 m setback from the reservoir edge will allow for a buffer area of vegetation close to the reservoir to be retained. Up to 400 rooms and family accommodation units will be located within the *Eco-Lodge* site with full-service amenities, including a drop off point, lobby and reception, food and beverage facilities and associated kitchens, banquet and event facilities, activity areas for learning, swimming pool and spa, general management office space, and related ancillary and support facilities. The *Eco-Lodge* will be operational 24 hours a day all year around to accommodate guests. As such, lighting will need to be in place 24 hours a day for safety and security purposes.

Areas for camping and similar activities, and related support facilities, will be designated in and around the attractions. These areas will cater to conservation, research and education needs and will be operational based on demand.

Figure 2.11: Eco-Lodge Site Boundary



Source: MPH, May 2016

Note: At the time of writing, further details on the Eco-Lodge footprint were not available. Existing habitat illustrated.

2.7 PLANET EXPLORER AND SRI SELETAR POINT

2.7.1 Planet Explorer and Sri Seletar Point Masterplanning

The *Planet Explorer* and *Sri Seletar Point* facility was originally planned to be built as separate buildings on two sites along the reservoir edge. The plan was changed to combine both into a single facility to reduce the building footprint to minimise impacts to areas of primary and mature secondary forests. Of particular concern were impacts on a patch of primary and mature secondary forest identified to the west of the proposed *Planet Explorer* and *Sri Seletar Point* (see *Figure 2.12*).

The reduction in footprint of the development will minimise edge effects on surrounding forests and open landscaped areas will be available for use by species of conservation concern. Building colours will be used to blend into the surrounding environment and reduce reflective capacity and the building lighting will be carefully planned such that it will be directed away from the sensitive forested areas. Edge effects from these buildings will be reduced by maintaining moisture differentials by the selective use of canopy structures and forested areas.

Key environmental sensitivities identified and corresponding design principle integrated into the concept design of *Planet Explorer* and *Sri Seletar Point* are as follows:

- The area is adjacent to an area of disturbed primary forest and mature secondary forest located to the west of the proposed *Planet Explorer* and *Sri Seletar Point* development boundary. Originally this area was slated for development. This area will now be avoided and no development will occur within this area;

- There are Critically endangered, Endangered and Vulnerable SRDB and International Union Conservation of Nature and Natural Resources (IUCN) listed Endangered flora species including important Dipterocarp species: *Shorea ovalis ssp. ovalis* and *Shorea macroptera*. The principles used for the design involved minimising the footprint of structures that would require clearing to retain all important flora species;

- Landscaping will use fast growing pioneer species followed by successional species to maximise habitat value surrounding the *Planet Explorer* and *Sri Seletar Point* area to minimise edge effects on the disturbed primary forest. Open landscaped areas will be available for use by important fauna when transiting the areas. The use of fencing and vegetative barriers will assist in reducing conflicts between humans and Project components with fauna; and

- Species that may interact with visitors such as the Sambar Deer (*Rusa unicolor*) and Wild Boar (*Sus scrofa*) will be prevented from entering the *Planet Explorer* and *Sri Seletar Point* area by using appropriately designed fencing.

2.7.2 *Planet Explorer and Sri Seletar Point Concept Design*

Planet Explorer and *Sri Seletar Point* (*Figure 2.12*) will be indoor educational areas located on a 1.56 ha plot. This structure will be 3 storeys high. The peak day visitorship for *Planet Explorer* and Sri Seletar Point is projected to be approximately 25,200. The attractions will be opened daily from 08.00 to 21.00 and broadly consist of the following:

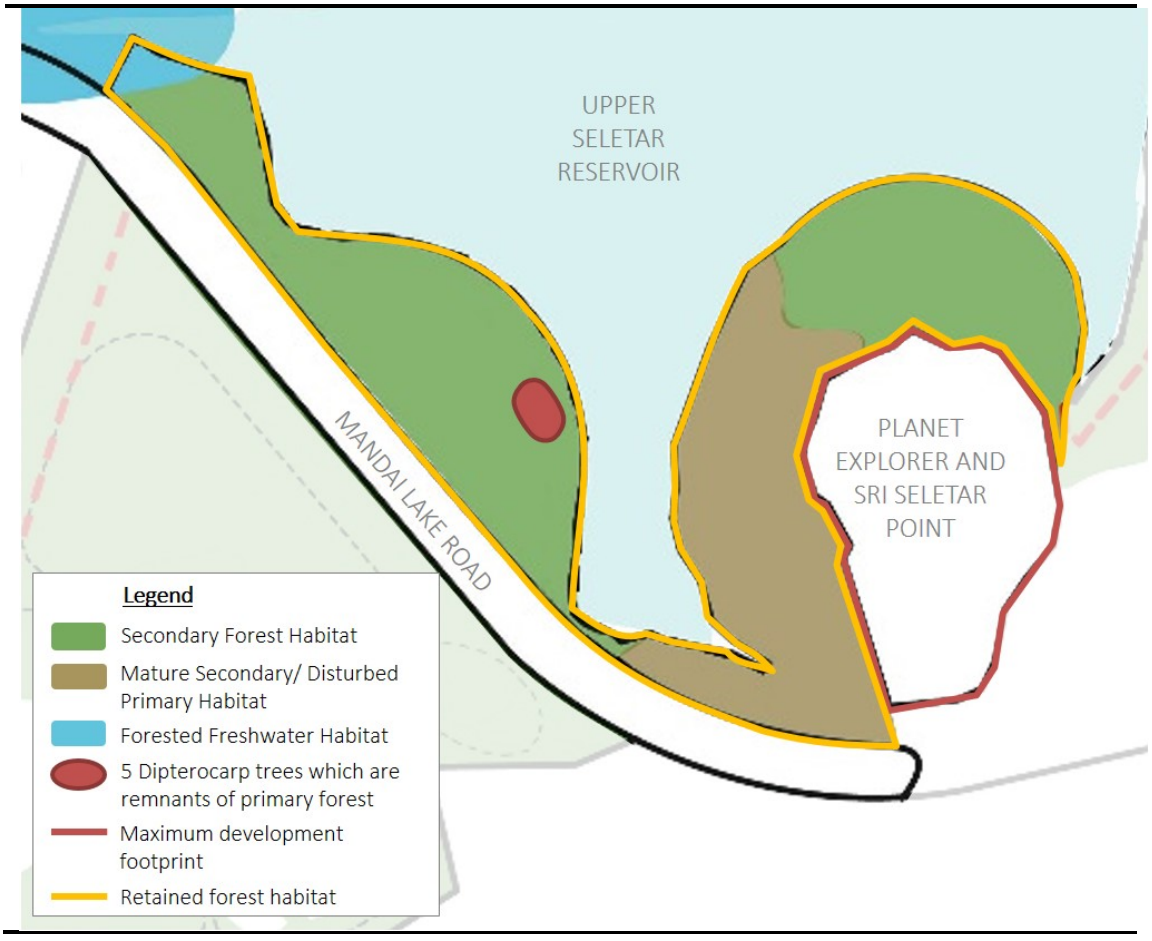
- Museums and Exhibition Building housing an indoor nature-themed entertainment hub, exhibition galleries for permanent and temporary exhibitions showcasing conservation, sustainability, natural sciences, and biodiversity themes.

- Meetings, Incentives and Conferences
  - Function Rooms to host events, workshops, breakout sessions or mini lectures; and Training Rooms for staff and vets from visiting zoos.

- Educational Facility
  - Forest Kindergarten to hold conservation classes for young children.

- Ancillary Facilities for Planet Explorer and Sri Seletar Point
  - Library;
  - Retail stores; and
  - Offices for staff.

Figure 2.12: Planet Explorer and Sri Seletar Point Development Boundary



Source: MPH, June 2016

2.8 RETAINED FORESTS, BUFFERS AND SETBACKS

As outlined in *Section 2.7*, an area with important forest values that has been identified is the disturbed primary and mature secondary forest located to the north and west of the *Planet Explorer and Sri Seletar Point*. This area is indicated in *Figure 2.13* as 'Retained Forests', and the area will be retained to protect its significant environmental value and there will be no development or activities within this area throughout the Project's construction and operation phases.

Buffer zones will be established within the *Rainforest Park North* and *Bird Park* immediately adjacent to the western boundary of the CCNR, in consideration to the important forest values (i.e. mature secondary forest dominated with native flora) along the eastern boundary of the *Rainforest Park North* and *Bird Park* sites, and to mitigate the potential impact of edge effects on the CCNR. With reference to *Figure 2.3* and *Figure 2.4*, the width of the buffer will be 50 m in the first 200 m segments to the north and south of Mandai Lake Road as the adjacent CCNR is narrower in these areas. Beyond the first 200 m segments, the adjacent CCNR is wider and the width of the buffer will be 45 m.

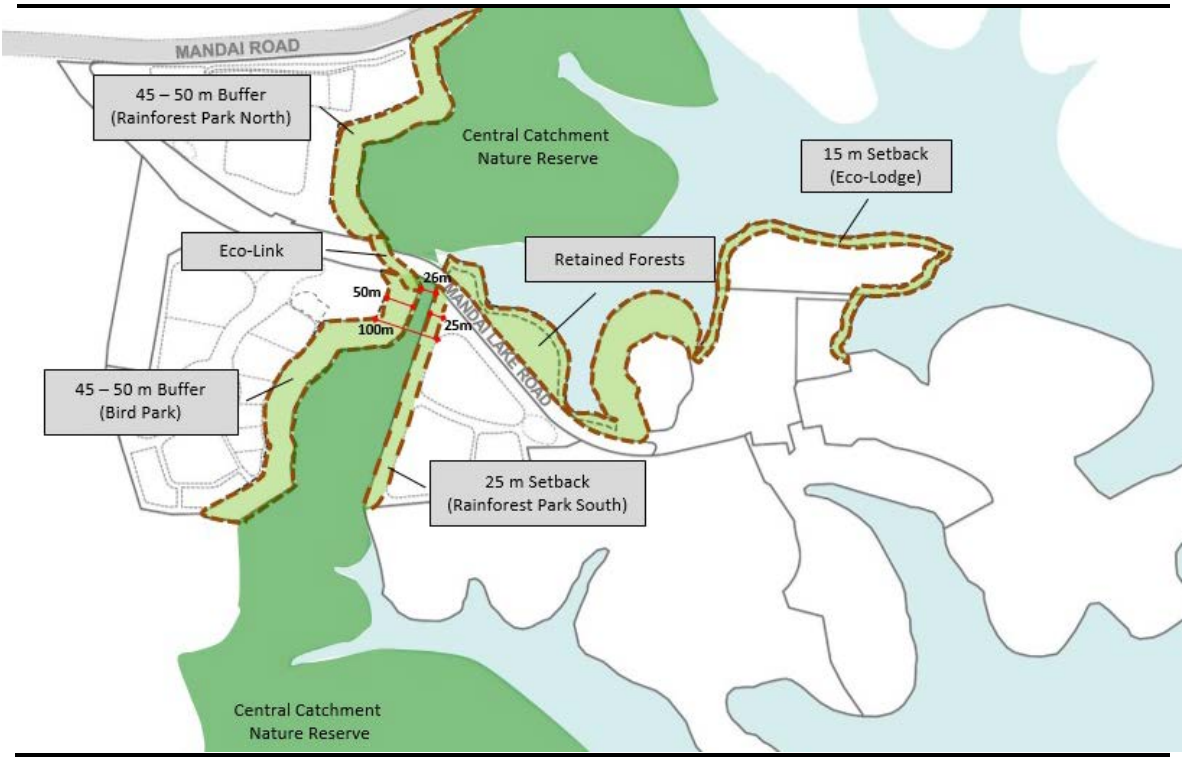
In addition to the buffers, MPH has proposed to introduce a 25 m wide setback from the eastern boundary of the CCNR within the *Rainforest Park South* as part of the repurposing of the existing *Night Safari*. A 15 m wide setback from the reservoir edge will also be provided for the *Eco-Lodge* site, so as to protect the land-water interface and provide continued connectivity along the edge of the Upper Seletar Reservoir.

Figure 2.13 illustrates the location of the CCNR, and the proposed retained forests, buffers and setback areas adjacent to the CCNR. With the establishment of the buffers and setback areas adjacent to the CCNR, the nature corridor will be widened to around 100 m at its narrowest point.

Prior to the start of construction, MPH will work with the relevant authorities to demarcate the boundaries of the CCNR, as well as the boundaries of the 45 – 50 m wide buffers and 25 m wide setback adjacent to the CCNR. The boundaries of the CCNR will be marked with either stone markers or pegs, which can be installed manually without vehicular entry and the use of heavy machinery or equipment. MPH will engage NParks on the design of the marking/pegs, as well as when the marking/pegging is carried out on the ground.

Apart from the construction of the *Eco-Link*, there will be no construction activities within the buffers and setback adjacent to the CCNR during the Project's construction phase. During the operation phase, there will be no visitor activities within the buffer and setback areas adjacent to the CCNR.

Figure 2.13: Retained Forests, Buffers and Setbacks



2.9 INFRASTRUCTURE AND SUPPORTING FEATURES

2.9.1 Back of House / Support Areas

The existing WRS Back of House areas (*Figure 2.14*) (such as the animal quarantine, animal holding areas, sewerage treatment plant, staff quarters, horticultural nursery etc) are located in land identified to house the future public amenities and the *Eco-Lodge*. It is proposed that these are relocated and redesigned to better optimise the available land within Mandai and to facilitate operations of the Project. Existing facilities such as the veterinary hospital, electrical substations, and the WTP will be upgraded and/or replaced to meet the needs of the new development.

Figure 2.14: Existing Back of House Areas

Source: MPH, March 2016

In summary, the Back of House and Support areas will consist of the following:

- A new 0.6 ha animal breeding facility located adjacent to the *Eco-Lodge*;
- A corporate and learning campus that consists of a cluster of low-rise buildings housing the corporate offices for the new Mandai precinct, learning facilities targeted at primary and pre-school children and also the Forest Kindergarten. The current corporate office will be refitted to accommodate some of these learning facilities, while others would be in newly built structures in the vicinity. The buildings will be setback 15 m from the water's edge and will not exceed 4 storeys in height;
- Animal quarantine area near to the main entrance road from Mandai Road, at the Rainforest Park, approximately 0.4 ha in land size, which will serve as an area to contain new animal arrivals;
- Construction of new animal clinic and treatment facilities to serve the needs of all 5 animal parks. This consists of a new animal hospital with additional animal treatment facilities, integrated with research, conservation and educational facilities, the *Bird Park* avian hospital, and small treatment facilities in *Rainforest Park's* Rehabilitation Centre for native fauna;
- Upgrade of the existing Integrated Services Building close to the *East Arrival Node* into a Central Animal Kitchen;
- New storage and maintenance facilities below the landscape deck in the *Arrival Nodes* to house operational supplies and retail merchandise, park operations storage and the maintenance workshop that will cater to Back of House requirements;

- Fodder areas in various identified locations in the Mandai precinct which will serve as emergency plant food supplies for some animals totalling 2 ha in area. The remaining fodder will be from off-site;

- Horticultural areas at the *West and East Arrival Nodes* to meet the nursery / fodder requirements for the new and existing attractions;

- At both *West* and *East Arrival Nodes*, staff will be able to access facilities such as changing rooms, showers, lockers, lunch and rest areas. These areas will accommodate both existing zoo staff and the expected increase in staff associated with the new attractions;

- The existing WTP will be decommissioned and replaced by new facilities. The current plan is to co-locate a new WTP within the carpark structure in the *West Arrival Node* and a new WTP within the basement in the *East Arrival Node*; and

- A new electrical substation will be located within the carpark structure at the *West Arrival Node* in conjunction with the authorities to facilitate supply of electricity for the increased load of the new operations.

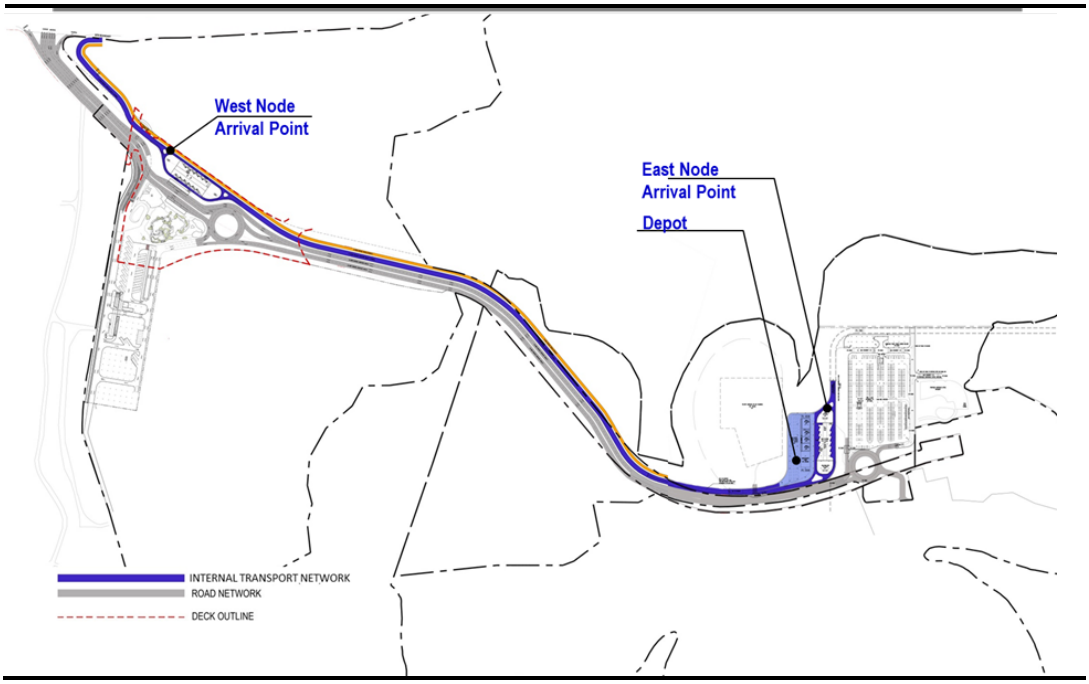
2.9.2 Transportation & Parking

Expanded parking will be provided to cater for additional visitors to the new attractions. The current concept plan includes parking at both the *East* and *West Arrival Nodes*, providing approximately 2,450 car parking spaces. The car parking will be located in the basement underneath the deck at the *East Arrival Node* and in a multi-story structure above the coach bays and Back of House facilities at the *West Arrival Node*.

The existing Mandai Lake Road may be widened but kept within the existing 30 m road reserve. There will be no encroachment upon the CCNR (at all times, during the operation and construction phase) from the eventual widened road as well as all related construction activities. The road reserve will accommodate pedestrian and cycling pathways, resting nodes and a corridor for an internal People Mover System (PMS) which will shuttle visitors between the *West* and *East Arrival Nodes*. The arrival points within the *West* and *East Arrival Nodes* as well as the internal PMS transport network are illustrated in *Figure 2.15*. Portions of the road will be covered by a garden deck that forms the *West Arrival Node*, and also be bridged over by the *Eco-Link*.

While the specific technology for the internal PMS has not been decided, some potential requirements for the system have been identified at the time of writing. The system to be implemented will likely be road-based, light on infrastructure and potentially automated. There is also potential for the PMS to be battery-powered, hence minimising the impact on the environment in terms of air and noise pollution as well as potential contamination risks from fuel and oil spillage. The internal PMS arrival points and depot will be located beneath the arrival decks.

Figure 2.15: Arrival Points within West and East Arrival Nodes



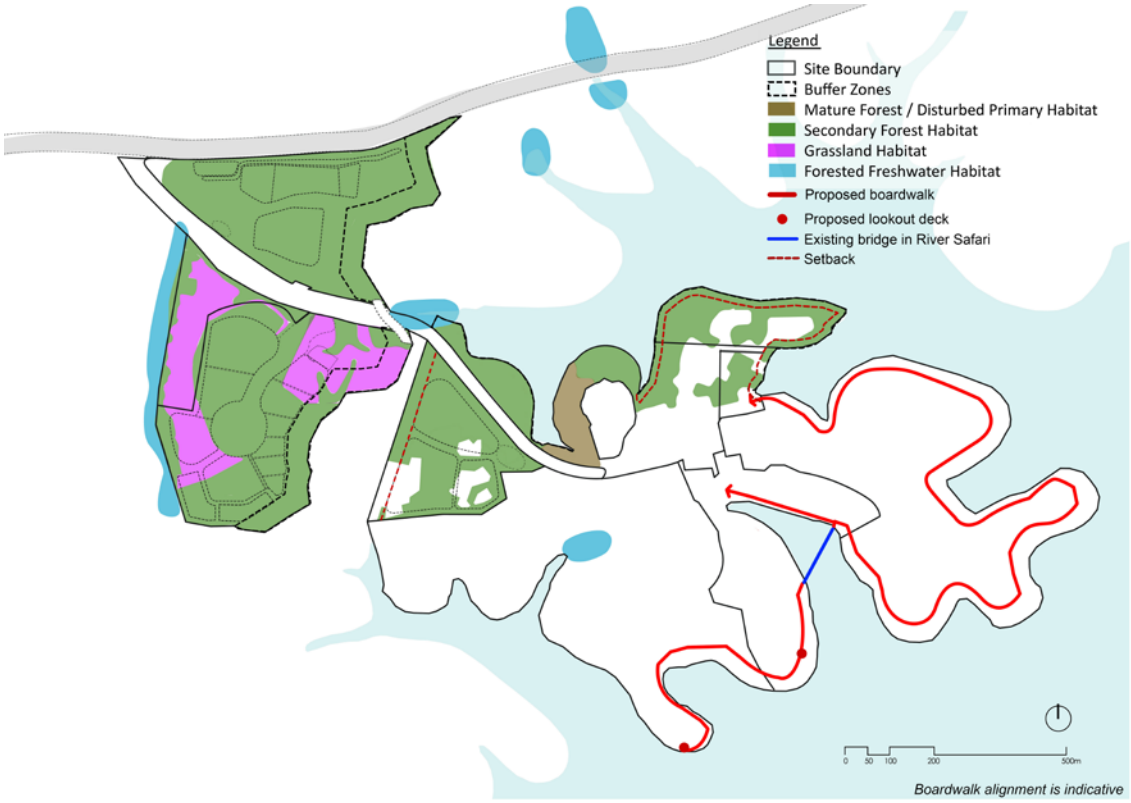
Source: MPH, May 2016

2.9.3 Boardwalk

A longer boardwalk system was originally planned around the entire reservoir edge to allow ungated public access to enjoy the reservoir scenery. The plan was changed to remove the stretch of boardwalk planned along the edge of the *Planet Explorer* and *Sri Seletar Point* facility to avoid any impact on the patch of primary and mature secondary forests identified as illustrated in *Figure 2.16*. The boardwalk around the *Night Safari* has also been shortened to avoid impact to sensitive vegetated areas along the edge of the reservoir.

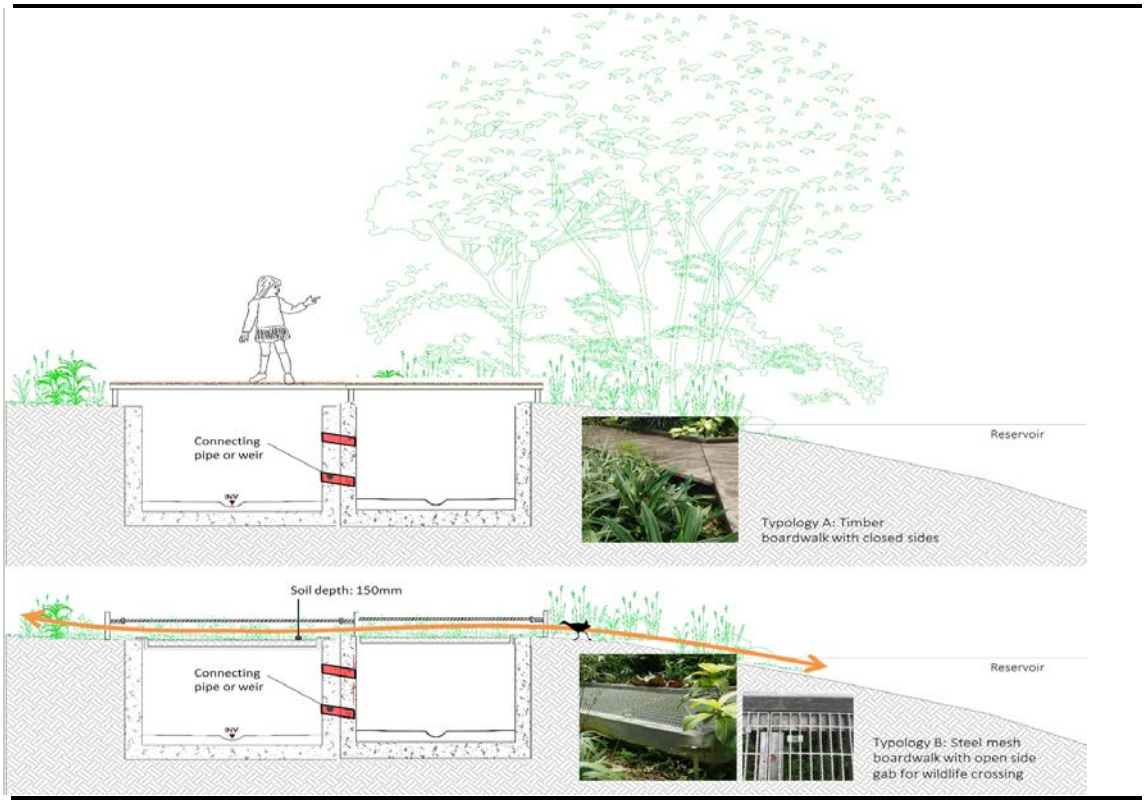
The proposed boardwalks are planned within the land boundary of the *Singapore Zoo*, *River Safari* and part of the *Night Safari*. The boardwalk will be constructed with pre-cast and pre-fabricated material, which will require only installation on site. With reference to *Figure 2.17*, the majority of the boardwalk will span over existing and upgraded drains around the *Singapore Zoo* and existing drains of the *Night Safari* (with the exception of a short segment that will be upgraded), varying from 2 m to 3 m wide. This will minimise the construction footprint and the need to clear vegetation, while facilitating animal movement across the open drain. A segment of the boardwalk will connect to the existing bridge (*Figure 2.16*). In case of the need for realignment due to localised site constraints, approvals from relevant agencies will be sought. Should any modifications be required to the existing bridge (*Figure 2.16*), relevant approvals will be sought from the authorities.

Figure 2.16: Boardwalk



Source: MPH, June 2016

Figure 2.17: Cross Section of Boardwalk



Source: MPH, May 2016

2.9.4 Drainage Infrastructure

Currently, stormwater runoff from the majority of the existing attractions (i.e. *Singapore Zoo*, *Night Safari* and *River Safari*) is collected in 4 open channel perimeter drains located at the *Night Safari, River Safari, Singapore Zoo* and Back of House areas. The design of the future stormwater and effluent discharge system will be developed in accordance with PUB's *Code of Practice for Surface Water Drainage*. PUB requirements for water quality management to control the risk of water quality impacts due to overflows to the Upper Seletar Reservoir will also be taken into account.

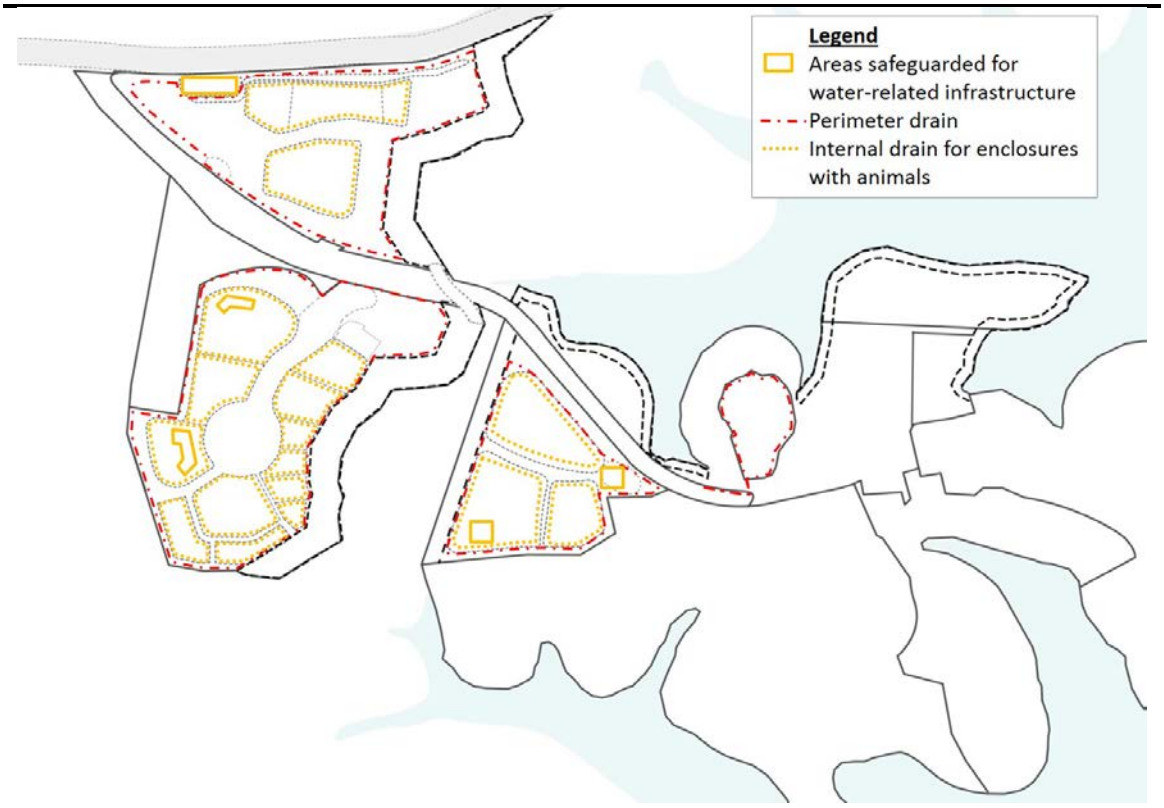
The future stormwater system will integrate the existing and new drainage infrastructure and be designed to contain site runoff from both existing and future attractions based on agencies' requirements and discharge it to an approved discharge point, prohibiting any polluted wastewater discharge to Upper Seletar Reservoir. A quantitative water quality risk assessment (the method statement is included in *Annex 16*) will be conducted to inform drainage infrastructure upgrading requirements for the existing attractions at the detailed design stage. Accordingly, the drainage capacity of the new attractions will take reference from the quantitative risk assessment findings of the existing attractions.

Any water that has come into contact with animal waste will be channelled to a WTP via a separate, dedicated collection system for treatment. Treated discharge from the WTP will be conveyed to effluent discharge pipelines and the discharge shall meet the National Environment Agency's (NEA) trade effluent discharge requirements to watercourses.

In total, there will be two (2) WTPs serving the Mandai precinct, each of which will be new and sized at 3,500 cubic meters per day (cmd): One is currently planned to be co-located within the carpark structure at the *West Arrival Node* that will receive stormwater runoff from animal enclosures in the *Bird Park* and *Rainforest Park North*; the other is currently planned to be located within the basement of the *East Arrival Node* to receive stormwater runoff from animal enclosures at the *Rainforest Park South, Singapore Zoo, Night Safari* and *River Safari*. The existing WTP which currently receives stormwater runoff from animal enclosures at the *Singapore Zoo, Night Safari* and *River Safari* will be decommissioned after the new WTP at the basement of the *East Arrival Node* becomes operational.

Figure 2.18 shows the areas safeguarded for water-related infrastructure within the new attractions to capture runoff from animal enclosures.

Figure 2.18: Areas Safeguarded for Water-Related Infrastructure



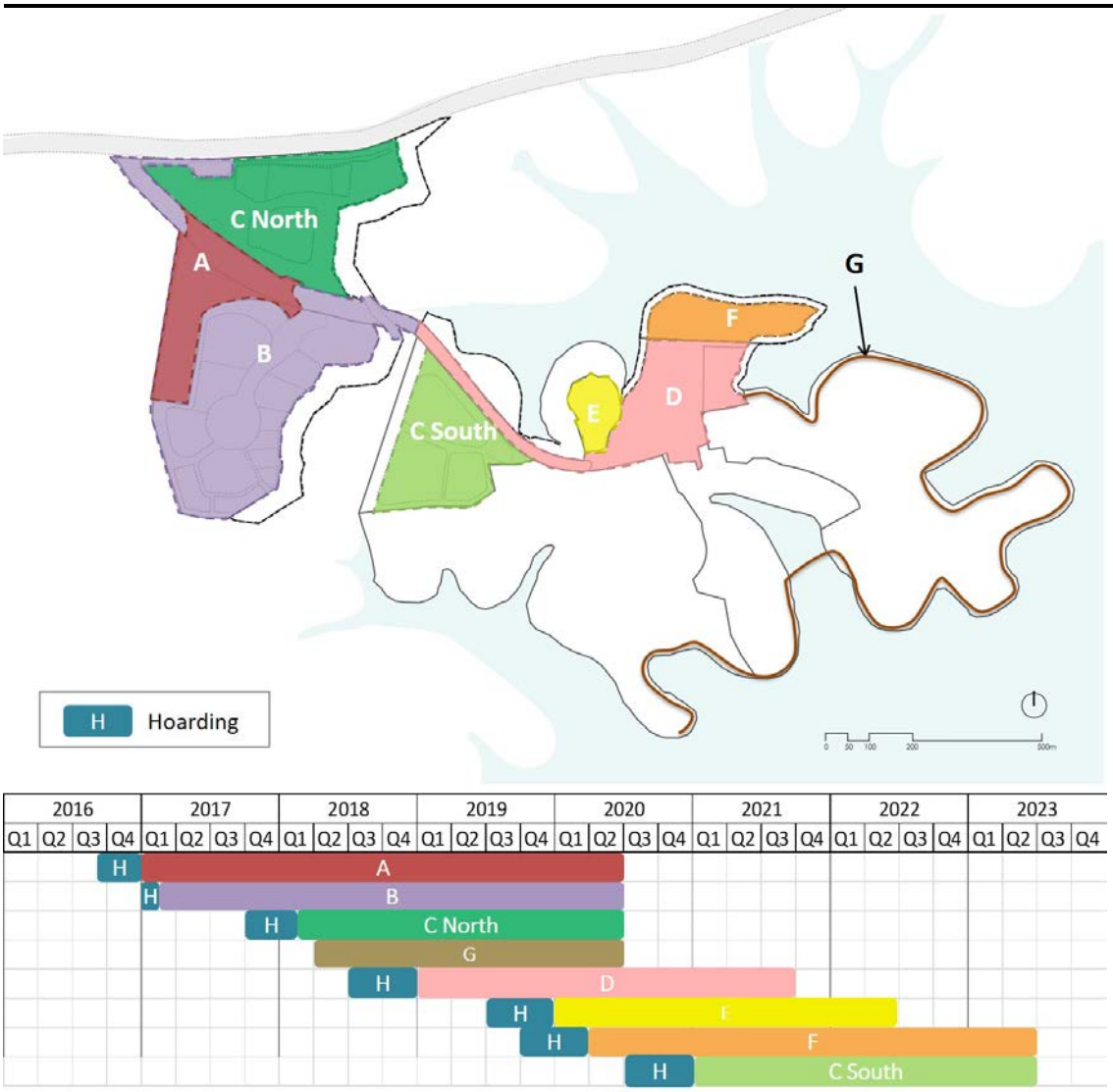
Source: MPH, June 2016

2.10 CONSTRUCTION PHASE

2.10.1 Construction Schedule

Construction for each phase will be broken down into packages based on operational requirements of existing and planned attractions, as well as anticipated contractors' capabilities and specialisation. Indicative construction phasing and construction package boundaries are shown on *Figure 2.19*. There will be no overnight construction activities as the default plans of the development. Should there be an emergency need for construction activities outside of the zoo operating hours, MPH will seek prior approval / clearance necessary from NParks.

Figure 2.19: Indicative Construction Phases



Source: MPH, June 2016

Note: Package A refers to only piling works for the *West Arrival Node*. Actual construction for the *West Arrival Node* will take place together with Package B.

2.10.2 Principal Construction Activities

Typical pre-construction and construction activities associated with development of the Project will include the following:

- Geophysical works for engineering design of building structures;
- Vegetation clearance and topsoil removal and storage;
- Utility diversions by utility companies;
- Road diversions, if required, in compliance with authority requirements;
- Laydown and storage area set-up (may include raw material storage, waste storage, concrete batching plants, hazardous material storage areas etc);

- Groundwater interceptor drains at areas where underground structures are to be developed;
- Set up of site offices;
- Provision of slope protection along the existing Mandai Lake Road, along the periphery of the Upper Seletar Reservoir adjacent to the *East Arrival Node* and potentially near an unnamed road along the Project western boundary;
- Demolition of existing Back of House facilities within WRS land;
- Site levelling and excavation works, e.g. for underground structures;
- Construction of all aboveground and underground structures;
- Replacement of the existing WTP;
- Modifications to Mandai Lake Road;
- Modifications to existing surface water drainage at the *Singapore Zoo* using efficient designs to minimise overland flow;
- Construction of new boardwalk and walking trails;
- Planting of vegetation in *Rainforest Park*, *Bird Park* and other areas;
- Establishing water features (e.g., fountains, waterfalls and ponds) within *the Bird Park, Rainforest Park* and *Arrival Nodes*;
- Connection of new sewer system to convey human waste to the existing PUB public sewer line; and
- Construction of perimeter fencing and netting over the aviaries.

2.10.3 Ancillary Facilities

Ancillary facilities required to support the construction phase will include:

- Site office;
- Portable sanitary facilities for construction workers, provided and maintained by a licensed third party waste contractor;
- Electrical and water supplies will be from mains supply, in agreement with the authorities;
- Raw material and equipment storage areas; and
- Temporary waste storage areas.

2.10.4 Manpower

The construction workforce will live at an off-site construction worker dormitory and transportation provided daily to bring personnel to and from the site. The number of workers onsite at any one time will vary throughout the construction phase. For example, during mechanical and electrical installation works it is anticipated that up to 350 personnel would be required, while the construction and civil workforce would be around 750. The peak construction workforce will be an estimated 6,000 workers.

2.10.5 Equipment

A significant quantity of construction vehicles and equipment will be required for the construction phase. The details for these resource requirements will be developed following detailed engineering and finalised by the construction Contractors, however will include equipment types as outlined in *Table 2.1.*

Table 2.1: Typical Construction Vehicles and Equipment

Typical	Vehicle / Equipment		
Clearance Utility diversions Demolition Piling Structure construction Reinstatement	• Excavator • Dump trucks • Generators • Road Ripper • Materials hoist • Air compressor • 360 Excavators • Jack hammer	• Cranes • Bar Bender & Cutters • Poker Vibratory • Bored piling rig • Lorries • Compactor and Roller • Vibratory Poker • Water Pump	• Water Cart • Bulldozer • Crawler Cranes • Dump Trucks • Asphalt Truck • Grinders • Concrete saws • Paver

2.10.6 Fuel, Chemicals and Raw Materials

Resources which will be required for construction works and which will be stored at laydown areas typically include chemicals and hazardous substances (as defined in the *Environmental Protection and Management (EPM) (Hazardous Substances Regulations, 2009*)) comprising of diesel, thinner, paint, lubricants, hydraulic oil, solvents; compressed gases such as acetylene and oxygen; and raw material such as cement and aggregates for concrete works, crushed stone, asphalt and bituminous materials for road works and steel rebar.

2.10.7 Power Supply

During construction, electrical power will be sourced from generators. The amount of power required or number of generators required will depend on the construction methods required and be developed at the detailed design phase of the works. Based on similar projects, it is anticipated that generators will be required to provide between 100 KVA and 1,000 KVA during the construction phase.

2.10.8 Water Supply

The construction activities outlined will require the use of water for dust suppression, concreting, potable use, sanitary facilities, recharging of groundwater etc. Water required for construction will be drawn from the mains in accordance with approvals from the authorities.

2.10.9 Lighting

Lighting requirements during the construction phase will be designed to primarily provide safety and security to the workforce. Requirements will be developed to align with Singapore code of practices, such as *SS531*, and construction risk assessments. Where feasible, without jeopardising safety and security, temporary lighting for construction works will be positioned so as to reflect away from natural habitats surrounding the area.

2.10.10 Waste Management

Waste types likely to be generated during construction include:

- Excavated earth / spoil generation for creation of building foundations and from site levelling activities. Using conceptual designs available for the Project, an estimation of the volume of excavated earth / spoil material that could be generated at the site is detailed in *Table 2.2*. Where possible the excavated material will be reused on-site or transported by licensed waste contractors to an approved waste management facility;

- Construction design of excavation works (e.g. underground carpark areas) will be such that groundwater ingress will be minimised as far as possible. In the event, however, groundwater seeps into excavated areas, appropriate monitoring should be in place to ensure that the wastewater produced meets the standards stipulated within the *EPM (Trade Effluent) Regulations*, prior to discharge into a nearby surface water drainage system. Additionally, a written permission will be obtained from the NEA prior to any discharge into a drain, in accordance with the *EPMA 2008*;

- Wastewater from wheel washing activities and stormwater runoff will be contained as far as possible and discharged to existing stormwater drains. All stormwater / surface run-off from the construction site will be properly managed in accordance with the *Sewage and Drainage Act*, including a PUB approved *Earth Control Measures Plan*;

- Waste from tree felling activities and vegetation clearance will be removed to a horticultural waste receiving facility;

- Domestic refuse, including food packaging will be bagged, temporarily stored on site in dedicated enclosed areas and removed daily;

- Sewage from temporary sanitary facilities. These will be provided and managed by a licensed third party sanitary waste contractor; and

- Toxic Industrial Waste, e.g. packaging such as empty bags, drums and containers used to contain chemicals will be temporarily stored in dedicated areas and disposed of via licensed third party toxic industrial waste collectors.

Table 2.2: Anticipated Volume of Excavated Material / Spoil Material Requiring Disposal

Structure	Number of Basement Levels	Approximate Depth (m)	Volume of Excavated Material* (m^3)
West Arrival Node and carparks	2	9	376,014
East Arrival Node and carparks	2	9	652,235
Eco-Lodge	1	4.5	175,238
Planet Explorer / Sri Seletar Point	2	9	231,182

Note:
*Based on concept design estimates and subject to change

2.10.11 Emergency Planning

Engineering and construction contractors will be required to develop and implement emergency planning measures required by the following regulatory requirements to safeguard the environment and worker health and safety:

- *Building Control Act;*
- *Control of Vectors and Pesticides Act;*
- *Code of Practice on Surface Water Drainage;*
- *Environmental Protection and Management Act;*
- *Environmental Public Health Act;*
- *National Heritage Board Act;*
- *Parks and Trees Act;*
- *Preservation of Monuments Act;* and
- *Sewerage and Drainage Act.*

2.11 PROJECT OPERATIONS

2.11.1 Projected Visitation

The current *Singapore Zoo, Night Safari* and *River Safari* attract an average of 10,500 visitors daily. By way of comparison, the Singapore Botanic Gardens has a daily visitorship of approximately 12,000.

The new attractions will be opened in two phases. The first phase is targeted to commence operations in 2020 and the second phase in 2023. The projected visitation is expected to increase significantly in the first few years and reach a steady stage in 2036. *Table 2.3* presents the current and the projected visitation levels that have been used as the basis of the concept design development. The increased numbers of visitors will result in a growth of traffic volume. *Table 2.4* outlines the breakdown based on different transportation modes.

Table 2.3: Current and Projected Future Visitation

	Current	Projected (2036)
Annual Visitation (to gated areas)	3,830,000	9,870,000 [1]
Annual Visitation (to non-gated areas)	0	2,400,000
Average Daily Visitation (to gated areas)	10,500	27,100
Average Daily Visitation (to non-gated areas)	0	6,600
Peak Weekend Visitation (to gated areas) [2]	22,500	57,900
Peak Weekend Visitation (to non-gated areas) [2]	0	14100

Notes:

[1] This is a conservative estimate as it includes a 12% buffer.

[2] The 95th percentile is used to estimate peak visitation.

Table 2.4: Breakdown of Current and Future Traffic Volume

Transport Mode	Current	Projected (2036)
Car	24.8%	20.3%
Taxi	32.3%	27.4%
Coach	11.7%	7.2%
Bus	30.3%	43.3%
Motorcycle	0.8%	0.7%
Walking	0.1%	1.1%

2.11.2 Operations Schedule

Prior to operations there will be a period of time for the arrival and settling of animals at the new attractions. The length of time required will vary depending on the species and type of enclosure animals are being introduced to. For the purposes of the indicative schedule, six months is envisaged for this integration phase. Periods of operation for all other areas are detailed in *Table 2.5*.

Table 2.5: Proposed Project Operational Hours

Attraction / Activity	Operational Hours
Rainforest Park	07.00 – 19.00 daily
Bird Park	09.00 – 18.00 daily
Eco-Lodge	24 hours / day
Planet Explorer and Sri Seletar Point	08.00 – 21.00 daily
East Arrival Node	06.00 – 24.00 daily
West Arrival Node	06.00 – 19.00 daily
Nature trails and boardwalk (public areas)	06.00 – 19.00 daily
Back of House	06.00 – 22.00 daily
Security	24 hours / day
Emergency	24 hours / day

2.11.3 Operational Activities

Typical activities associated with the operational phase of the Project will include:

- Cleaning and maintenance of the attractions, buildings and infrastructure;
- Animal integration, welfare and veterinary operations;
- Landscaping and horticultural maintenance;
- Feeding of animals and cleaning of enclosures;

- Research and development;
- Guest services/ Front of House operations;
- Retail, food and beverage outlet operations;
- Sanitary services;
- Waste management including waste treatment plant operations; and
- Management and administration.

2.11.4 Ancillary Facilities

Ancillary facilities required to support operations of the Project include:

- Sub-stations and power distribution system;
- Stand-by power generators;
- Water holding and pressure booster systems;
- Fire alarm / control systems;
- Storage areas;
- Quarantine;
- Off-exhibit holding areas;
- Animal breeding area;
- Veterinary services;
- Plant nursery;
- Fodder crop plantation;
- Maintenance and vehicle workshops;
- Security barriers, command post, command centre;
- Sewerage collection and treatment system;
- Pollution control systems (e.g. storm water drainage interceptors);
- Vehicle park;
- Staff welfare facilities (office, changing and rest areas); and
- Information Technology.

2.11.5 Manpower

It is anticipated that an additional 900 staff will be required to manage and oversee operations at the new attractions.

2.11.6 Fuel, Chemicals and Raw Materials

Fuel and chemicals will be required during operations, for example for on-site vehicle and motorised equipment use; and chemical additives for the WTP. Fuel and hazardous materials will be stored and used in accordance with both the manufacturer's recommendations and requirements of the authorities, such as Singapore Civil Defence Force (SCDF).

Specific details on equipment, fuel, chemicals and raw material requirements will only be available following detailed design of the Project.

2.11.7 Power Supply

The power supply for operations will be drawn from the Singapore Power grid. A new electrical substation will need to be constructed.

2.11.8 Water Supply

During operations, raw water will either be supplied from the Upper Seletar Reservoir or from the PUB mains supply. Water supply infrastructure and quantities will be ascertained during detailed engineering and the operational requirements agreed with PUB.

2.11.9 Lighting

External lighting arrangements will be under the purview of the Land Transport Authority (LTA) in accordance with safety requirements first and foremost. Where needed for safety or operational reasons lighting will be installed in such a way as to be sympathetic to the animal requirements and be energy efficient as much as possible, such as using Light Emitting Diode (LED) lighting and control systems. The anticipated lighting requirements developed at detailed design, will consider the operational hours as outlined in *Table 2.5*.

2.11.10 Waste Management

Waste types expected to be generated during operation of the Project including the following:

- Horticultural wastes will be removed from the Project by a horticultural waste contractor for disposal at a receiving facility or used to generate compost for use on-site;
- Stormwater runoff from roads or public areas (non-animal contact) will be routed to the roadside drains for ultimate discharge outside water catchment areas;
- Human waste from the new attractions / public areas will be connected to the new PUB public sewer along Mandai Road. Animal waste and used water from animal contact / enclosure will be routed to the new and upgraded WTPs;
- General wastes, including domestic refuse such as food packaging, will be temporarily stored on site in dedicated enclosed areas and removed by a licensed domestic general waste receiver daily; composting may be explored for food waste; and
- Toxic Industrial Waste (TIW), e.g. packaging such as empty bags, drums and containers used to contain chemicals will be temporarily stored in dedicated areas and disposed of via licensed third party TIW waste collectors.

3 ADMINISTRATIVE FRAMEWORK

The administrative framework within which the Project will be designed, constructed and operated is determined by both international conventions to which Singapore is a signatory and national legislation and standards. This chapter presents an overview of international conventions as well as national legislation, standards and policies relevant to the Project. In addition, international guidelines which the Project may adopt for elevated international recognition and compliance are presented herein. MPH's vision and guiding principles for the Project have also been included – these will continue to be instrumental in shaping the development of the Project. Further details, including emission limits and detailed specifications, can be found in *Annex 1*.

3.1 INTERNATIONAL CONVENTIONS

Singapore is a signatory to the following international conventions of relevance to the project:

- Convention on Biological Diversity (CBD); and
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

3.1.1 Convention on Biological Diversity

The CBD is an international treaty that calls for the conservation of biological diversity and the environment. It establishes guiding principles and policies for its signatories, and commits them to developing a national biodiversity strategy and action plan to be integrated into national policy. Singapore signed the Convention in 1992 and formulated the Singapore National Biodiversity Strategy and Action Plan (NBSAP) in 2009. Of particular relevance to the Project is Article 9 from the Convention, *Ex-situ Conservation*. This article provides guidance on the measures to be taken such that the conservation of animals removed from their natural habitats complements conservation efforts undertaken within natural habitats.

3.1.2 Convention on International Trade in Endangered Species of Wild Fauna and Flora

CITES is an international agreement targeted at ensuring that the trade of wild animals and plants does not threaten their survival. Singapore has been party to CITES since 1987, and the Agri-Food and Veterinary Authority (AVA) is the designated authority responsible for administering the CITES licensing system. The CITES Appendices include approximately 5,600 species of animals and 30,000 species of plants [(1)] that require protection from overexploitation. A number of these animal and plant species can be found within and in proximity to the Project area.

[1] Convention on International Trade in Endangered Species of Wild Fauna and Flora (no date) **The CITES Species.** Retrieved from http://www.cites.org/eng/disc/species.php

3.2 NATIONAL POLICIES

3.2.1 National Biodiversity Strategy and Action Plan

The Singapore NBSAP was prepared in 2009 by the National Parks Board (NParks) to fulfil Singapore's commitment as a signatory to the CBD. The NBSAP sets out the principles for conservation of biodiversity in Singapore and calls for greater consideration of biodiversity issues in policy decisions. The NBSAP promotes the conduct of an EIA in the early stages of development projects to assess potential environmental impacts and to avoid or mitigate these to the extent possible.

3.2.2 Nature Conservation Master Plan

Developed and launched in 2015, NParks' Nature Conservation Master Plan (NCMP) outlines Singapore's biodiversity conservation plans for the next five years in order to achieve the vision of a "City in a Garden". The NCMP comprises four aspects, namely: (i) conservation of key habitats; (ii) habitat enhancement, restoration, and species recovery; (iii) applied research in conservation biology and planning; and (iv) community stewardship and outreach in nature[(2)].

The conservation of key habitats involves the safeguarding and strengthening of Singapore's core biodiversity areas by creating buffer areas and enhancing ecological connectivity. To date, NParks has unveiled plans to create green buffers around the CCNR, and establish nature ways and broaden the Park Connector Network (PCN).

Programs for conservation encompass a spectrum of activities including species recovery, with a focus on species that are endemic, native, rare or critically endangered; habitat protection and enhancement with the aim of increasing biodiversity of degraded areas; and management of human-wildlife interaction with species such as the Long-tailed Macaque (*Macaca fascicularis*) and Wild Boar (*Sus scrofa*). NParks' research plan under the NCMP involves conducting comprehensive surveys and long term monitoring of biodiversity. Last but not least the NCMP aims to reach out to the community and encourage greater interest and participation in biodiversity conservation.

3.2.3 Sustainable Singapore Blueprint 2015

The Sustainable Singapore Blueprint (SSB) 2015 outlines Singapore's national vision and plans for a more sustainable and higher quality living environment. It reflects a growing need to balance infrastructure development with the preservation of green spaces for public enjoyment. The SSB sets targets to be achieved by 2030 for six aspects in Singapore: green and blue spaces (i.e. waterbodies); mobility; resources sustainability; air quality; drainage and; community stewardship. These targets aim to adopt best practices in the private, public and domestic sectors to maintain a pollution-free environment in Singapore.

[2] NParks (2015) **Nature Conservation Master Plan.** Retrieved from https://www.nparks.gov.sg/news/2015/6/nature-conservation-masterplan.

3.3 NATIONAL ADMINISTRATIVE REQUIREMENTS

National environmental management requirements that will be relevant to the Project are found in a number of Acts, Regulations and Guidelines. These Acts and Regulations are listed in *Table 3.1*.

Table 3.1: List of Applicable Acts, Regulations and Guidelines to the Project

Environmental Aspect	Applicable Acts, Regulations & Guidelines
Surface Water Protection	• *Public Utilities Act, 2002* • *Public Utilities Act (Reservoirs, Catchment Areas and Waterway) Regulations, 2006* • *Sewerage and Drainage Act, 2001* • *Sewerage and Drainage Act (Surface Water Drainage) Regulations, 2008* • *Environmental Protection and Management Act, 2002* • *Environmental Protection and Management (Trade Effluent) Regulations, 2008* • *Guidebook on Erosion and Sediment Control at Construction Sites* (PUB, 2014) • *Code of Practice on Surface Water Drainage, 6th Edition* (PUB, 2011) • *SS 593: 2013 Code of Practice for Pollution Control* (SPRING, 2014) • *Managing Urban Runoff - Drainage Handbook 1st Edition* (PUB, 2013)
Air Quality Protection	• *Environmental Protection and Management Act, 2002* • *Environmental Protection and Management (Vehicular Emissions) Regulations, 2008* • *Environmental Protection and Management (Air Impurities) Regulations, 2008* • *Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations, 2012* • *Singapore Air Quality Targets (NEA)* • *World Health Organisation Guidelines* • *SS 593: 2013 Code of Practice for Pollution Control* (SPRING, 2014)
Noise	• *Environmental Protection and Management Act, 2002* • *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008* • *Environmental Protection and Management (Vehicular Emissions) Regulations, 2008* • *SS 593: 2013 Code of Practice for Pollution Control* (SPRING, 2014) • SS602:2014 Code of Practice for Noise Control on Construction and Demolition Sites • *World Health Organisation Guidelines*
Fire Safety	• *Fire Safety (Petroleum and Flammable Materials – Exemption) Order, 2008* • *Fire Safety (Petroleum and Flammable Materials) Regulations, 2008* • *CP 5: 1998 Code of Practice for Electrical Installations* (SPRING, nd)
Habitat Protection/ Conservation of Protected Areas	• *Parks and Trees Act, 2006* • *Parks and Trees Regulations, 2006* • *Parks and Trees (Preservation of Trees) Order, revised 1998* • *International Union for Conservation of Nature* (IUCN) *World Commission on Protection Areas* (WCPA) *Guidelines* • *International Finance Corporation Performance Standards and Guidelines* • *Handbook on Tree Conservation & Tree Planting Provision for Development*

Environmental Aspect	Applicable Acts, Regulations & Guidelines
	Projects, (NParks, nd)
Wildlife Protection and Welfare	• *Wild Animals and Birds Act, 2000* • *Wild Animals and Birds (Bird Sanctuaries) Order, 1992* • *Singapore Red Data Book, Second Edition, 2008*
Importation of Animals and Plants • Disease • Endangered Species • Animal Welfare	• *Endangered Species (Import and Export) Act, 2008 (Chapter 92A)* • *Animals and Birds Act, 2002, (Chapter 7)* • *Control of Plants Act, 2000, Chapter 57A* • *Control of Plants (Plant Importation) Rules*
Waste and Hazardous Substances Management Waste Management	• *Environmental Protection and Management (Hazardous Substances) Regulations, 2008* • *Environmental Public Health Act, 2002* • *Environmental Public Health (General Waste Collection) Regulations, 2000* • *Environmental Public Health (Toxic Industrial Waste) Regulations, 2000* • *SS 593: 2013 Code of Practice for Pollution Control* (SPRING, 2014) • *Sewerage and Drainage Act, 2001, Chapter 294* • *Sewerage and Drainage (Trade Effluent) Regulations, 2008*
Vectors and Pesticides Management	• *Control of Vectors and Pesticides Act, 2002*

3.4 GOVERNMENT AGENCY REQUIREMENTS

Extensive consultation has been undertaken with relevant Singapore government agencies and some have listed specific requirements for the Project.

Table 3.2: Project-Specific Regulatory Requirements

Recommended Planning Principles/ Guidelines	Justifications
Environmental Concerns (Wildlife Issues)	
Mandatory	
Developer must ensure exterior and artificial lighting do not infiltrate or be directed towards the CCNR.	• To ensure animals in the CCNR are not negatively impacted by light pollution. • Cited in consultation with NParks.
Developer must minimize the noise from the proposed development during the construction stage and operations of the development, especially at night.	• To ensure the corridor for wildlife movement in and around the CCNR is not adversely impacted by the development. • To ensure animals in the CCNR are not negatively impacted by noise pollution. • Cited in consultations with NParks.

Recommended Planning Principles/ Guidelines	Justifications
Within 0 – 50 m of the buffer zone adjacent to the CCNR, developments are limited to low impact activities. The exact nature or type of these activities is subject to the results of the EIA, which would be evaluated by the Technical Agencies. Within 50 – 100 m of the buffer zone adjacent to the CCNR, in addition to the low impact activities, developments may include low impact lodging. The exact nature or type of these activities is subject to the results of the EIA, which would be evaluated by the Technical Agencies.	• To ensure the CCNR is not negatively impacted by development. • Ensure very low impact and low volume visitation. • To enhance native wildlife habitat and encourage foraging by native wildlife.
Recommended	
Developer will be encouraged to provide overhead and underpass wildlife crossings for terrestrial and arboreal native animals of the forest and grassland habitats across Mandai Lake Road. Examples of overhead arboreal crossing is to have trees close together such as their spread touch across roads or include cables strung across the road supported by columns for the arboreal species.	• To ensure the existing migration of wildlife for the northern CCNR to the southern CCNR is not negatively impacted. • Reduce native animal 'road-kill' on Mandai Lake Road. • To improve vehicular safety on Mandai Lake Road by reducing the number of animals crossing the road pavement.
Environmental Concerns (Flora)	
Mandatory	
All new planting within the 100 m CCNR buffer zone must be native species.	• To ensure the surrounding CCNR is not degraded by invasive non-native plant species. • To provide forage and shelter for native wildlife species on the site. • To ensure the corridor for wildlife movement in the CCNR will not be adversely impacted. • Cited in consultations with NParks.
Permission from NParks must be obtained before the removal of trees greater than 1 m in girth.	• Cited in consultations with NParks.
Recommended	
New planting proposed in the development site outside of the buffer zone are encouraged to be primarily native trees and plant species attractive to the native wildlife approved by NParks. In the event that non-native species of plants are desirable; a proposed plant list of non-invasive, non-native species should be reviewed and	• To prevent invasive non-native species from degrading the CCNR. • Cited in consultations with NParks.

Recommended Planning Principles/ Guidelines	Justifications
approved by NParks.	
Site Development	
Mandatory	
Developer must recognize that monkeys may disturb their visitors and should undertake preventive measures to address this issue themselves. Preventive measures should still allow other species to move freely in and out of the development.	• Cited in consultations with NParks.
Developer must ensure provision of pedestrian connectivity or a people-mover system between the proposed sites across Mandai Lake Road.	• Cited in consultation with URA.
Recommended	
Developer will be encouraged to be sensitive to the rich biodiversity of the area so as to encourage a native wildlife habitat and enhance the natural character of the site.	• To ensure the development is a leading example of nature-friendly leisure developments. • To ensure the developments encourage long term conservation of the natural environment in Mandai.
Developer will be encouraged to locate and configure development (buildings, roads, carparks, etc) on existing open areas or areas where there has been previous land disturbance. Developer will be encouraged to consider low impact development where there have not been previous disturbances.	• To remove as few trees as possible. • To assure a diversity of habitat types and ecosystem on the development site and ensure that the development is environmentally sensitive to the area's biodiversity. • To provide visitors with a rainforest setting and give them an immersive experience with nature when they visit Mandai.
Water Quality and Quantity	
Mandatory	
Proposed development should not change the water quality, catchment boundary, catchment area and yield. It should be in accordance to the *'Code Of Practice for Pollution Control'* of NEA for activities allowed within the water catchment area.	• To ensure there are no changes within the Sungei Mandai water catchment area. • Cited in consultation with PUB.
Proposed development should be aware that captive exotic animals have the potential to pollute stormwater and such a proposal will require water treatment methods.	• To ensure that stormwater to the Sungei Mandai water catchment area is not compromised in quality or quantity. • To ensure proper drainage of the development.

Recommended Planning Principles/ Guidelines	Justifications
The minimum platform level for the proposed site should not be lower than the adjacent road levels or ground levels, whichever is higher.	• Cited in consultation with PUB.
The Project is encouraged to introduce Water Sensitive Urban Design (WSUD) strategies.	• Cited in consultation with PUB.
Domestic wastewater is to be conveyed and discharged to the existing 1.8m diameter sewer along Woodlands Road located approximately 2.6km away.	• Cited in consultation with PUB.
Animal waste or sludge from animal enclosures must not be discharged to the PUB sewer.	• Cited in consultation with PUB.
Drainage systems to be designed to accommodate up to a selected storm event (consultation with PUB ongoing; certain portions of the existing cut-off drainage system around the Upper Seletar Reservoir is designed for a 1 in 2 year event).	• Cited in consultation with PUB.
Existing drainage system not to be altered without prior approval.	• Cited in consultation with PUB.
Water treatment will be required as captive animals may pollute stormwater.	• Cited in consultation with PUB.
The animal waste streams from both the new development and the existing attractions shall be segregated and routed to the new STPs. Human waste from both the new development and existing attractions is to be connected and discharged into a public sewer.	• Cited in consultation with PUB.
Use of on-site sewage treatment plant is allowed only for animal waste.	• Cited in consultation with PUB.
Development / activities during the construction and operational phase shall not cause pollution directly or indirectly into water bodies.	• Cited in consultation with PUB.
The proposed development shall comply with all the applicable requirements and provisions of the Singapore Standard on Code of Practice for Pollution Control (i.e. *SS593:2013*), the Code of Practice on Environmental Health, the Code of Practice on Sewerage and Sanitary Works, the Code of Practice on Surface Water Drainage, the Environmental Protection and Management Act, the Environmental Public Health Act, the	• Cited in consultation with NEA and PUB.

Recommended Planning Principles/ Guidelines	Justifications
Sewerage and Drainage Act, the Radiation Protection Act, the Energy Conservation Act and their Regulations	
Recommended	
Developer will be encouraged to provide constructed water bodies on the site such as bio-filtration swales, and/or storm-water detention ponds.	• To reduce the increased amount of rainwater run-off from the site due to hard surface development and to reduce rainwater run-off loads on existing sewer system such that the proposed development does not change the catchment's yield significantly. • To provide enhanced native animal habitat and encourage diversity of native species.
Fire Safety Issues	
Mandatory	
Developer must comply with the Fire Safety Act and Regulations, the prevailing "*Code of Practice for Fire Safety Precautions in Buildings*" (Fire Code) and the relevant Codes of Practices and Guidelines. In addition, the following conditions will apply: (a) To consult SCDF on the acceptability of the site location if the premises is to store, handle, use, transport or import of hazardous materials which may have impact within the premises or on the surrounding existing or new developments. The developer is also to ensure no prevailing "Health and Safety (H&S)" buffer zone encroaches upon the proposed sites of workers' quarters. (b) To consult SCDF on any specific developments or structures having impact on SCDF operations e.g. deep basement works (which are more than 4 storey or more than 24 metres in depth), tunnel or any other special developments, etc.	• Cited in consultations with SCDF.

Source: MPH, 2014

3.5 INTERNATIONAL GUIDELINES

International standards and guidelines that ERM has adopted for the EIA include the following:

- World Association of Zoos and Aquariums (WAZA) Guidelines;
- International Union for Conservation of Nature (IUCN) Guidelines;
- International Finance Corporation (IFC) Performance Standards;
- UK Institute of Air Quality Management (IAQM) Guidance; and
- United Nations Framework Convention on Climate Change (UNFCC).

3.5.1 *World Association of Zoos and Aquariums Guidelines*

WAZA is the unifying organization for the world zoo and aquarium community with more than 300 members from around the world. WAZA defines responsibilities for its members that encourage them to participate meaningfully in global biodiversity conservation; be engaged in environmental education; and cultivate the highest standards in animal welfare and husbandry. It is noted that the Singapore Zoological Gardens and the Jurong Bird Park are members of WAZA. WAZA publishes strategies to help guide its members on measures they can adopt to realize their full potential in conserving global biodiversity.

3.5.2 *International Union for Conservation of Nature Guidelines*

IUCN is an international organization dedicated to nature conservation and the development of sustainable solutions to tackle the world's environmental challenges. It has developed a series of policy statements and guidance documents to provide agencies involved in biodiversity conservation around the world with a framework within which to operate. These guidance documents encompass the following issues which will be relevant to the Project:

- The use of *ex situ* management for species conservation;
- Reintroduction and other conservation translocations;
- The prevention of biodiversity loss caused by alien invasive species; and
- The strategic planning for species conservation.

Another conservation tool developed by the IUCN is the IUCN Red List of Threatened Species, which provides assessments of conservation status of species to help inform decision making regarding biodiversity conservation. The list forms the basis of assessment of species sensitivity and is often one of the key resources used in evaluating the potential impacts on biodiversity from a proposed development. This EIA will be making reference to the IUCN Red List in its evaluation of environmental impacts.

3.5.3 *International Finance Corporation Performance Standards*

The IFC publishes environmental and social performance standards to define its clients' responsibilities for managing their risks in these two aspects. There are eight performance standards, of which Performance Standard 6 - *Biodiversity Conservation and Sustainable Management of Living Natural Resources* is most relevant to the project since it includes measures to assess and manage biodiversity values. Developers who wish to secure financing from the IFC, or the many international banks that reference these standards, are required to adhere to these Performance Standards.

3.5.4 *UK Institute of Air Quality Management Guidance*

The Institute of Air Quality Management (IAQM) is a UK entity comprising air quality professionals, which works to develop the science behind air quality. It has published guidance on best working practices for air quality assessments specific to land-use and development planning, which are frequently cited in international EIAs.

3.5.5 *United Nations Framework Convention on Climate Change*

The UNFCCC is an international treaty established with the goal of stabilising atmospheric greenhouse gas (GHG) concentrations. Singapore has been party to the convention since 1997 and developed a National Climate Change Strategy in 2008 with the aim of reducing GHG emissions.

3.6 *MANDAI PARK HOLDINGS VISION*

Mandai Park Holdings aspires to "*be a world class nature themed attraction for recreation and education, with green public spaces for Singaporeans and visitors to enjoy and appreciate nature. This includes the development of new attractions that will be integrated with the existing Singapore Zoo, Night Safari and River Safari*". In order to fulfil its vision, the organization has adopted three guiding principles [3]:

- Inclusion: A rejuvenating escape for family and friends to share discoveries and create memories;
- Sustainability: A sustainability showcase for the next generation; and
- Integration: Thoughtful integration of the existing attractions and Mandai's natural heritage.

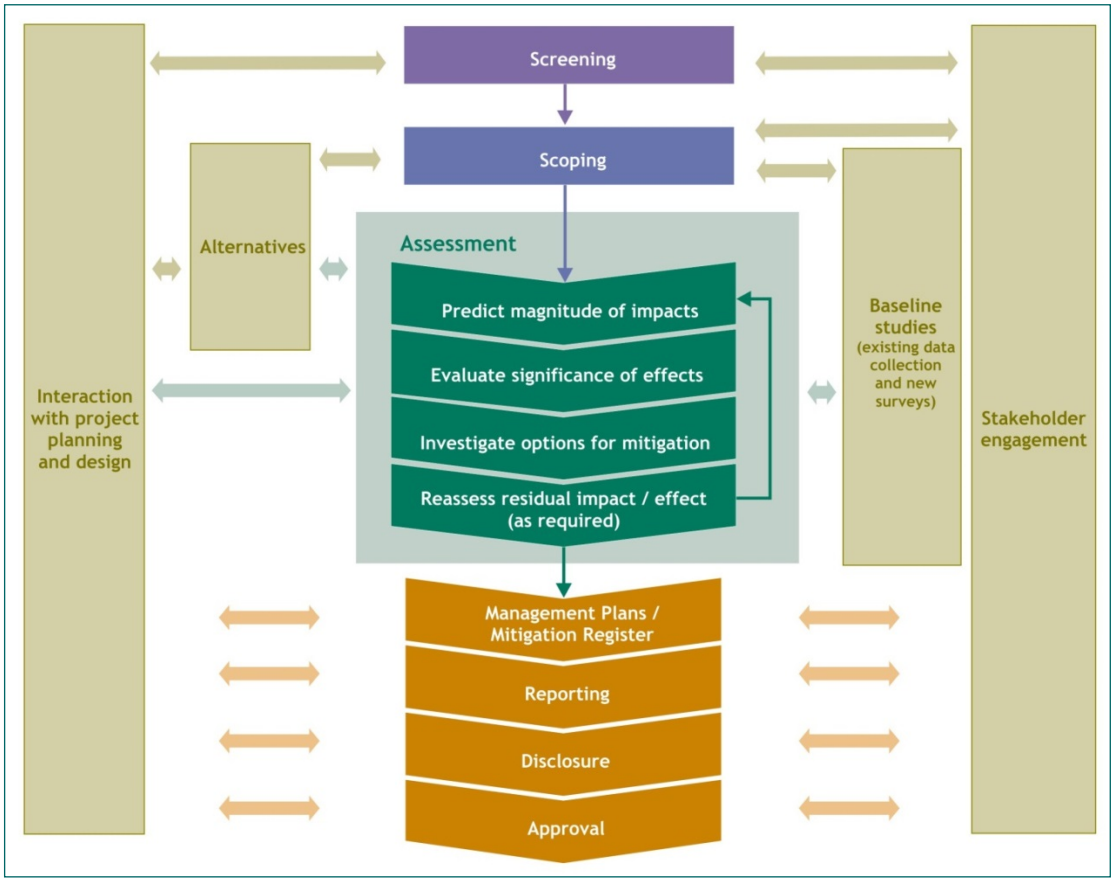
[3] **Mandai Project** (2015). Retrieved from http://www.mandai.com/index.html#.

4 IMPACT ASSESSMENT METHODOLOGY

4.1 INTRODUCTION

The EIA methodology followed the approach shown in *Figure 4.1*. It involved a systematic process that predicted and evaluated the potential impacts from the Project on aspects of the physical and biological environment, and identified measures required to avoid, minimise, mitigate, offset or compensate for adverse impacts; and to enhance positive effects where practicable. The stages of the Impact Assessment (IA) process are described below.

Figure 4.1: Impact Assessment Process



Source: ERM, 2014

4.2 SCREENING

At the initial stage of the EIA, preliminary information was provided to aid in the determination of legal and other requirements applicable to the Project. This step was conducted using a high level description of the Project and its associated facilities.

4.3 SCOPING

Scoping was undertaken to identify the Area of Influence (AOI) for the Project which forms the Study Area for baseline studies and within which impacts are assessed. Potential interactions between Project activities and environmental receptors in the Area of Influence

were identified via a workshop with MPH, advisors from the National University of Singapore (NUS), and the operator of the existing Singapore Zoo, WRS. A Scoping Report was developed, and subsequently submitted to and received clearance from the EIA technical agencies.

This stage is intended to ensure that the IA focuses on those issues that are most important for design, decision-making and stakeholder interest. The findings of the scoping exercise are reported in *Chapter 5*.

Table 4.1 presents the environmental resources/receptors considered in the scoping stage, together with the changes that might indicate a Project-related impact.

Table 4.1: Environmental Resources/Receptors and Impacts Considered in Scoping

Resources/Receptors	Impacts
Physical Environment	
Ambient Air Quality / Dust Deposition	Increase in vehicular emission and dust emission
Global Climate	Edge effect resulting in changes to the microclimate
Ambient Noise	Change in ambient noise levels
Groundborne Noise & Vibration	Change in vibration levels and subsequent generation of groundborne noise
Surface Water and Hydrology	Changes to physical, chemical or biological quality of surface water bodies; Introduction of exotic species, changes in habitat quality, abundance, diversity; effluent discharge
Geology	Changes to geology, geomorphology, topography, including changes to physical and chemical properties and soil ecology
Hydrogeology	Contamination of shallow or deep groundwater resources, change in groundwater resources
Visual	Change in topography and landscape
Biological	
Terrestrial Habitats	Changes in habitat quality and conditions, and subsequent effects on the ecosystem
Terrestrial Flora & Fauna	Changes to vegetation community, health, species abundance and diversity and impact on endangered species and changes to wildlife assemblages
Aquatic Habitats	Changes on the aquatic ecosystem within the nearby waterbodies
Aquatic Flora & Fauna	Changes to aquatic vegetation community, health, species abundance and diversity and impact on endangered aquatic species
Protected Areas	Compatibility of activities with the designated CCNR

4.4 BASELINE CONDITIONS

Baseline environmental conditions were documented for relevant resources/receptors that were identified during scoping as having the potential to be significantly affected by the Project. The baseline conditions are documented in *Chapter 6.0* of this EIA Report.

4.5 STAKEHOLDER ENGAGEMENT

An effective IA Process requires engagement with relevant stakeholders in order to understand stakeholder views on the Project, identify risks to be assessed and to develop appropriate mitigation and enhancement measures.

Details of the Stakeholder Engagement undertaken as part of the EIA are presented in *Chapter 7.0*.

4.6 IMPACT ASSESSMENT

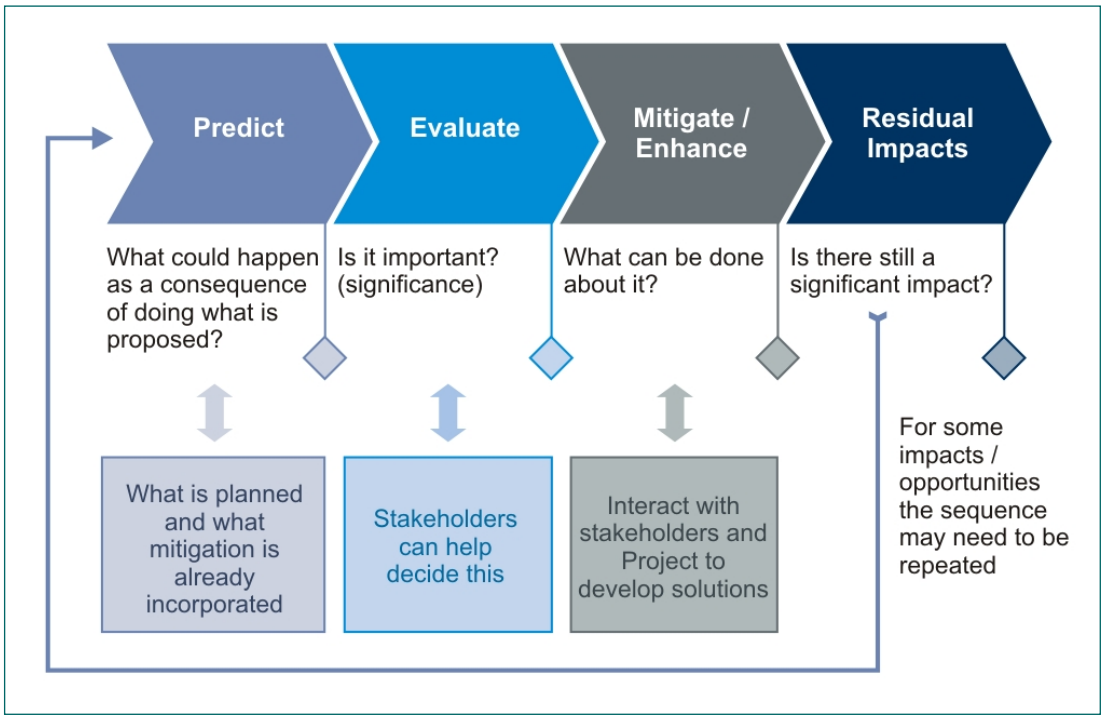
Impact identification and assessment starts with scoping and continues through the remainder of the IA Process. The principal IA steps are summarised in *Figure 4.2* and comprise:

- Impact prediction: to determine what could potentially happen to resources/receptors as a consequence of the Project and its associated activities.
- Impact evaluation: to evaluate the significance of the predicted impacts by considering their magnitude and likelihood of occurrence, and the sensitivity, value and/or importance of the affected resource/receptor.
- Mitigation and enhancement: to identify appropriate and justified measures to mitigate negative impacts and enhance positive impacts.
- Residual impact evaluation: to evaluate the significance of impacts assuming effective implementation of mitigation and enhancement measures.

4.6.1 Prediction of Impacts

Prediction of impacts is essentially an objective exercise to determine what is likely to happen to the environment as a consequence of the Project and its associated activities. From the potentially significant interactions identified in Scoping, the impacts to the various resources/receptors are elaborated and evaluated. The diverse range of potential impacts considered in the IA process typically results in a wide range of prediction methods being used, including quantitative, semi-quantitative and qualitative techniques.

Figure 4.2: Impact Assessment Process



Source: ERM, 2014.

4.6.2 *Evaluation of Impacts*

Once the prediction of impacts is complete, each impact is described in terms of its characteristics (e.g. 'type', 'scale', 'duration', 'frequency', 'extent'). The terminology used to describe impact characteristics is shown in *Table 4.2* and the definitions for the type designations are shown in *Table 4.3*.

The above characteristics and definitions apply to planned and unplanned events. An additional characteristic that pertains only to unplanned events is 'likelihood'. The likelihood of an unplanned event occurring is designated using a qualitative scale, as described in *Table 4.4*.

Once an impact's characteristics are defined, the next step in the impact assessment phase is to assign each impact a 'magnitude'. Magnitude is typically a function of some combination (depending on the resource/receptor in question) of the following impact characteristics:

- Extent
- Duration
- Scale
- Frequency

Additionally, for unplanned events only, magnitude incorporates the 'likelihood' factor discussed below.

Table 4.2: Impact Characteristic Terminology

Characteristic	Definition	Designations
Type	A descriptor indicating the relationship of the impact to the Project (in terms of cause and effect).	Direct; Indirect; Induced
Extent	The "reach" of the impact (e.g. projected for several kilometers, etc.).	Local; Regional; International
Duration	The time period over which a resource / receptor is affected.	Temporary; Short-term; Long-term; Permanent
Scale	The size of the impact (e.g. the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.)	[no fixed designations; intended to be a numerical value or a qualitative description of "intensity"]
Frequency	A measure of the constancy or periodicity of the impact.	[no fixed designations; intended to be a numerical value or a qualitative description]

Table 4.3: Impact Type Definitions

Designations	Definition
Type	
Direct	Impacts that result from a direct interaction between the Project and a resource/receptor (e.g. between occupation of a plot of land and the habitats which are affected).
Indirect	Impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g. viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land).
Induced	Impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project (e.g. influx of camp followers resulting from the importation of a large Project workforce).

Table 4.4: Definitions for Likelihood Designations

Likelihood	Definition
Unlikely	The event is unlikely but may occur at some time during normal operations.
Possible	The event is likely to occur at some time during normal operations.
Likely	The event will occur during normal operations (i.e. it is essentially inevitable).

Magnitude essentially describes the intensity of the change that is predicted to occur in the resource/receptor as a result of the impact. As discussed above, the magnitude designations themselves are universally consistent, but the descriptions for these designations vary on a resource/receptor-by-resource/receptor basis. The universal magnitude designations are:

- Positive
- Negligible
- Small
- Medium
- Large

In the case of impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is utilised, but the 'likelihood' factor is considered, together with the other impact characteristics, when assigning a magnitude designation.

In addition to characterising the magnitude of impact, the other principal impact evaluation step is definition of the sensitivity/vulnerability/importance of the impacted resource/receptor. There are a range of factors to be taken into account when defining the sensitivity/vulnerability/importance of the resource/receptor, which may be physical, biological, cultural or human. Other factors may also be considered when characterising sensitivity/vulnerability/importance, such as legal protection, government policy and stakeholder views.

As in the case of magnitude, the sensitivity/vulnerability/importance designations themselves are universally consistent, but the definitions for these designations vary on a resource/receptor basis. The sensitivity/vulnerability/importance designations used herein for all resources/receptors are:

- Negligible
- Low
- Medium
- High

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterised, the significance can be assigned for each impact. The sensitivity and magnitude definitions for the different environmental aspects considered in this assessment are provided in *Annex 2.0*. Impact significance is designated using the matrix shown in *Figure 4.3*.

The matrix applies universally to all receptors, and to all categories of impacts on these receptors, since the receptor-specific considerations are factored into the assignment of magnitude and sensitivity/vulnerability/importance designations. *Box A* explains the impact significance ratings.

Impact prediction and evaluation take into account any embedded controls (i.e. physical or procedural controls that are already planned as part of the Project design). An example of an

embedded control is an acoustic enclosure that is designed to be installed around a piece of noise generating equipment.

Figure 4.3: Impact Significance

		Sensitivity/ Vulnerability/ Importance of Resource/ Receptor			
		Negligible	Low	Medium	High
Magnitude of Impact	Negligible	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Negligible	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Major
	Large	Negligible	Moderate	Major	Critical

Box A: Context of Impact Significances

An impact of **negligible significance** is one where a resource/receptor will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of **minor significance** is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be well within applicable standards.

An impact of **moderate significance** has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or causing a major impact is not best practice. The emphasis for moderate impacts is therefore on reducing them to a level that is as low as reasonably practicable (ALARP). This does not mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of **major significance** is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An impact of **critical significance** has a similar definition, but is only applicable to the biodiversity assessment and when large magnitude impacts interact with critical habitats [(1)].

An aim of IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long-term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

(1) Critical Habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes.

4.6.3 *Identification of Mitigation and Enhancement Measures*

Once the significance of an impact has been characterised, the next step is to evaluate what mitigation and enhancement measures are warranted. For the purposes of this IA, ERM has adopted the following Mitigation Hierarchy:

- Avoid at Source, Reduce at Source: avoiding or reducing at source through the design of the Project (e.g. avoiding by siting or re-routing activity away from sensitive areas or reducing by restricting the working area or changing the time of the activity).
- Abate on Site: add something to the design to abate the impact (e.g. erosion control).
- Abate at Receptor: if an impact cannot be abated on-site then control measures can be implemented off-site (e.g. fencing to protect ecological sensitive receivers).
- Repair or Remedy: some impacts involve unavoidable damage to a resource (e.g. forestry clearance to create access) and these impacts can be addressed through repair, restoration or reinstatement measures.
- Compensate in Kind or Other Means: where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance may be appropriate (e.g. planting to replace damaged vegetation).

The priority in mitigation is to first apply mitigation measures to the source of the impact (i.e. to avoid or reduce the magnitude of the impact from the associated Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (i.e. to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

4.6.4 *Residual Impact Assessment*

Once mitigation and enhancement measures are declared, the next step in the IA Process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the implementation of the proposed mitigation measures which are designed to reduce the magnitude of the predicted impacts.

4.6.5 *Cumulative Impacts*

A cumulative impact is one that arises as a result of the interactions of Project activities with activities external to the Project (e.g. from a nearby Project) to create an additional impact. The methods used to assess cumulative impacts are strongly influenced by the status of the other activities (e.g. already in existence, approved or proposed) and the availability of reliable data to undertake an assessment.

The impact assessment process itself is broadly similar to that presented herein, i.e. scoping to define the committed developments, level of information available, potential interactions; baseline data gathering which is usually captured in the study area of the project; impact assessment to determine the magnitude and significance of impacts considering the

vulnerability of the resources and receptors and their limits of acceptable change; and development of any management and monitoring measures to mitigate significant impacts.

4.7 MANAGEMENT, MONITORING AND AUDIT

The final stage in the IA Process is definition of the management and monitoring measures that are needed to identify whether: a) impacts or their associated Project components remain in conformance with applicable standards; and b) mitigation measures are effectively addressing impacts and compensatory measures and offsets are reducing effects to the extent predicted.

5 SCREENING AND SCOPING

This chapter presents the approach and the findings from the screening and scoping stage of the EIA process. The key issues which were identified through the screening and scoping process are assessed in detail in *Chapter 8 and Chapter 9* of this EIA report.

5.1 SCOPING

The environmental concerns were further refined through a scoping workshop with MPH, NUS (independent technical advisor), WRS as well as CPG (the masterplanning consultant for the conceptual master plan). Scoping is a systematic process that involves identifying the components of the Project and the activities involved in its construction and operation, and considering how these could be expected to interact with known environmental conditions in the vicinity of the Project. Interactions associated with the Project construction and operation activities and environmental receptors were classified into one of the following:

- **No interaction:** where the Project is unlikely to interact with the resource/receptor (e.g. wholly terrestrial projects may have no interaction with the marine environment);
- **Interaction likely, but not likely to be significant:** where there is likely to be an interaction, but the resultant impact is unlikely to change baseline conditions in an appreciable/detectable way;
- **Significant interaction:** where there is likely to be an interaction, and the resultant impact has a reasonable potential to cause a significant effect on the resource/receptor; and
- **Positive Interaction:** where there is likely to be an interaction that will result in a positive effect on the resource/receptor.

As the initial scoping was undertaken during the conceptual design stage of the masterplanning phase, the scoping was revisited and updated as the master plan evolved. The key project activities and potential interactions were reviewed and updated to reflect the master plan available as of 4th December 2015.

The findings of Scoping are detailed within the potential interactions matrix provided in *Annex 2.0* and summarised in *Table 5.1*. Scoping highlighted air quality, noise, surface water quality, soil and groundwater, terrestrial and aquatic habitats and fauna and protected area were considered to have potentially significant interactions with the Project activities. The potentially significant interactions for which are carried forward for further consideration in the impact assessment are discussed in *Table 5.1*.

Table 5.1: Summary of Scoping Findings

Resource/ Receptor	Scoping Summary
Ambient air quality	Demolition of existing structures and earth moving activities such as excavation will generate atmospheric emissions of particulates, as will the operation of equipment within the Project area during the pre-construction and construction phases (both PM_{10} and $PM_{2.5}$). Elevated levels of airborne particulates may have impacts on human health and the environment, and may result in nuisance impacts due to soiling of existing WRS operations. The use of diesel fueled construction vehicles and equipment will result in vehicular emission of CO, $PM_{2.5}$, PM_{10} and NO_2 that may in turn cause an impact to human health. Similarly, an increase in the number of visitors to the new attractions and employees will directly contribute to an increase in traffic volume and as a result, vehicular emissions.
Ambient noise, groundborne noise and vibration	Noise emissions from various construction and pre-construction activities may result in disturbance to ecological and human receptors. Groundborne vibration may be significant during ground disturbance activities such as piling.
Surface Water	During construction, impacts to surface water quality could arise from the following: • Increased sediment loading from exposed ground and surface runoff that contains chemicals/fuels; • Construction of shoreline boardwalk adjacent to the Upper Seletar Reservoir; • Upgrading of the perimeter drain around WRS attractions; • Demolition and relocation of the existing STP; and • Unplanned event such as firewater application as a result of a fire. Impacts associated with the operation are public littering to the Upper Seletar Reservoir from boardwalk and overflow of surface runoff caused by a major rainfall event or failure of STP may also impact surface water quality (i.e. unplanned event). The surface runoff could carry animal wastes and pathogens that are detrimental to the Upper Seletar Reservoir given its use as a drinking supply.
Soil and groundwater	The construction of underground carparks and other underground structures might intercept groundwater and require groundwater withdrawal that could impact groundwater flow. This may cause secondary impacts on groundwater dependent vegetation and any surface waterbodies in hydraulic connectivity with intercepted groundwater.

Resource/ Receptor	Scoping Summary
Terrestrial habitats & Terrestrial flora & fauna	Habitats within the Project area will be modified through a change of landscape to accommodate the Project design. Portions of these habitats provide high biodiversity value for fauna and flora species and provide a valuable buffer to the CCNR. Habitats within the Project area have already been identified as important for fauna (including threatened and protected species) and loss of this habitat, coupled with fragmentation, disturbance and displacement caused by construction and operational activities will have significant impacts to fauna species. Construction activities that are likely to impact fauna species include: • Land clearance for preparation of construction work areas; • Shepherding of wildlife from the Project area prior to construction of the Rainforest Park and Bird Park amenities; • Dust and noise generated from activities such as demolition, construction, road works, etc; • Increase in vehicular and human traffic, which may result in higher incidence of roadkill and wildlife behavioral or distribution changes; and • Increase in luminance levels due to night-time works, which may result in wildlife behavioral or distribution changes.
Aquatic habitats & Aquatic flora & fauna	Aquatic habitats may be affected directly by construction or operational activities or indirectly as a result of surface water quality impacts mentioned above. This could also affect aquatic flora and fauna living within surface water bodies such as the Upper Seletar Reservoir and an unnamed stream along the western boundary of the proposed Bird Park.
Protected Area	There will be no direct works within protected areas such as the CCNR. Construction and operation activities will occur within the Project boundary. Nonetheless, these activities may have impact (e.g. dust emissions during construction) on flora and fauna within the CCNR.

6 BASELINE ENVIRONMENT

This chapter describes the baseline environment of the Project area, including the ambient air quality, ambient noise environment, surface water quality, geological & hydrogeological resources, and ecological resources, including biodiversity. Information outlined is based on the review of publicly available data; information provided by the Client; data provided by various government agencies and information collected during field surveys in the Project area between late-March and December 2015.

6.1 PROJECT SETTING

6.1.1 Existing Land Use

Currently the Project area consists of disused and forested parcels of land to the north and south of Mandai Lake Road, to the west of the *Singapore Zoo*.

According to a historical review of the Project area[1], the land parcels north and south of Mandai Lake Road were formerly occupied by residents of the Sungei Mandai Village up until 1985. The eastern portion of the land parcel to the south of Mandai Lake Road was formerly used as an orchid plantation. The site of the orchid plantation currently comprises a vacant single storey building and grassland.

Forested land parcels on either side of Mandai Lake Road

Former Mandai Orchid Garden site, located south of Mandai Lake Road

Grassland formerly used as an orchid plantation, south of Mandai Lake Road

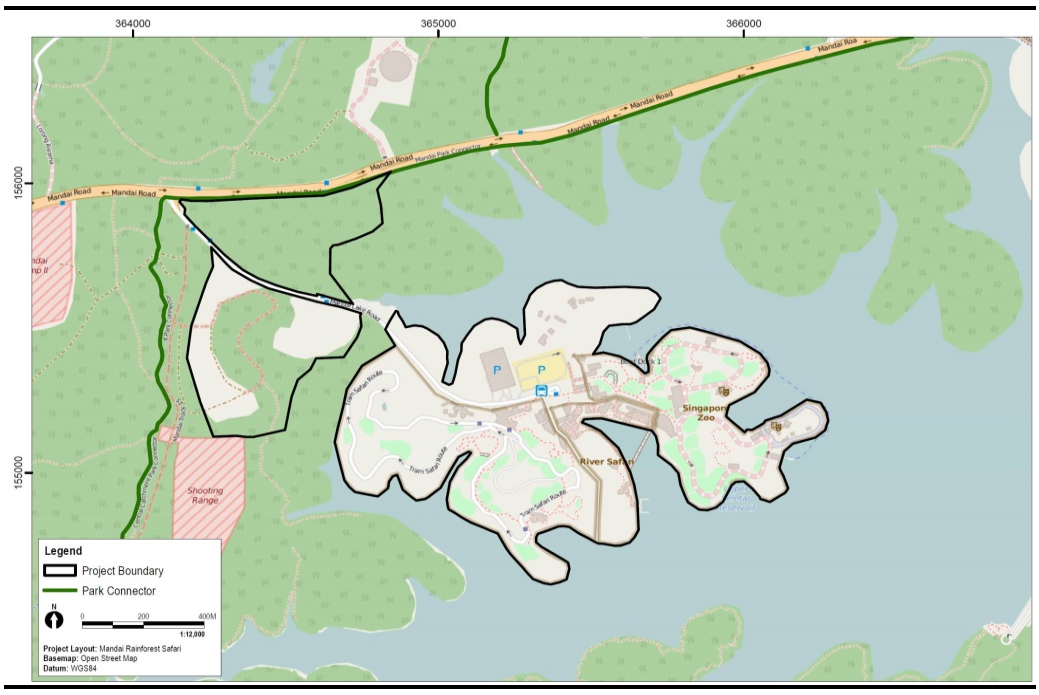
[1] Singapore History Consultants Pte Ltd (13 November 2015) **Final Report on the History and Heritage of Mandai.**

Park connectors [2] run parallel to the southern boundary of Mandai Road and in a north/south direction to the west of the Project area as illustrated in *Figure 6.1*. The park connector to the west of the Project area is a dirt and asphalt trail which commences near the end of Chestnut Avenue and is utilised mostly for hiking and mountain biking. These park connectors are part of the Northern Explorer and CCNR network that are currently managed by NParks. It is observed that an unnamed road, which runs parallel to the park connector, is also utilised by cyclists.

Cyclists using the unnamed road parallel to the park connector, 2015

It was observed in December 2015 that track widening and repair works were carried out within the Project area, south of Mandai Lake Road. The works were conducted by the existing landlord. A site visit was undertaken to confirm the nature of the works undertaken on 5th December 2015. The works have widened the track network over the site. The road has been re-surfaced with gravel. Some trees have been removed as a result of the widening. It is not considered to be a significant impact on the habitats present on site. Only a small proportion of grassland and young secondary forest has been removed. The road re-surfacing has improved the condition of the road, however a small amount of stormwater runoff containing sediment was observed entering local water ways. Some soil erosion was also observed along road batters. These impacts are considered to be minor and temporary in nature as the road surface and batters will re-stabilize following the disturbance.

Figure 6.1: Park Connectors around the Project Area



[2] Jogging or cycling tracks that link residential areas to parks and nature sites around Singapore.

6.1.2 Committed Developments

There are a number of committed developments that have been identified within or in proximity to the Project boundary. The committed developments for which public information is available and are considered further within this EIA are summarised in *Table 6.1.*

Table 6.1: Committed Developments

No.	Description	Location	Nearest Distance from Project Boundary	Estimated Schedule
Transport Infrastructure				
1	Thomson Line's Mandai Depot, a train maintenance depot for the Thomson-East Line	Along Mandai Lake Road, between the exit to Seletar Expressway and Lorong Lada Hitam	1.7 km	Construction on-going and to be completed in 2019 (1)
2	Thomson-East Mass Rapid Transit Line, Springleaf Station	Along Upper Thomson Road, between Mandai Road and Seletar Expressway	2.1 km	Construction on-going and to be completed in 2020 (2)
3	Thomson-East Mass Rapid Transit Line, Woodlands South Station	Near the junction of Woodlands Avenue 1, Woodlands Drive 16 and Woodlands Drive 17	2.2 km	Construction on-going and to be completed in 2020 (3)
Others				
4	Sewer rehabilitation and replacement works	Along Mandai Lake Road and Mandai Road	0.1 km	Q3 2014 to Q4 2017 (4)
5	Singapore Power Cable Tunnel Project, North South 2 - Mandai	Near the junction of Mandai Avenue, Sembawang Road and Yishun Avenue 1	4.2 km	Construction on-going and to be completed in 2018 (5)

Notes:

(1) Land Transport Authority (18 October 2013). **LTA Awards Four Contracts For Thomson Line.** Retrieved from http://www.lta.gov.sg/apps/news/page.aspx?c=2&id=e24d3853-ee73-4d65-922b-bba5dcb8beb7

(2) Land Transport Authority (24 January 2014). **Civil Contract Awarded for the Construction of Thomson Line's Tunnels to Springleaf Station.** Retrieved from http://www.lta.gov.sg/apps/news/page.aspx?c=2&id=f3391fc9-d86f-425a-9745-7e798a16a076

(3) Land Transport Authority (23 August 2019). New MRT Station in Woodlands in 2019. Retrieved from http://www.lta.gov.sg/apps/news/page.aspx?c=2&id=987c56c1-2992-49d9-b176-5a8f7faa2bb5

(4) Singapore Power (no date). **Transmission Cable Tunnel Project.** Retrieved from http://www.singaporepower.com.sg/irj/servlet/prt/portal/prtroot/docs/guid/104fe742-860b-3010-c283-fde030c41fbd

(5) PUB (3 November 2015) **Construction Projects Interactive Map, Project Number 1140436, Title: Porposed Sewers in Mandai Road Area.** Retrieved from http://app.pub.gov.sg/CPUsers/ShowSimpleProj.aspx?prjID=416

6.1.4 Topography

The general topography of the Project area is characterised by gently undulating terrain, with elevation being slightly higher towards the north east [3] as illustrated on *Figure 6.2*. The highest peaks are located south of Mandai Lake Road, with an elevation of 51 m above mean sea level (msl). Within this area south of Mandai Lake Road the lowest lying areas occur between 12 to 23 m above msl along the western fringe of the land and adjacent to Mandai Lake Road.

North of Mandai Lake Road, the topography is flat along Mandai Lake Road and Mandai Road with elevations measured at approximately 13 m rising to 45 m above msl towards the edge near the CCNR.

While most of the terrain of the Project area is gently undulating, there are some steep slopes located in the land parcel north of Mandai Lake Road, with the steepest slope being a rise of 6m over a distance of 10m situated approximately in the centre of the land parcel.

In addition to the two plots of land described above, the Project area also includes the areas currently leased to WRS comprising the *Singapore Zoo, Night Safari* and *River Safari* as well as the area currently occupied by carpark facilities and the WRS Back of House area. Based on topographical surveys conducted in 2009, the elevation of the terrain at WRS varies from 24 m to 40 m above msl, with elevations of 40 m at the current location of the *Night Safari*. While no topographical surveys have been conducted since then, the topography is unlikely to change because the area has been used by WRS for a considerable period of time.

[3] Mandai Topographical Survey, 2015

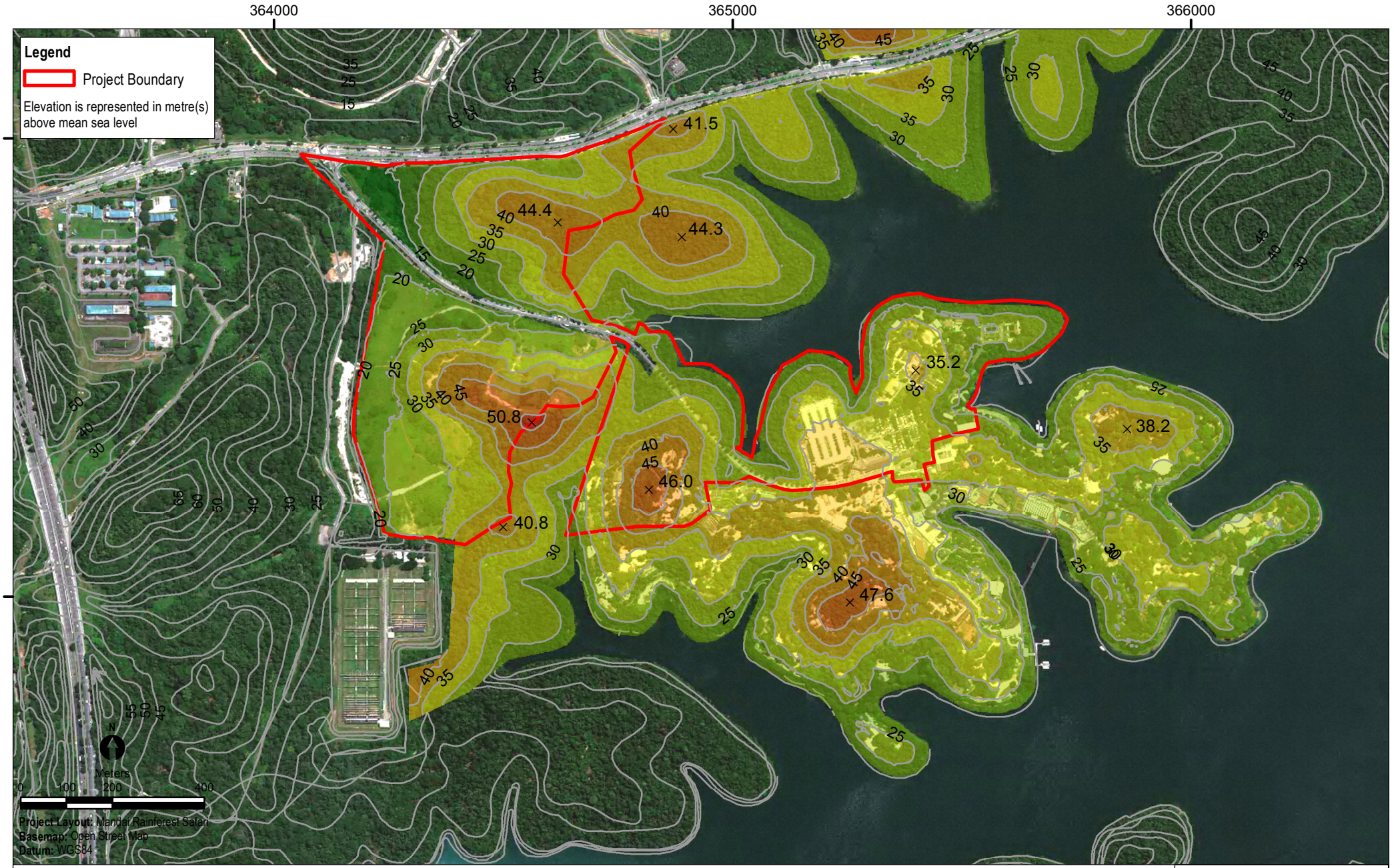


Figure 6.2 Topography of the Project Area

Reference:
Project Site and the adjacent CCNR (coloured area): Mandai Topographical Survey, 2015
Broader Mandai Area (uncoloured area): Historical Topographical Survey, year unknown
Service Layer Credits: World View 2 Imagery

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6.2 CLIMATE & AIR QUALITY

6.2.1 Study Area

The Study Area for air quality is defined as the area within which human or ecological receptors may be adversely affected by atmospheric emissions from the Project. Airborne particulate matter emitted from the Project during construction is likely to have a relatively localised impact. Dust particles between 30 and 100 mm in diameter generally settle within 100 m of the source [4], while trackout [5] from vehicle emissions may occur up to 500 m from the Project site without mitigation [6]. The Area of Influence has therefore been set at 500 m from the Project site boundary; however, cumulative effects at other sensitive receptors within 2 km from the Project boundary have also been evaluated.

6.2.2 Sources of Information

The existing climatic regime and air quality in the Study Area has been developed with reference to the following information sources:

- Data obtained from short-term field measurement of particulate matter less than 10 microns in diameter (PM_{10}) within the Project area during the Southwest monsoon period between July and August 2015, and during the inter-monsoonal period in October 2015;
- Greenhouse gas emission targets for 2020 and 2013 energy consumption statistics published by the Energy Market Authority (EMA);
- Long-term ambient air quality statistics published by the Ministry of the Environment and Water Resources (MEWR) for the years 2011 to 2014;
- Publicly available street directories developed by Streetdirectory Pte Ltd and the Singapore government integrated map system, OneMap; and
- Climate, meteorological and ambient air quality data published by the NEA for 2012 - 2014.

6.2.3 Prevailing Climatic Conditions

Singapore is located 1 degree north of the equator where the climate is uniformly hot and humid with abundant rainfall. The typical daily temperatures vary between 23 ˚C and 34 ˚C, with the extremes ranging from 19.4 ˚C to 36.0 ˚C [7].

[4] United States Environment Protection Agency (1995) **Fugitive Dust Sources**, AP-42 Section 13.2. Retrieved from http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s02.pdf

[5] Trackout is the transport of dust and dirt from the construction site onto the public road, where it may be deposited and then re-suspended by vehicle using the road. Trackout arises when heavy duty vehicles (HDVs) leave the construction site with dusty materials, which may then spill onto the road or when HDVs transfer dust and dirt onto the road having travelled over muddy ground on site.

[6] Greater London Authority (July 2014) **The Control of Dust and Emissions During Construction and Demolition, Supplementary Planning Guidance.** Retrieved from https://www.london.gov.uk/sites/default/files/Dust%20and%20Emissions%20SPG%208%20July%202014_0.pdf

[7] National Environment Agency (2013) **Local Climatology.** Retrieved from http://www.nea.gov.sg/weather-climate/climate-information/local-climatology

The country is affected by the Northeast (NE) and Southwest (SW) monsoon winds that occur from December to early March and from June to September, respectively. Between the two monsoon seasons are the two inter-monsoon periods which occur from late March to May and from October to November.

6.2.3.1 Rainfall

The average annual rainfall in Singapore is 2,339 mm [8]. The wet season usually occurs from October to January, and December normally contributes the most rainfall in the year due to the monsoon rain-belt. Based on data reported by the NEA from 1869 to 2013, December is the month with the highest monthly mean rainfall of 288.4 mm; while July, with 158.6 mm, has the lowest monthly mean. The mean number of days with thunderstorms in December and July over the 32 year period from 1982 to 2013 were 19 and 13, respectively.

According to the most recent Annual Weather Review [9] published by the NEA, the north eastern portion of Singapore, near Seletar, received the most rainfall across the different monsoon periods in 2013. Data provided by the PUB indicates that the average daily rainfall at Upper Seletar Reservoir was 8.8 mm in 2013.

6.2.3.2 Relative Humidity

The mean relative humidity in Singapore is 84.1%, and is fairly constant throughout the year. Fluctuations in humidity are more evident throughout the day, where humidity can reach highs of 90% during the morning, and as low as 60% during mid-day during dry periods. Relative humidity can reach 100% during periods of prolonged rainfall [8].

6.2.3.3 Sunlight Intensity

Solar irradiance or insolation measures the intensity of sunlight incident at the ground surface. Factors such as the angle of the sun throughout the day, cloud cover and humidity, will influence the amount of surface irradiance. While Singapore is located on the equatorial belt, the high relative humidity and high average annual rainfall contribute to absorption and scattering of solar radiation. The average annual solar irradiance in Singapore is approximately 131 W/m^2 [10].

The NEA also measures the degree of solar radiation from the ultraviolet spectrum at the Changi Meteorological Station. Measurements are described using the Ultraviolet Index (UVI), which was developed by the World Health Organisation (WHO), United Nations Environment Program (UNEP) and the World Meteorological Organisation (WMO). The UVI ranges from 0 (low) to 11+ (extreme) and indicates the potential for harmful effects to human skin and eyes due to UV exposure. The average daily maximum UVI values between May 2010 to April 2012 range between 6 and 9; and the highest UVI values are typically measured between 11 am and 3 pm daily [11].

[8] Meteorological Services Singapore (nd) **Climate of Singapore.** Retrieved from http://www.weather.gov.sg/climate-climate-of-singapore/

[9] National Environment Agency (2013) **Annual Weather Review 2013.** Retrieved from http://www.nea.gov.sg/docs/default-source/training-knowledge-hub/publications/annual-weather-review-(2013).pdf?sfvrsn=2

[10] Energy Market Authority (September 2015) **Solar Photovoltaic Systems.** Retrieved from https://www.ema.gov.sg/Solar_Photovoltaic_Systems.aspx

[11] National Environment Agency (2015) **Ultraviolet Index (UVI).** Retrieved from http://www.nea.gov.sg/weather-climate/weather-information/uvindex

6.2.3.4 Illuminance

Light pollution can be described as artificial light that alters the natural patterns of light and dark in ecosystems [12]. This can be manifested as lighting of facilities during the construction and operation phases of the Project, that may for example, impact the species within the CCNR as well as animals in the existing WRS operated parks. Light pollution can have harmful effects on animals, such as disruption of migratory patterns for birds and reduced metamorphosis for certain nocturnal species[13].

A baseline light survey was carried out between 20 May 2015 and 15 October 2015 at selected locations within the Study Area (*Figure 6.3*). Each survey location was selected based on the possibility of the area being affected by future construction and operational lighting. The survey was undertaken at night to capture influences from moonlight and artificial lighting. Further details on the survey methodology, selected survey locations and findings are provided in *Annex 3.0* and *Annex 4.0*. It is noted that the original survey Zones delineated in *Annex 3.0, Figure 2.1* were updated to reflect access restriction to Zone C due to special use activities and a request by NParks to extend the ecology and biodiversity surveys (detailed later in this Chapter) to include the forested area of Ulu Sembawang. For this reason, there is no "Zone C" in *Figure 6.3* and a Zone H is included to cover the Ulu Sembawang area.

Based on the findings of the light survey undertaken, the following general observations were made:

- Light level readings at the same points for the full moon phase were generally higher than the new moon phase, with the exception of LF03 and LF05. These may have been due to the presence of other sources of artificial lighting, denser cloud cover and tree cover;

- During the new moon phase (i.e. with minimal influence from natural light), it was observed that light levels at points exposed to artificial lighting (i.e. LA04, LF04, LD01, LF03, LF05) were generally higher than light levels of points within the forest or in undeveloped areas;

- Sky glow in the night sky was observed from several points within the survey area, mostly above Zone F and in the direction of residential areas southwest of Zone D. Sky glow is understood to be caused by either natural or artificial sources of light; and

- The highest light reading was recorded from LD01 during both the full moon and new moon periods. This survey location was located along the pavement adjoining Mandai Lake Road and the light measurements recorded can be attributed to the streetlamps.

[12] Longcore T and Rich C (2004) **Ecological Light Pollution**. Frontiers in Ecology and the Environment. 2(4). 191-198.

[13] Deda P, Elbertzhagen I, & Klussmann M (2008) **Light Pollution and The Impacts on Biodiversity, Species and Their Habitats.** In Starlight–A common heritage. International Conference in Defence of the Quality of the Night Sky and the Right to Observe the Stars. Starlight Initiative, Instituto de Astrofísica de Canarias (IAC), La Palma, Canary Islands, Spain

Figure 6.3 Survey Zones

Service Layer Credits: World View 2 Imagery

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6.2.3.5 Wind Direction

Northerly to North easterly winds are the prevailing winds of the NE monsoon from December to March, with speeds ranging from 6 to 10 km/hr. Wind speeds can reach 30 to 40 km/hr in the months of January and February [8].

During the SW monsoon, from June to September, the prevailing winds are from south or southeast, with speeds between 6 and 10 km/hr. The SW monsoon is occasionally accompanied by Sumatra Squalls, with wind gusts of 40 to 80 km/hr occurring between the predawn hours and mid-day [8]. The winds during the inter-monsoon periods are usually light and blow in variable directions.

6.2.3.6 Greenhouse Gas Emissions & Climate Change

Singapore contributes less than 0.2% of global GHG emissions [14]. The emissions of carbon dioxide (CO_2) associated with the use of energy for development and human needs are the major contribution to national GHG emissions, and the total CO_2 emitted in Singapore during 2013 was approximately 43,201 kt [15].

Singapore is projected to produce 77,200 kt of GHG in 2020 based on the emission data obtained in 2005. Industry is predicted to be the major contributor that will account for approximately 60.3% of the total projected emission, followed by the transportation sector at 14.5% and buildings at 13.8% [16]. Contributions from the Project will fall under the category for buildings (commercial and service related). Latest statistics published by the EMA indicate that energy consumption for the commercial and service sector was 11.9% of the total energy consumed in 2013 [17].

Singapore has been a signatory to the UNFCCC as a non-Annex I party since 1997 and acceded to the Kyoto Protocol in 2008. Although there are no mandatory reduction targets for non-Annex I countries, Singapore has embarked on policies and measures to reduce the projected 2020 emissions (i.e. 77,200 kt) by 7 -11% [21].

6.2.4 Extreme Weather Events

6.2.4.1 Haze

Smoke haze originating from forest fires in Indonesia is occasionally encountered in Singapore. Based on NEA's Pollutant Standards Index (PSI) data, the overall air quality was largely "Good" between 2012 and 2013, and "Moderate" for 2014. However, there were 8 days in 2013 in which the air quality was deemed "Unhealthy" and "Very Unhealthy" as presented in *Table 6.2*. At the time of writing, data for 2015 was not available. However, elevated

[14] National Climate Change Secretariat (15 December 2014) **Singapore's Emissions Profile.** Retrieved from https://www.nccs.gov.sg/climate-change-and-singapore/national-circumstances/singapores-emissions-profile

[15] Ministry of the Environment and Water Resources (2014). **Key Environmental Statistics 2014.** Retrieved from http://www.mewr.gov.sg/grab-our-research

[16] National Climate Change Secretariat (15 December 2014) **Singapore's Emissions Profile.** Retrieved from https://www.nccs.gov.sg/climate-change-and-singapore/national-circumstances/singapores-emissions-profile

[17] Energy Market Authority (2015) **Total Final Energy Consumption.** Retrieved from http://www.ema.gov.sg/cmsmedia/Publications_and_Statistics/Publications/ses/2015/wp-content/uploads/2015/07/Section3_TotalFinalEnergyConsumption.pdf

transboundary haze levels in Singapore from Kalimantan and Sumatra were observed in the months of September to October 2015. Historical haze advisories published by the NEA indicate that overall air quality during these months were deemed "Unhealthy" and "Very Unhealthy" [18].

Table 6.2: Summary of 24-hour PSI Between 2012 and 2014

Year	Days	No. of Days (% of time) in which PSI was classified as			
		Good (0 – 50)	Moderate (51 – 100)	Unhealthy (101 – 200)	Very Unhealthy (201 - 300)
2012	366	342 (93%)	24 (7%)	0 (0%)	0 (0%)
2013	365	341 (94%)	16 (4%)	5 (1%)	3 (1%)
2014 (1)	365	18 (5%)	335 (92%)	12 (3%)	0 (0%)

Note:
(1) As of 1 May 2014, $PM_{2.5}$ was added as the sixth air quality parameter to be considered in the calculation of 24 hr PSI. According to the NEA, this resulted in more days being classified as "Moderate" in 2014, as compared to 2012 and 2013 [19].

Source: National Environment Agency, 2013 [20] and 2014 [21]

6.2.4.2 Hail

Hail is uncommon in Singapore. In the afternoon of 25 June 2013, a hailstorm of short duration occurred in the western parts of Singapore (Jurong, Bukit Batok and Clementi). The previous event was reported in March 2008 [22].

6.2.4.3 Microbursts

Microbursts are strong downward currents of air that occur as a result of heavy rainfall during thunderstorms. These typically occur over a localised area and for a duration of up to 10 minutes [23]. High wind speeds generated during microbursts have been observed to cause breakage of tree branches and the uprooting of trees. In February 2011, a microburst event with recorded wind speeds of 77.8 km/h, affected a wide stretch of vegetation within the CCNR. This event was suspected to have occurred because of the heating of land areas in the afternoon, causing winds to be pulled from reservoirs towards the land. This resulted in the creation of a localised microburst at Mandai causing the uprooting or de-topping of several trees, in particular those with a trunk circumference of less than 1 m [24].

18 National Environment Agency (2015) **Advisories.** Retrieved from http://www.nea.gov.sg/corporate-functions/newsroom/advisories

19 National Environment Agency (11 March 2014) **New Air Quality Reporting System from 1 May 2014.** Retrieved from https://www.nea.gov.sg/corporate-functions/newsroom/news-releases/new-air-quality-reporting-system-from-1-may-2014

20 National Environment Agency (2013). **Environmental Protection Division Report 2013.** Retrieved from http://www.nea.gov.sg/training-knowledge/publications/environmental-protection-division-annual-report

21 National Environment Agency (2014). **Environmental Protection Division Report 2014.** Retrieved from http://www.nea.gov.sg/training-knowledge/publications/environmental-protection-division-annual-report

22 National Environment Agency (nd) **Hail.** Retrieved from http://www.nea.gov.sg/training-knowledge/weather-climate/hail

23 Meteorological Services Singapore (nd) **Weather Systems.** Retrieved by http://www.weather.gov.sg/learn_weather_systems/

24 Mandai Attraction Meeting (2016), based on National Environment Agency and Weather Experts.

6.2.5 *Air Quality*

The NEA conducts routine monitoring of ambient air quality through the Telemetric Air Quality Monitoring and Management System (TAQMMS). This system comprises remote monitoring stations around Singapore monitoring ambient air quality and roadside air quality. The NEA air quality monitoring stations monitor both ambient and roadside air quality.

At the air monitoring stations, automatic analysers continuously monitor common urban air pollutants including sulphur dioxide SO_2, oxides of nitrogen (NO_x), carbon monoxide (CO), ozone and particulate matter (PM_{10} and $PM_{2.5}$). At selected stations, meteorological parameters including wind speed and direction, temperature and relative humidity are also monitored.

The range of ambient air quality measured across Singapore over the last three years is presented in *Table 6.3* alongside the relevant ambient air quality targets. This data does not reflect spatial variations in ambient air quality in different parts of Singapore. Ambient air quality data from individual stations that are in closer proximity to the Project area is not typically available in the public domain, though it may be provided by the NEA on a case-by-case basis.

Table 6.3: Nationwide Average Ambient Air Quality for Singapore, 2011- 2014

Measured Species	Averaging Period	Range of Concentrations in Ambient Air (2011-2014) (µg/m^3) [1]	2020 Air Quality Targets (µg/m^3) [2]	Long-Term Air Quality Targets (µg/m^3) [2]
SO_2	24-hour	**75 – 98**	50	20
	Annual	10 -14	15	15
$PM_{2.5}$	24-hour[3]	**41- 176**	37.5	25
	Annual	**17- 20**	12	10
PM_{10}	24-hour[3]	50 **-215**	50	50
	Annual	20 - **31**	20	20
Ozone	8-hour	**122 - 139**	100	100
NO_2	1-hour	132 - 189	200	200
	Annual	24 - 25	40	40
CO	1-hour	2,300 - 7,500	30,000	30,000
	8-hour	1,800 - 5,500	10,000	10,000

Notes:
(1) Numbers in **bold** denote exceedance of the 2020 and long-term ambient air quality targets.
(2) Singapore has adopted the World Health Organisation Air Quality Guidelines (WHO AQG) for PM10, NO_2, CO, and the WHO AQG Interim Targets for PM2.5 and SO_2 as air quality target for 2020.
(3) 24-hour particulate matter (i.e. PM_{10} and $PM_{2.5}$) concentrations are 99th percentile while short-term concentrations of other species are maximum values.

Source: Ministry of the Environment and Water Resources, 2014 [25]

While concentrations of NO_2 and CO are within the air quality targets for Singapore, levels of SO_2, particulate matter and ozone are observed to exceed the 2020 and long-term targets in most of the recent years.

[25] Ministry of the Environment and Water Resources (2014). **Key Environmental Statistics 2014.** Retrieved from http://www.mewr.gov.sg/grab-our-research

Two rounds of air quality sampling for PM_{10} were conducted by ERM at selected areas (*Figure 6.4*) within the Project area between June and July, and October 2015. PM_{10} was selected considering the typical air emissions associated with the Project construction and operational activities. Details of the methodology adopted, sampling locations and analytical reports for the survey are provided in *Annex 3.0* and *Annex 5.0* respectively. It is noted that one location detailed in *Annex 3.0*, AQ02, was subsequently relocated to the rear of the *Night Safari* amphitheatre to target the localised air quality in proximity to the potential ecological receptors within the *Night Safari* compound.

Baseline air sampling results are summarised in *Table 6.4*.

Table 6.4: Baseline Air Sampling Results [(1)]

Sample ID	Parameters	Results [µg/m^3][(2)]		
		Round 1		Round 2
		Gravimetric Sampling	Light Scattering	Light Scattering
AQ01	Maximum 24 hr PM_{10} concentration	63	23	94
	Minimum 24 hr PM_{10} concentration	- [(3)]	14	44
AQ02	Maximum 24 hr PM_{10} concentration	52	27	73
	Minimum 24 hr PM_{10} concentration	17	15	13
AQ03	Maximum 24 hr PM_{10} concentration	35	19	129
	Minimum 24 hr PM_{10} concentration	- [(3)]	13	62
AQ04	Maximum 24 hr PM_{10} concentration	49	61	141
	Minimum 24 hr PM_{10} concentration	21	27	36
AQ05	Maximum 24 hr PM_{10} concentration	45	56	153
	Minimum 24 hr PM_{10} concentration	28	17	35
AQ06	Maximum 24 hr PM_{10} concentration	49	28	113
	Minimum 24 hr PM_{10} concentration	21	16	12

Notes:

(1) Measurements were undertaken for 1 week at each sampling location. The maximum, mean and minimum 24 hr PM_{10} concentration recorded across 7 days is presented for each survey round.

(2) Measurements were undertaken using light scattering method and a reference method, gravimetric sampling. Based on co-location findings during Round 2, measurements obtained using the light scattering method was found to be most consistent with measurements at the nearest NEA monitoring station. Measurements undertaken using the light scattering method were therefore presented for Round 2.

(3) Gravimetric filter sample weight was below the limit of reporting (LOR) of 0.05 mg.

The following key observations were noted from the baseline air sampling results:

- During Round 1 of the survey, the measured baseline 24 hour PM_{10} concentrations were generally within the Singapore Ambient Air Quality target of 50 µg/m^3 (0.050 mg/m^3), with the exception of measurements at sampling locations AQ04 and AQ05. 24 hour PM_{10} concentrations at AQ04 and AQ05 were recorded at up to 61 µg/m^3 and 56 µg/m^3 respectively. An analysis of the data collected however indicates that PM_{10} measurements at all sampling locations were predominantly influenced by sources outside the Study Area as opposed to sources in close proximity to each meter;

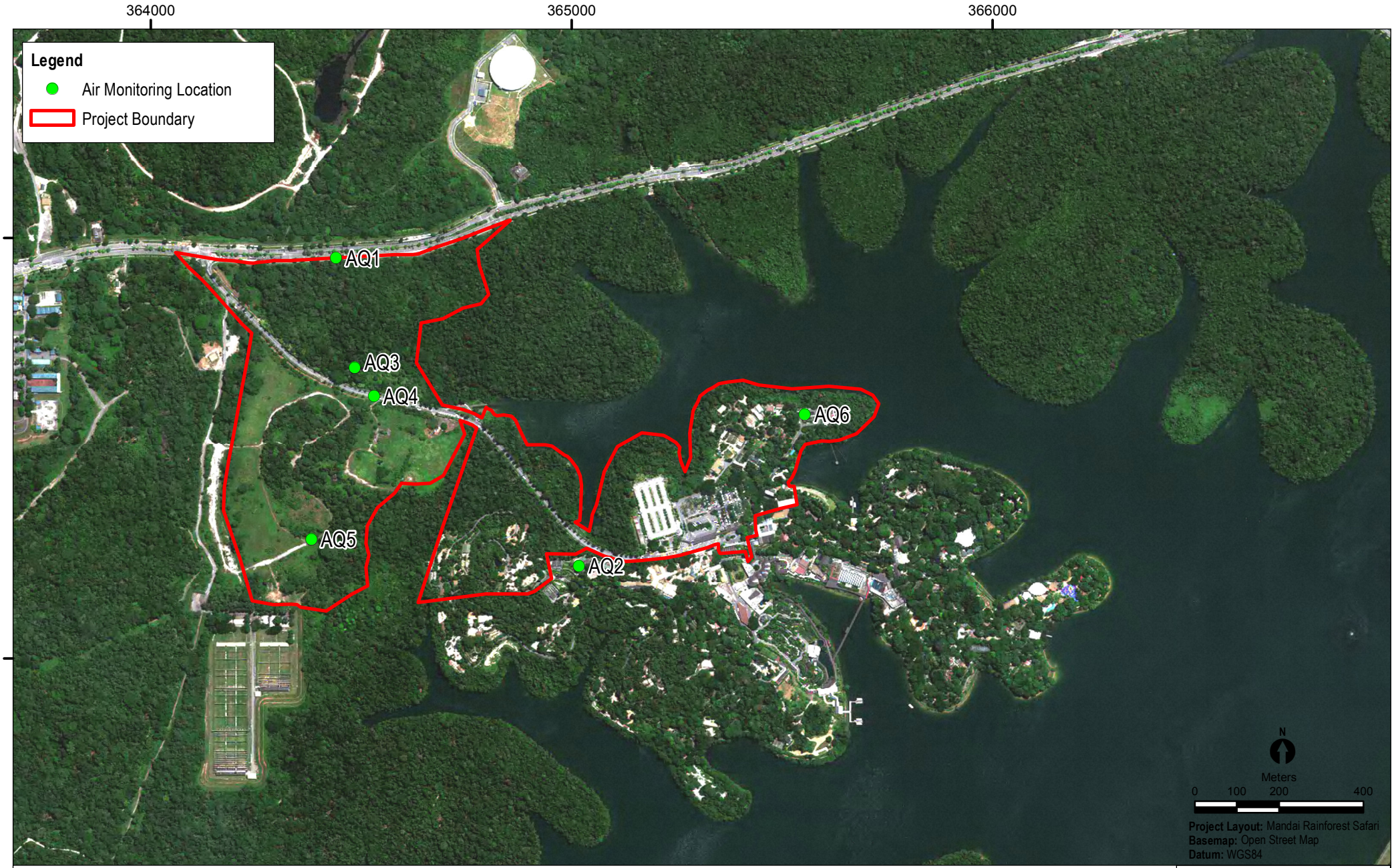

Figure 6.4 Air Monitoring Locations

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- In general, PM_{10} concentrations at AQ04 and AQ05 were higher than that recorded at the other sampling locations. It is observed that meters were deployed at AQ04 and AQ05 between 24 July and 1 August 2015, whereas measurements were undertaken at the other sampling locations between 1 and 18 August 2015. The difference in overall PM_{10} levels at AQ04 and AQ05 as compared to the other sampling locations may be due to the change in regional weather conditions between the months of July and August 2015. Data published by the ASEAN Specialised Meteorological Centre (ASMC) shows an increase in hotspots at Sumatra and Borneo towards the end of July due to lower than normal rainfall in the region [(26,27)]. The number of hotspots observed in the first half of August was markedly reduced due to higher than normal rainfall in the region;

- A review of hourly wind data from the meteorological services division of the NEA indicated that spikes in PM_{10} concentrations in the early morning occurred when the wind direction was predominantly from a westerly and north westerly direction. These spikes were observed at all locations. In conjunction with a review of the surrounding land uses, it can be surmised that the PM_{10} measurements may have been influenced by contributions from the Bukit Timah Expressway and/or emissions from industrial estates to the west of the Project area;

- During Round 2 of the survey, a sampling meter (AQ07) was co-located at one of NEA's monitoring station near the Project area for a period of 2 weeks between 8 and 21 October 2015. Co-location was undertaken to calibrate the sampling meters against the NEA's monitoring station. Comparison of the measurements from AQ07 and the NEA station showed close correlation of the measurements made using the light scattering method and the 24 hour PM_{10} concentrations measured at the NEA station. Measurements using the light scattering method at all other sampling locations undertaken by ERM during Round 2 of the survey, were subsequently adjusted. No adjustments to measurements in Round 1 were made as co-location was not undertaken during Round 1 of the survey;

- In general, the baseline 24 hour PM_{10} concentrations measured during Round 2 of the sampling in the month of October 2015 were above the Singapore Ambient Air Quality target. The measurements were predominantly affected by the transboundary haze from Kalimantan and Sumatra, which occurred throughout the month. Exceedances in adjusted average concentrations (see *Tables A5.7 to A5.13 in Annex 5.2*) during this monitoring period ranged between 52 $\mu g/m^3$ to 153 $\mu g/m^3$; and

- Monsoonal rains at the end of October 2015 resulted in ambient measurements of PM_{10} to fall below the Singapore Ambient Air Quality 24 hour target. For example, ambient 24 hour average PM_{10} concentrations at AQ02 and AQ06 ranged between 13 – 36 $\mu g/m^3$ and 10 – 22 $\mu g/m^3$ respectively, during the period between 28 to 31 October 2015 after the monsoon arrived, in comparison to measurements of between 52 $\mu g/m^3$ to 153 $\mu g/m^3$ earlier in the month.

[26] ASEAN Specialised Meteorological Centre (2015) **Monthly Weather & Haze Review - Update of Regional Weather and Smoke Haze for August 2015.** Retrieved from http://asmc.asean.org/update-of-regional-weather-and-smoke-haze-for-august-2015/

[27] ASEAN Specialised Meteorological Centre (2015) **Monthly Weather & Haze Review - Update of Regional Weather and Smoke Haze for September 2015.** Retrieved from http://asmc.asean.org/update-of-regional-weather-and-smoke-haze-for-september-2015/

6.3 NOISE

6.3.1 Study Area

The Study Area for noise is defined as the area within which human or ecological receptors may be adversely affected by noise generated during construction and operation activities. Noise generation associated with the construction and operational activities likely to be associated with the Project, will likely attenuate within 1,000 m of the Project boundary. The Study Area will therefore consider noise sensitive receptors within 1,000 m of the Project boundary.

6.3.2 Sources of Information

The existing noise environment in the Study Area was developed with reference to the following information sources:

- Field surveys and site reconnaissance within the Project area;
- Meteorological data published by the Meteorological Service Singapore (MSS) [28]; and
- Hourly wind data from the nearest wind sensor along Bah Soon Pah Road, provided by the MSS for the months of July and August 2015.

6.3.3 Local Ambient Noise Environment

A site reconnaissance undertaken in June 2015 highlighted a number of existing noise sources within the Project area, including:

- Road traffic along Mandai Lake Road and Mandai Road and to a lesser extent the Bukit Timah Expressway;
- Cyclists along Mandai Lake Road and the park connector along Mandai Road;
- Artillery activities at the adjacent special use areas;
- Overhead air traffic;
- Movement of people within WRS, using trams, boats etc;
- Animal and insect vocalisations both within the forested areas outside WRS, and within WRS premises; and
- The weather, such as thunder and rain events.

[28] Meteorological Services Singapore (2015) **Historical Daily Records.** Retrieved from http://www.weather.gov.sg/climate-historical-daily/

Long-term noise measurements were conducted over one week periods during June/July and October 2015 at selected locations within the Project area. At locations near to roads, noise measurements and traffic counts were also undertaken over a 15 minute period during peak and off-peak traffic hours, on a weekday and weekend. Furthermore, supplementary manned short-term (i.e. 15 minute) measurements were taken in July at locations where equipment could not be deployed for a longer period of time. Full details of the methodology adopted are provided in *Annex 3.0*, while the consolidated survey findings and the full analytical report are appended in *Annex 6.0.* It is noted, subsequent to the baseline methodology issuance (provided in *Annex 3.0*), the noise survey locations were refined in conjunction with updated conceptual design of the Project to ensure key areas were covered. The rationale for the final survey locations selected and their location are provided in *Table 6.5* and *Figure 6.5* respectively.

Table 6.5: Rationale for Selection of Noise Survey Locations

Survey Location	Rationale (Location representative of baseline noise levels in areas detailed)	Survey Period
NL01	Forested areas within Zone B with exposure to traffic along Mandai Road and Mandai Lake Road	Long-term and short-term (with traffic count)
NL02	WRS compound with no exposure to traffic along Mandai Lake Road (Zone F)	Supplementary short-term
NL03	Forested areas within Zone B with limited exposure to traffic noise	Long-term
NL04	Forested areas within Zones B and D with exposure to traffic along Mandai Lake Road	Long-term and short-term (with traffic count)
NL05	Noise levels at high elevation within Zone D	Long-term
NL06	Noise levels at low elevation within Zone D	Long-term
NL07	Noise levels within the WRS compound with exposure to traffic along Mandai Lake Road	Long-term and short-term (with traffic count)
NL08	Representative of baseline noise levels at Palm Park Court, which is occasionally used by external parties for events and as a temporary camping ground	Long-term
NL09	Temporary staff lodging within the WRS compound (Zone F)	Long-term
NL10	Ecological habitats within CCNR (Zone E), with limited/no exposure to traffic along Mandai Lake Road	Long-term
NL11	Ecological habitats within CCNR (Zone A) with limited exposure to traffic along Mandai Lake Road	Supplementary short-term
NL12	Forested area in Zone F, with limited exposure to traffic along Mandai Lake Road	Supplementary short-term
NL13	Entrance of the Singapore Zoo (Zone F)	Supplementary short-term

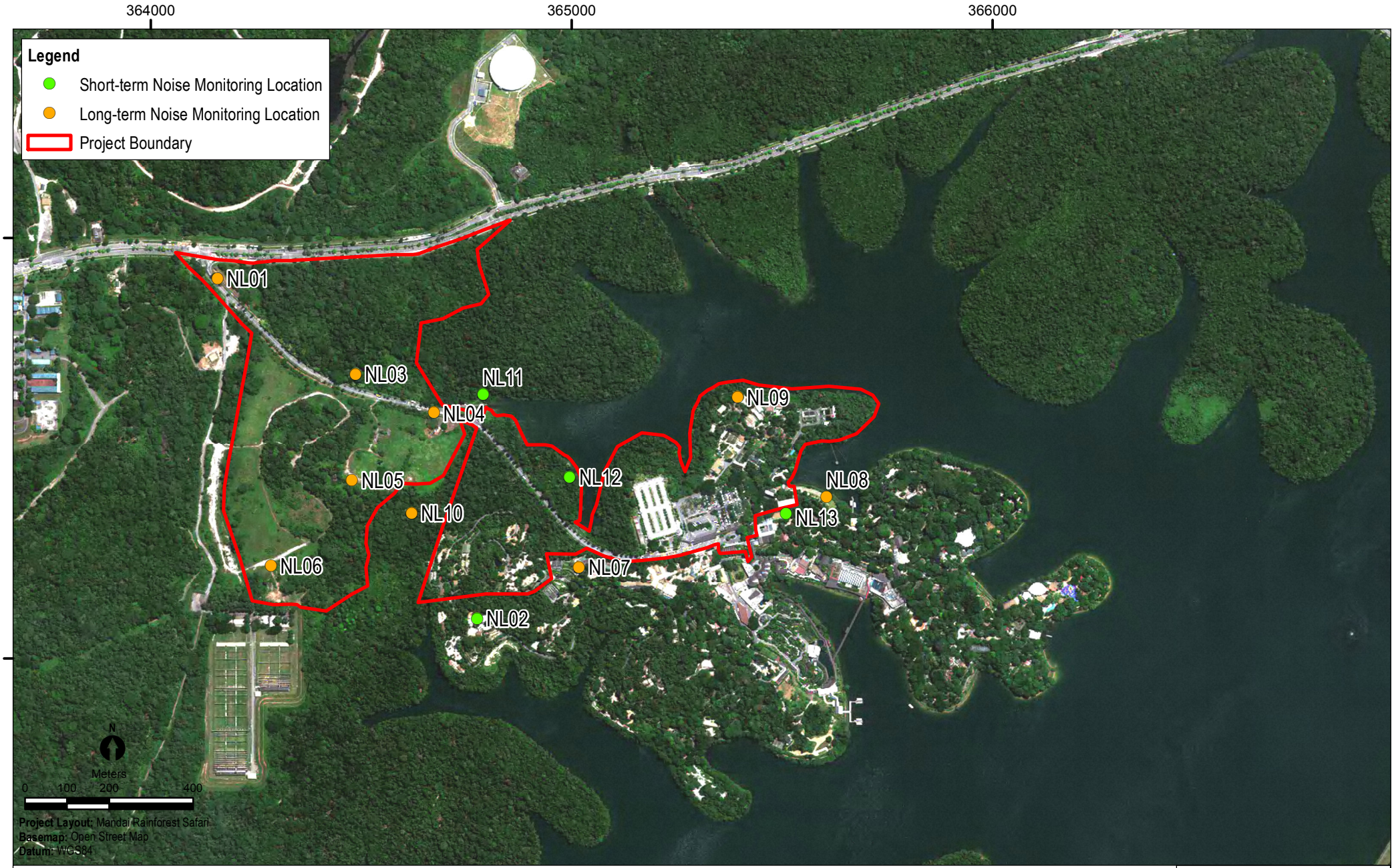

Figure 6.5 Noise Monitoring Points

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The results for the long-term and supplementary short-term noise surveys are summarised in *Table 6.6* and *Table 6.7* respectively.

Table 6.6: Long Term Noise Survey Results (dB(A)) [(1)]

Survey Locations	Parameters		Minimum	Mean	Maximum
NL01	$L_{Aeq,12hr}$	Day	70	71	72
		Night	67	67	68
	$L_{Aeq,1hr}$	Day	68	71	77
		Evening	68	70	76
		Night	59	64	72
	$L_{Aeq,5min}$	Day	70	71	72
		Evening	69	70	73
		Night	65	66	67
NL03	$L_{Aeq,12hr}$	Day	53	56	59
		Night	51	54	59
	$L_{Aeq,1hr}$	Day	49	55	66
		Evening	50	55	60
		Night	44	52	68
	$L_{Aeq,5min}$	Day	53	56	59
		Evening	53	55	58
		Night	48	53	59
NL04	$L_{Aeq,12hr}$	Day	71	72	73
		Night	67	68	69
	$L_{Aeq,1hr}$	Day	67	72	75
		Evening	70	71	73
		Night	51	61	73
	$L_{Aeq,5min}$	Day	71	72	73
		Evening	71	71	72
		Night	64	65	67
NL05	$L_{Aeq,12hr}$	Day	46	53	57
		Night	51	54	59
	$L_{Aeq,1hr}$	Day	40	50	65
		Evening	46	53	62
		Night	47	53	64
	$L_{Aeq,5min}$	Day	46	53	57
		Evening	50	54	59
		Night	50	54	59
NL06	$L_{Aeq,12hr}$	Day	47	57	59
		Night	48	53	60
	$L_{Aeq,1hr}$	Day	41	52	67
		Evening	47	55	69
		Night	45	49	64
	$L_{Aeq,5min}$	Day	47	54	59
		Evening	50	56	65
		Night	47	50	56
NL07	$L_{Aeq,12hr}$	Day	54	59	63
		Night	54	56	60
	$L_{Aeq,1hr}$	Day	48	44	72
		Evening	56	59	63
		Night	46	53	69
	$L_{Aeq,5min}$	Day	54	58	63
		Evening	56	59	62
		Night	51	54	61

Survey Locations	Parameters		Minimum	Mean	Maximum
NL08	$L_{Aeq,12hr}$	Day	54	60	68
		Night	46	49	53
	$L_{Aeq,1hr}$	Day	45	54	78
		Evening	44	50	59
		Night	44	48	60
	$L_{Aeq,5min}$	Day	54	60	68
		Evening	45	50	57
		Night	46	48	54
NL09	$L_{Aeq,12hr}$	Day	49	53	60
		Night	49	51	58
	$L_{Aeq,1hr}$	Day	48	52	70
		Evening	47	51	57
		Night	47	50	66
	$L_{Aeq,5min}$	Day	49	53	60
		Evening	47	51	55
		Night	49	50	59
NL10	$L_{Aeq,12hr}$	Day	50	53	57
		Night	48	52	63
	$L_{Aeq,1hr}$	Day	43	52	62
		Evening	47	54	73
		Night	44	49	63
	$L_{Aeq,5min}$	Day	50	53	57
		Evening	49	55	69
		Night	46	49	55

Note:
(1) Measurements were undertaken over a period of 1 week at each location for each round of survey. The minimum, mean and maximum results were calculated over the full data sets collected over 2 rounds of survey for each location.

Table 6.7: Supplementary Short Term Noise Survey Results [(1)]

Survey Locations	Parameters	Minimum	Mean	Maximum
NL02	$L_{Aeq,5min}$	43	51	57
NL11	$L_{Aeq,5min}$	46	50	58
NL12	$L_{Aeq,5min}$	45	49	54
NL13	$L_{Aeq,5min}$	58	65	70

Note:
(1) 15 minute measurements were undertaken at each location for one peak and off-peak period, on a weekday and weekend between June and August 2015. The minimum, mean and maximum $L_{Aeq,5min}$ values were calculated over the four data sets collected at each location.

The following key observations are noted from the baseline noise survey results:

- A review of historical weather data at the nearest monitoring station (Mandai) indicated that rainfall events occurred in June/July, i.e. during the Round 1 noise survey. Site observations confirmed that no rainfall events occurred in October, i.e. during the Round 2 noise survey. As rainfall events during the Southwest monsoon are typically of short duration; and noise measurements taken during Round 1 indicated that contributions from rainfall were not distinguishable from contributions from other localised noise sources; seasonal variations were not an influence for noise levels measured at the Project area;

- Differences in noise levels measured between June/July (Round 1) and October (Round 2) are largely attributed to the following activities observed:
    - Higher frequency of aircraft flying overhead during the daytime to early evening, due to the Singapore National Day parade rehearsals in June/July 2015;
    - Operation of diesel motor, possibly for grass cutting activities at the special use areas on 6 October 2015;
    - Daytime construction activities for a new tram station near NL07 in October (during Round 2); and
    - Occurrence of haze throughout the October Round 2 survey, which may have contributed to the less frequent vocalizations of caged gibbons in the *Singapore Zoo* recorded at NL08.
- Noise levels measured during both survey rounds at NL01 and NL04, ranged from $L_{Aeq,12hr}$ 70 to 73 dB(A) in the day, and from 67 to 68 dB(A) at night. As these locations are within 2 m of the nearest road, noise measurements were dominated by emissions from vehicular traffic. Aircraft were also observed overhead on occasion;
- Noise levels within the forested area at NL03, which is located approximately 50 m from Mandai Lake Road, ranged from $L_{Aeq,12hr}$ 53 to 56 dB(A) in the day, and 51 to 53 dB(A) at night, and were observed to be dominated by natural sounds;
- Measured noise levels were similar at survey locations NL05, NL06 and NL10, ranging from $L_{Aeq,12hr}$ 46 to 55 dB(A) in the day, and from 48 to 54 dB(A) at night, despite varying distances from the special use areas. Noise measurements at these locations were dominated by natural sounds;
- Survey locations within Zone F were spaced to capture noise levels at the *Night Safari*, the *Singapore Zoo* and the Back of House areas within the *Singapore Zoo* premises. The measured noise levels across these locations varied in accordance with the nearest noise sources as follows:
    - NL07 ranged from $L_{Aeq,12hr}$ 54 to 57 dB(A) in the day, from 54 to 56 dB(A) at night. Hourly evening noise levels were typically higher than daytime noise levels. Measurements at NL07 were therefore surmised to be dominated by operations within the *Night Safari*, in particular during night shows held periodically at the *Night Safari* Amphitheatre. Noise from vehicular traffic along Mandai Lake Road approximately 30 m away was partially shielded by low buildings surrounding NL07;
    - Noise levels at NL08 were dominated by operations within the *Singapore Zoo*. Levels recorded in the day ranged from $L_{Aeq,12hr}$ 54 to 61 dB(A), and 46 – 49 dB(A) at night. Daytime levels were generally higher than those recorded in the evening and night, when the zoo is closed. Noise sources observed during daytime zoo operations include intermittent calls from caged gibbons located beside Palm Park

Court and at the animal quarantine area; as well as human activity at Palm Park Court and the nearby zoo exhibits;

- Noise levels measured at NL09 ranged from $L_{Aeq,12hr}$ 49 to 53 dB(A) in the day, and from 49 dB(A) at night. These measurements were generally lower than those recorded at NL07 and NL08 as the staff dormitories were effectively shielded from nearby zoo operation areas such as the nursery and animal quarantine areas. Noise recorded at this location was dominated by insect calls and human activity from the nearest staff dormitory.

- Supplementary short term (i.e. 15 minute) measurements were undertaken at monitoring locations within the forested areas north of Mandai Lake Road (NL11 and NL12); at the atrium outside the *Singapore Zoo* entrance (NL13); and within a service road in the *Night Safari* premises (NL02). The measured noise levels across these locations varied in accordance with the nearest noise sources;

- Short-term noise levels measured at NL01 and NL04 are consistent with long term noise measurements at these locations in the daytime, i.e. $L_{Aeq,15min}$ levels range between 70 to 72 dB(A) as compared to $L_{Aeq,12hr}$ daytime levels of 70 to 73 dB(A). This confirms that noise from nearby vehicular traffic was the dominant source at these locations;

- Short-term noise levels measured are much higher than long term measurements at NL07, i.e. $L_{Aeq,15min}$ 67 – 70 dB(A) compared to $L_{Aeq,12hr}$ 54 – 57 dB(A) in the daytime. This suggests that short-term noise levels at NL07 are not dominated by vehicular traffic along Mandai Lake Road but by more localised sources of noise such as maintenance activities within the working area behind the *Night Safari* amphitheatre;

- Supplementary short-term noise levels measured during the weekdays at NL02 were dominated by overhead aircraft observed during the survey. Similarly, noise levels at NL11 and NL12 during the weekday peak period was measured at $L_{Aeq,15min}$ 53 dB(A) due to contributions from aircraft during the survey. At other times, noise levels at NL02, NL11 and NL12 were dominated by natural sounds. Noise sources unique to these survey locations, such as *Night Safari* operations at NL02 and passing vehicular traffic at both NL11 and NL12, occurred intermittently during the survey; and

- Noise levels measured during peak period at NL13 ranged between $L_{Aeq,\ 5min}$ 66 to 70 dB(A) and were dominated by human traffic and activity at the dining atrium at the *Singapore Zoo* entrance. During off peak hours at WRS, noise levels were measured at $L_{Aeq,15min}$ 67 dB(A) during the weekday, and at $L_{Aeq,15min}$ 69 dB(A) during the weekend, and were dominated by area cleaning and zoo closure activities.

6.4 SURFACE WATER

6.4.1 Study Area

The Study Area is defined as areas encompassing the surface water features (streams, reservoirs, canals or other permanent or seasonal water bodies) within and adjacent to the Project that may be affected by construction and operational activities associated with the Project, i.e. Upper Seletar Reservoir; small streams within WRS; streams within the CCNR north of Mandai Lake Road; a stream which flows parallel to the western boundary of the *Bird Park*, approximately 25 m from the Project boundary; and existing drainage infrastructure which transports stormwater within and from the Project area as shown on *Figure 6.6*.

6.4.2 Sources of Information

The existing surface water characteristics of the Project area have been identified from the following sources of information:

- Observational data collected during a site reconnaissance and surface water feature mapping;
- Physical water quality details from field surveys carried out by ERM;
- Monitoring information available from the PUB;
- Existing surface water drainage infrastructure plans available for the Study Area;
- Online publications from government authorities such as annual reports; and
- Satellite and aerial photographic imagery.

6.4.3 Surface Water Streams Within the Project Area of Influence

6.4.3.1 Stream within WRS

A natural stream runs along the western boundary of the *Night Safari* and feeds into the Upper Seletar Reservoir to the south. The stream is located down-gradient from the *Night Safari* and the perimeter cut-off drain. Due to its topographical position, the stream is inferred to be a natural watercourse fed by runoff from the surrounding uphill areas.

6.4.3.2 *Unnamed Stream Parallel to the Project Western Boundary*

An unnamed stream flows parallel to the western boundary of the *Bird Park*, approximately 25 m from the western boundary of the Project area. The stream is partly natural and channelized in some areas, beginning close to a special use area and ending near the junction of an unnamed road and Mandai Lake Road, where it joins a channelized drain running along Mandai Lake Road. Flow at the stream was observed to be slow and towards the north away from the Project area. The stream is located within the Sungei Mandai Water Catchment Area. Water from the Sungei Mandai Water Catchment Area is either: captured by the PUB abstraction station and pumped to the Upper Seletar Reservoir; or discharged to sea.

6.4.3.3 *Streams within the CCNR*

A few natural streams were observed within the CCNR north of Mandai Lake Road as illustrated in *Figure 6.6*. Similar to the stream within the *Night Safari*, these streams discharge to the Upper Seletar Reservoir. Due to their close proximity to the Project area, some of these streams could be impacted during the construction and operation activities of the project. Further description of these streams can be found in *Section 6.6.*

6.4.4 *Stormwater Drains*

Extensive stormwater drainage infrastructure exists at the *Singapore Zoo*; Mandai Road and Mandai Lake Road; and the *Night Safari*. This consists of both open air and covered drains.

6.4.4.1 *WRS Operated Areas*

The existing WRS consists of two kinds of stormwater drains, namely perimeter cut-off drains and road-side drains. The existing WRS is surrounded by a series of perimeter cut-off drains at the boundary. The primary function of the perimeter cut-off drains is to intercept stormwater runoff to prevent it from entering the Upper Seletar Reservoir. Stormwater collected within the perimeter drains is pumped for off-site discharge to sea [(29)] via pump stations located within the WRS. In some areas of the *Singapore Zoo*, such as the existing Back of House areas, stormwater is routed through a pump station at the WTP for off-site discharge to sea (*Figure 6.6*).

[29] Wildlife Reserve Singapore (20 November 2015). **WRS Infrastructure Services Facilities Management.**

There is also a section of roadside drain that begins from the existing WRS carpark and ends near the lay-by area along Mandai Lake Road. Stormwater collected within this roadside drain is ultimately discharged to the Upper Seletar Reservoir.

Perimeter Cut-off Drain along the staff quarters within Singapore Zoo

Perimeter Cut-off Drain Within Night Safari

6.4.4.2 Stormwater Drain along Mandai Lake Road

The stormwater drain along Mandai Lake Road is an open air canal that flows north. As shown in *Figure 6.6*, the drain begins near the lay-by area across the former Mandai Orchid Farm and runs along Mandai Lake Road, the Sungei Mandai catchment area and eventually discharges into sea.

Open air canal along Mandai Lake Road

6.4.5 Upper Seletar Reservoir

Upper Seletar Reservoir is the third impounding reservoir in Singapore. It was first built in the 1920 as Seletar Reservoir and expanded several times in 1940. It was renamed Upper Seletar Reservoir in 1986 after Sungei Seletar was dammed up to form the Lower Seletar Reservoir today. The primary use of the reservoir water is as a supply to the PUB for treatment and distribution as potable water. The reservoir stores rainwater runoff collected from the surrounding catchment as well as water pumped from seven nearby streams [30]. Water from the Upper Seletar Reservoir is transferred to other reservoirs for storage and subsequently treated in a waterworks before being distributed as potable water [26]. The

View of Upper Seletar Reservoir from Singapore Zoo

[30] National Library Board (2014) **Singapore Infopedia: Seletar Reservoir.** Retrieved from http://eresources.nlb.gov.sg/infopedia/articles/SIP_562_2005-01-19.html

reservoir is part of the CCNR and is home to numerous aquatic flora and fauna species. The PUB has designated a fishing zone at the eastern end of the Upper Seletar Reservoir. There is one known direct outflow from the Project area into Upper Seletar Reservoir (i.e at the lay-by area near Mandai Lake Road as shown in *Figure 6.6*). There is also an indirect discharge to Upper Seletar Reservoir – The unnamed Stream located west of the Project area flows north west to the Sungei Mandai Catchment Area, where it is either captured by the PUB abstraction station and pumped to the Upper Seletar Reservoir; or discharged to sea. Further details on the unnamed stream are presented in *Section 6.4.3*.

Stormwater runoff from the Sungei Mandai catchment area, where part of the Project boundary resides, is channelled into Sungei Mandai and collected in a stormwater abstraction pond near Kranji Turf Club. The water collected in the stormwater pond is pumped into the Upper Seletar Reservoir. PUB undertakes regular sampling of water quality at Sungei Mandai and Upper Seletar Reservoir, given that both serve as a key drinking water supply to Singapore. A summary of the historical monitoring results between 2013 and 2014 are shown in *Annex 7.0.*

6.4.6 *Surface Water Sampling*

Two rounds of samplings were conducted during the Southwest monsoon (10 June 2015) and inter-monsoon season (7 October 2015) at five sampling locations as presented in *Figure 6.6*. The surface water sampling locations include one point at the unnamed stream (SW02), one point at the stormwater drain along Mandai Lake Road (SW01), two points within WRS (SW05 and SW08) and one point at the natural stream outside of the *Night Safari* boundary. As explained in *Section 6.3.3,* these final survey locations were refined from the identified locations in the Method Statement (Annex 3.0) as the project design evolved. The rationale for each location is summarized in Table 6.8.

Table 6.8: Surface Water Sampling Location Rationale

Survey Location	Rationale
SW 01	Representative of water quality downstream of the proposed Rainforest Park North and Bird Park
SW 02	Representative of water quality upstream of the proposed Bird park. Note, the canal flows towards SW01.
SW 05	Representative of water quality of runoff from the northern part of WRS's premises collected in the cut off drain.
SW 08	Representative of water quality of runoff from WRS's premises collected in the cut-off drain.
SW 09	Distinct aquatic environment.

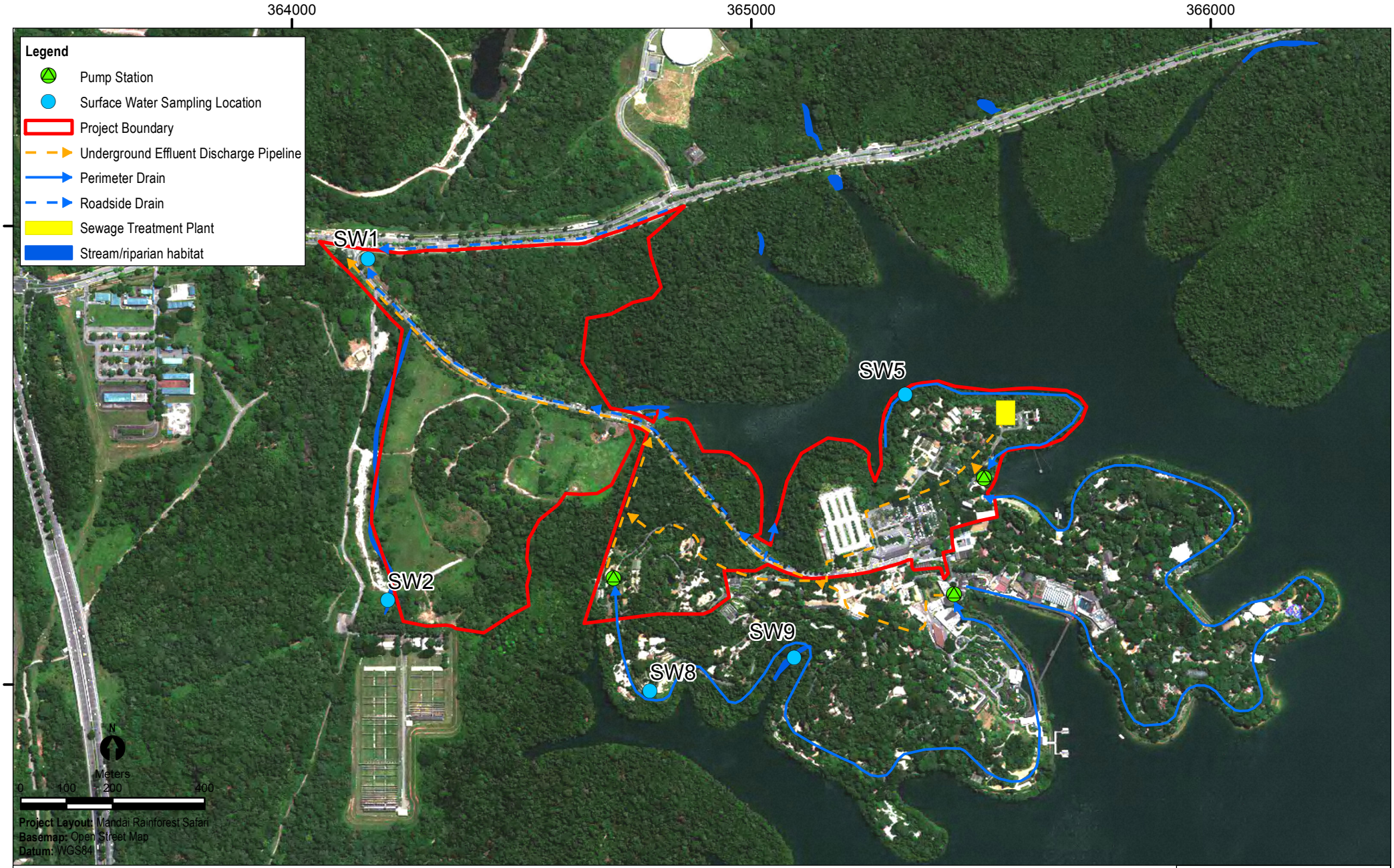

Figure 6.6 Surface Water Sampling Locations

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At WRS, the sampling locations comprised a perimeter cut-off drain situated at the staff quarters and animal quarantine area in the north of WRS grounds (SW05, *Figure 6.6*). The other location is a perimeter cut-off drain within the *Night Safari* (SW08, *Figure 6.6*). Water collected within this drain is channelled to a pumping station where it is ultimately pumped for discharge to sea. An additional round of sampling was carried out at the locations within WRS during the rain to understand the quality of stormwater runoff within WRS. The rain event occurred on 11 November 2015 in the afternoon between 2 pm and 4 pm with highest 120 minutes rainfall recorded to be 24.8 mm [31]. The event began with showers accompanied with lightning. Due to safety concerns, samples were collected at around 3:30 pm when the rain subsided. Sampling at SW09 was discontinued during the inter-monsoon period due to fallen trees prohibiting access to the sampling location.

SW01, SW02 and SW09 were located at surface waterbodies discharging to the Upper Seletar Reservoir, either through direct discharge or pumped from the abstraction station. The Upper Seletar Reservoir is considered as a controlled watercourse as per the *Environmental Protection and Management (Trade Effluent) Regulations 2008*, while sampling points at the perimeter cut-off drains within the Zoo (i.e. SW05 and SW08 within the *Singapore Zoo* and *Night Safari* respectively) discharge to sea which is considered to be an uncontrolled watercourse. The sampling results, based on the locations of the discharge points, were compared against the respective discharge limits for controlled and uncontrolled watercourses stipulated within the *Environmental Protection and Management (Trade Effluent) Regulations 2008* (see *Table 6.9* and *Table 6.10*). All sampling results were found to be within the limits with the exception of pH measured at SW 08 and SW09 during the first round of sampling. However the result of the subsequent samplings for SW08 indicated that the pH measurements were within the limit of 6 to 9.

In addition, significant variation was observed between the two rounds of results at SW08 for Total Dissolved Solids (TDS), turbidity, total phosphorous, total nitrogen and BOD_5 and COD. For these parameters, the results of the second round are more than 2 times higher than the first round. In general, a higher TDS reading suggest an increase in inorganic and/or organic matter dissolved in water. Turbidity is a measure of water cloudiness/ muddiness and water turbidity could be caused by suspended soil particles, floating organisms as well as small fragments such as dead plants. For total phosphorus and total nitrogen, there are many sources, both natural and anthropogenic. Since SW08 is at the perimeter cut-off drain which collects storm water from surface drainage within the *Night Safari*, potential sources could include runoff from fertilized lawns or runoff from animal manure storage areas, for example.

The results of the sampling undertaken during the rain demonstrated elevated concentrations of *E. coli* at both sampling locations. Since these survey locations are at the perimeter cut-off drain which collects stormwater from the surface drainages within WRS, the elevated concentrations could be attributed to animal waste washed off from WRS.

[31] Meteorological Service Singapore (2016) Historical Daily Records for Mandai Nov 2015. Retrieved from http://www.weather.gov.sg/climate-historical-daily/

Table 6.9: Baseline Surface Water Quality Sampling Results - Sampling Points Discharged to a Controlled Watercourse

Parameter	Unit	LOR [1]	EPM (Controlled Watercourse)[2]	SW 01		SW 02		SW 09
				R1 (SW Monsoon, Sunny)	R2 (Inter-monsoon, Sunny)	R1 (SW Monsoon, Sunny)	R2 (Inter-monsoon, Sunny)	R1 (SW Monsoon, Sunny)
pH at 25˚C	pH Unit	0.1	6 – 9	7.0	7.0	6.9	6.9	**5.2**
Temperature	˚C	0.1	45	27.9	29.8	27.8	29.6	27.6
TDS	mg/L	5	1,000	85	104	65	75	56
TSS	mg/L	5	30	<5	<5	<5	<5	<5
Turbidity	NTU	0.1	-	5.50	9.40	9.20	7.30	2.90
P	mg/L	0.003	-	<0.003	0.05	<0.003	0.047	<0.003
N	mg/L	0.1	-	1.15	1.22	1.07	<0.10	3.40
E. coli	MPN/ 100 ml	1.8	-	130	350	49.0	47.0	79.0
BOD_5 at 20˚C	mg/L	2	20	<2	<2	<2	<2	<2
COD	mg/L	1	60	8	7	9	11	4
Chlorophyll a	mg/m^3	1.0	-	<1.00	<1.00	<1.00	<1.00	<1.00
DO	mg/L	0.1	-	7.35	7.47	6.60	6.44	7.07
Oil & Grease (Total)	mg/L	5 for R1 1 for R2/ R3	1	<5	<1	<5	<1	<5

Notes:

(1) LOR = Limit of Reporting

(2) Limits for discharge into a controlled watercourse as per the *Environmental Protection and Management (Trade Effluent) Regulations, 2008.*

(3) Value in bold denotes an exceedance of the limits.

(4) Abbreviations: TDS - Total Dissolved Solids; TSS - Total Suspended Solids; P - Total Phosphorus; N - Total Nitrogen; BOD5 – 5-day Biochemical Oxygen Demand; COD – Chemical Oxygen Demand; DO – Dissolved Oxygen

(5) Sampling methodology provided in *Annex 1.0*.

(6) Sampling and analysis completed by ALS Laboratories. Full analytical report provided in *Annex 7.0*.

Table 6.10: Baseline Surface Water Quality Sampling Results- Sampling Points Discharged to an Uncontrolled Watercourse

Parameter	Unit	LOR [1]	EPM [2] (Uncontrolled Watercourse)	SW 05			SW 08		
				R1 (SW Monsoon, Sunny)	R2 (Inter-monsoon, Sunny)	R3 (Rain,120-min rainfall; 24.8 mm)	R1 (SW Monsoon, Sunny)	R2 (Inter-monsoon, Sunny)	R3 (SW Monsoon, Sunny)
pH at 25˚C	pH Unit	0.1	6 – 9	7.2	7.1	6.5	**5.1**	7.4	6.7
Temperature	˚C	0.1	45	29.0	29.5	26.2	27.8	29.1	26.3
TDS	mg/L	5	-	137	119	28	35	163	168
TSS	mg/L	5	50	<5	<5	<5	<5	<5	5
Turbidity	NTU	0.1	-	1.50	1.80	4.50	1.30	3.90	66.0
P	mg/L	0.003	-	0.072	0.032	0.091	<0.003	0.831	0.362
N	mg/L	0.1	-	1.78	<0.10	0.82	2.70	8.10	1.92
E. coli	MPN/ 100 ml	1.8	-	180	220	>1,600	350	430	>1,600
BOD_5 at 20˚C	mg/L	2	50	<2	<2	3	<2	25	5
COD	mg/L	1	100	9	11	11	6	68	37
Chlorophyll a	mg/m^3	1.0	-	4.53	4.51	1.97	<1.00	2.80	5.10
DO	mg/L	0.1	-	7.65	7.62	7.43	5.94	7.35	7.36
Oil & Grease (Total)	mg/L	5 for R1 1 for R2/ R3	10	<5	<1	<1	<5	<1	3

Notes:

(1) LOR = Limit of Reporting

(2) Limits for discharge into an uncontrolled watercourse as per the Environmental Protection and Management (Trade Effluent) Regulations, 2008.

(3) Value in bold denotes an exceedance of the limits.

(4) Abbreviations: TDS - Total Dissolved Solids; TSS - Total Suspended Solids; P - Total Phosphorus; N - Total Nitrogen; BOD5 – 5-day Biochemical Oxygen Demand; COD – Chemical Oxygen Demand; DO – Dissolved Oxygen

(5) Sampling methodology provided in *Annex 1.0*.

(6) Sampling and analysis completed by ALS Laboratories. Full analytical report provided in *Annex 7.0.*

6.5 GEOLOGY & HYDROGEOLOGY

6.5.1 Study Area

The Study Area for the geological and hydrogeological baseline is defined as the immediate footprint of the Project area, including any construction worksites and any nearby waterbodies, e.g. Upper Seletar Reservoir, which may be in hydraulic connectivity with groundwater underlying the Project area.

6.5.2 Sources of Information

Information used to inform the baseline geological and hydrogeological characteristics of the Study Area include the following:

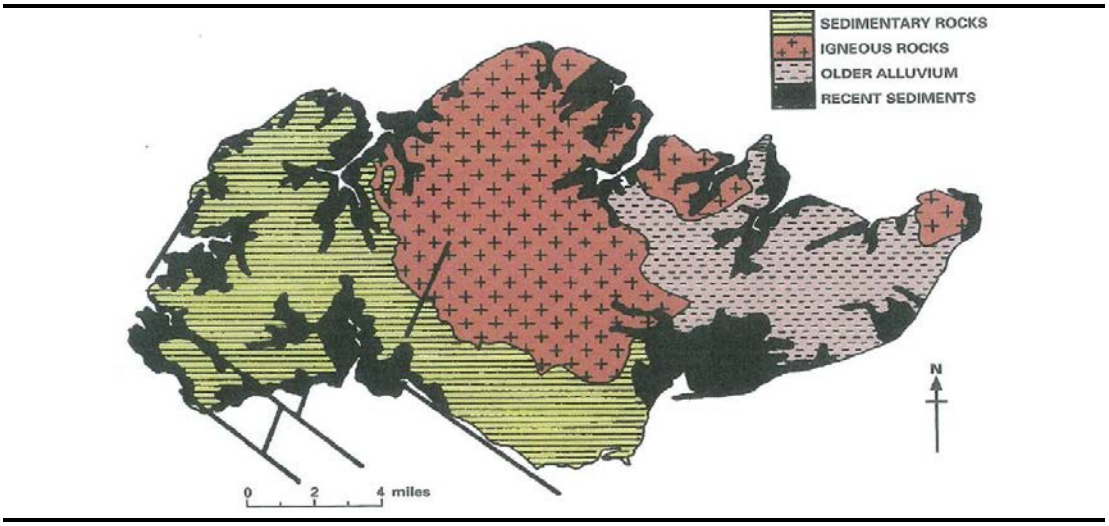
- Site reconnaissance of the Project area;
- Topographical, geological and hydrogeological maps; and
- Shallow soil and groundwater sampling and analysis undertaken at targeted areas.

6.5.3 Geology

6.5.3.1 Regional Geology

The land area of Singapore comprises Singapore Island and several smaller islands, with a total land mass of approximately 700 km^2. Singapore Island is low-lying with approximately two-thirds of the island being less than 30 meters above sea level (m asl) [32]. It is characterised by several distinctive geomorphic areas which reflect the underlying geology. The most distinctive topography is found in the central area where the Project is located, with hills between 60 and 100 m in elevation and steep valleys. The primary geological formation within this area is igneous rock as illustrated on *Figure 6.7*.

Figure 6.7: Primary Geological Regions of Singapore



[32] Chia Lin Sien, Ausafur Rahman, Dorothy Tay H.H. (1991), **The Biophysical Environment of Singapore**, Singapore University Press, 1991, ISBN 9971-69-144-2

Source: Alexander, F E S (1950) **The Geology of Singapore and the Surrounding Islands.** Singapore Government Press

Review of the *Geology of Singapore, 2nd Edition* [33] shows that the igneous rock underlying the Project area is largely Bukit Timah Granite, however a small section of Alluvial member is also noted at the junction of Mandai Lake Road and Mandai Road and along the unnamed road along the western boundary of the *Bird Park*. Further details on the formations underlying the site are provided in *Table 6.11*.

Table 6.11: Geological Formations in Project Area

Bukit Timah Granite	The Bukit Timah Granite has been dated to the late Permian to middle Triassic period, approximately 200 to 250 million years ago. The principal minerals include quartz (30%), feldspar (60-65%), biotite and hornblende, with mineralogical variations from adamelite to granodiorite. Typically, the Bukit Timah Granite is rich in ferromagnesian minerals resulting in a more acidic composition. Individual minerals are medium to coarse grained, usually light grey and sometimes pinkish [34]. The degree of weathering of the Bukit Timah granite across the region is influenced by the climatic conditions with the tropical monsoonal rainfall conditions that contribute to surface erosion and weathering. There are six main weathering profiles, from Grade VI, indicative of residual soil, to Grade I, indicative of freshly weathered granite[3]. The residual soil (Grade VI) and the completely weathered (Grade V) Bukit Timah Granite are typically characterised as reddish to yellowish brown sandy silt and silty sand. The highly weathered (Grade IV) and moderately weathered (Grade III) Bukit Timah Granite are typically characterised as moderately weak to strong granite, with closely spaced fractures. Slightly weathered (Grade II) and fresh (Grade I) Bukit Timah Granite are commonly described as moderately strong to very strong massive granites, with widely spaced irregular fractures. The fresh (Grade I) Bukit Timah granite has an average Uniaxial Compressive Strength of 180 megapascals (MPa), the highest being over 300 MPa; the weathered rock grades are characterised by much lower strengths.
Kallang Formation	The Kallang Formation originates from sediments deposited over the last 15,000 years, from the Holocene and late Pleistocene to the present. The Kallang Formation can be subdivided into five groups based on the type of depositional environment [35]. It is anticipated that the Kallang sedimentary units that may be encountered in the Study Area will comprise primarily alluvial and potentially transitional estuarine sediments. Kallang Formation deposits in this area are anticipated to occur in former river valleys, incised into the underlying Bukit Timah bedrock, along low lying areas and waterways, for example along the unnamed road along the western boundary of the *Bird Park*. The Kallang Formation sub-group in the vicinity of the Study Area is the Alluvial member, variable terrestrial sediment ranging from pebble beds through sand, muddy sand and clay to peat.

6.5.3.2 *Local Geology*

Soil sampling, up to 8 m below ground level (bgl), was undertaken from 24 to 31 July 2015 and 11 November to 4 December 2015, at a total of 23 locations across the Project area as shown on *Figure 6.8*. Prior to the commencement of the soil sampling, unexploded ordnance (UXO) survey and cable scanning were undertaken to verify subsurface clearance *(Annex 8.0)*. As

[33] Defence Science and Technology Agency (2009) **Geological Maps of Singapore, Scale 1: 25,000.** Geology of Singapore (2nd Edition)
[34] Jian Zhao (17 January 2012). **Underground Space Development in Singapore Rocks.** PTRC and NCUS Workshop on Underground Space and Rock Cavern Development in Singapore, NTU.
[35] Aung Kyaw Htoon, Kyi Yu (6 June, 2009) **Late Pleistocene Geology of Singapore for Engineering Geologists**, MGSS Workshop.

outlined in the Baseline Method Statement (*Annex 3.0*), preliminary shallow sampling was conducted using hand augers at numerous locations presented in *Figure 6.8* in July as screening to determine locations for further investigation. A subsequent soil and groundwater survey was conducted in November 2015. This involved drilling of boreholes (labelled BH01 – BH08 on *Figure 6.8*) at or in close proximity to the hand auger locations for the collection and analyses of soil and groundwater. Soil samples were collected for geological characterisation as well as for laboratory analysis to determine baseline quality as outlined in *Annex 9.0*.

To determine the baseline soil quality, reference was made to the "Target Values" (DTVs) and "Intervention Values" (DIVs) issued by the Dutch Ministry of Housing, Physical Planning and the Environment in 2010. The DTVs represent background soil and groundwater analyte concentrations in the Netherlands, whereas the DIVs indicate the soil and groundwater analyte concentrations (numerical values), above which adverse effects on humans or the environment may occur due to the concentration of contaminants.

The findings of the field survey are detailed in *Annex 9.0* and summarised as follows:

- The Project area is predominantly underlain by soft to firm sandy silt with components of gravel or clay. SS11, SS15 and BH4 were observed to be underlain by medium dense sandy gravel. Beneath the top layer, clayey silt, gravelly silt or sandy silt were observed to be the main soil type within SS01, SS02, SS03, SS06, SS09, SS10, SS12, BH/MW1 and BH/MW3 to a maximum depth of 3.0 m bgl. Soft to firm silty clay was encountered within SS04, SS05, SS08 and BH/MW3 at depths ranging between 1 m and 3 m bgl. Soft to firm clay was encountered at SS07, SS11, SS15 and BH/MW4 at depths ranging between 0.5 m and 3 m bgl and at BH/MW1, BH/MW3, BH/MW4 and BH/MW6 at depths between 3 m to 6 m bgl.

- At the following locations SS06, SS08, SS11, SS13 and SS14, obstructions suspected to be boulders or concrete slabs were encountered before the proposed maximum depth of 3.0 m bgl could be reached by hand auger. The boulders and concrete could be attributed to fill materials associated with the development of the area, for example SS08 (zoo workers quarter), SS11 (former orchid farm), SS14 (pathways). While ERM could not ascertain the source of the obstructions at SS06 and SS13, they are likely either natural cobbles or boulders present within the ground or backfill material.

In general, concentrations of most analytes in the soil samples were below their respective DIVs with the exception of the following:

- **Cadmium, copper and zinc:** Cadmium is a natural element in the earth's crust and traces can be found in all soils and rocks. Copper is a metal that occurs naturally throughout the environment and its compounds are commonly used in agriculture to treat plant diseases, water treatment and preservatives for wood, leather and fabrics. Zinc is found in soil and has many commercial uses such as coatings to prevent rust. The sources of these heavy metals detected above their respective DTVs cannot be confirmed at this time.

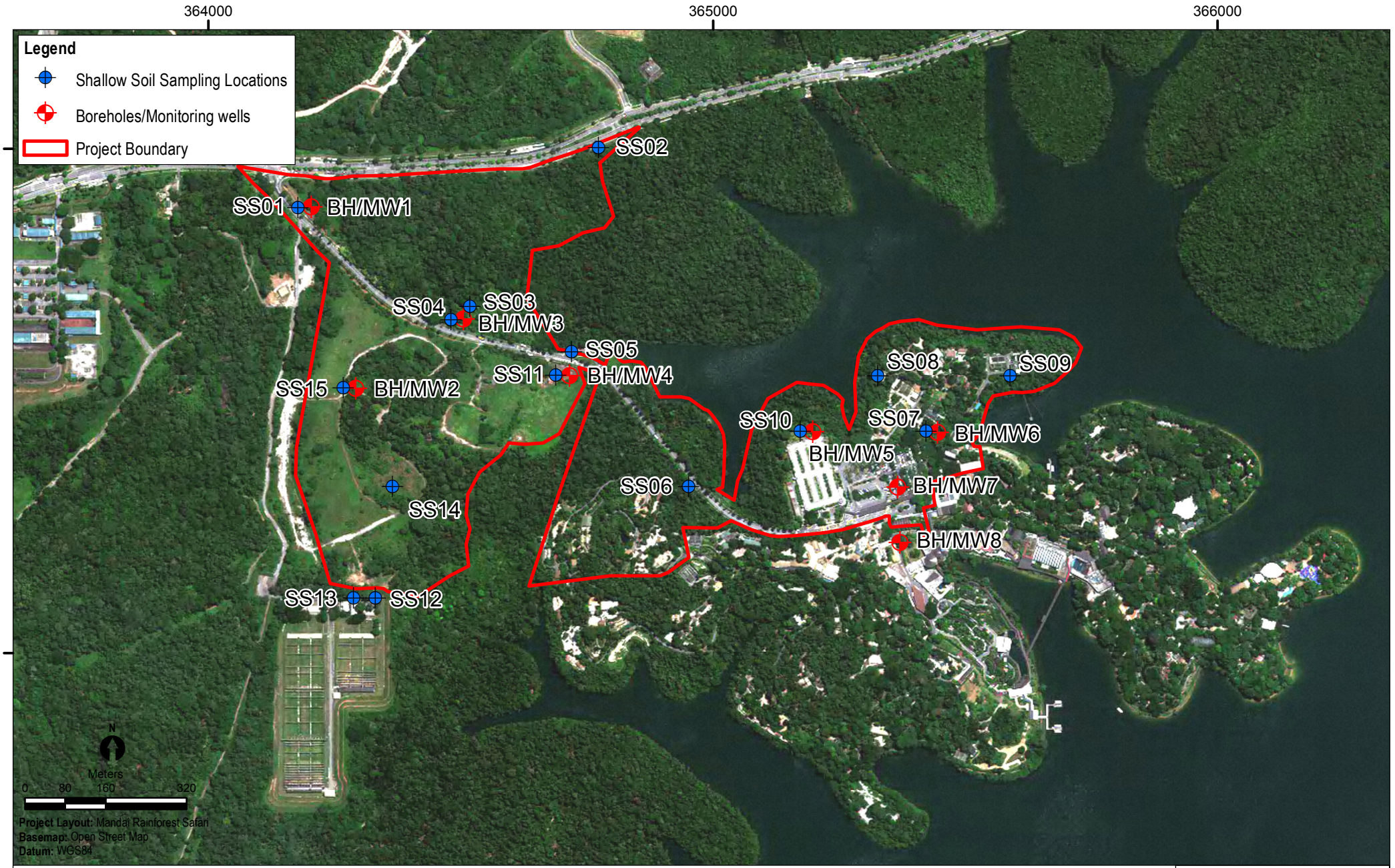


Figure 6.8 Shallow Soil Sampling and Monitoring Well Locations

Service Layer Credits: World View 2 Imagery

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- **Mineral oil:** The detection of slightly elevated levels of mineral oil and some fractions of TPH (C_{15}–C_{36}), while below the DIV of mineral oil, indicates the possibility of presence of small and possibly isolated areas of hydrocarbon impacts. Such locations (SS04, SS11, SS12, SS13, SS14 and BH/MW4) are located within or along adjacent to the special use areas where artillery exercises are carried out occasionally. The possibility of activities from such exercises (maintenance of weaponry using lubrication oil, or refilling of diesel into vehicles) contributing to the concentrations of TPH and mineral oil detection cannot be discounted.

- **Polynuclear Aromatic Hydrocarbons (PAHs):** were detected above the limit of reporting (LOR) at SS13 at a depth of 1.5m. There are no published DTV and DIV for PAH in soil except for Sum of PAH (soil with organic matter up to 10%) and the detected concentrations did not exceed the DIV. PAHs are typically formed during the incomplete combustion of organic substances. PAHs are also found in coal tar, crude oil, creosote and roofing tar, and a few are used in medicines or to make dyes, plastics and pesticides. The source of PAH at SS13 cannot be ascertained.

- **Arsenic:** Arsenic was detected at different locations across the Study Area, at some locations above the DIV. The highest concentration, i.e. 240 mg/kg was recorded at BH/MW1 at 2.3 m blg. Arsenic present in the environment are naturally occurring or resulting from human activities (e.g. agriculture and wood preservation). Limited information and data were available to determine the source of arsenic in the soil at the Study Area.

- **Antimony:** which was detected above the DTV at most of the borehole locations, is found naturally in the environment.

- **Other components:** detected above LOR include phosphorus, potassium, calcium, magnesium, iron, manganese and dissolved nitrogen at all borehole locations. Boron, sulphur and chlorine were detected at a few of the borehole locations. However, it is noted that these parameters do not have any published DIVs.

6.5.4 Groundwater

Groundwater monitoring wells were installed following the completion of drilling at each borehole between 11th November and 4th December 2015. Groundwater samples were collected for analysis of a suite of parameters outlined in the Baseline Method Statement (*Annex 3.0*). Groundwater level gauging was conducted upon development of monitoring well and groundwater levels were further verified by a confirmatory survey after a stabilization period of at least 24 hours from the installation of the monitoring well.

The groundwater analysis results were compared against the DIV and DTV and a summary of the findings (*Annex 9.0*) is summarised as follows:

- No odours were perceived during the installation of the monitoring wells and no visual signs of contamination were observed from the groundwater samples.

- Groundwater was first encountered at depths ranging from 0.8 to 6.0 m bgl during the drilling. Following well installation and the stabilisation period, standing water level ranged between 1.132 m and 6.990 m below top of pipe (m btop). The groundwater levels measured were suspected to be influenced by slow groundwater recharge rates, hence another round of groundwater level gauging was conducted and levels measured ranged between 1.535 m to 6.530 m btop.

- According to the calculated groundwater elevations, groundwater was estimated to flow towards the northwest as presented in *Figure 6.9*.

- Concentrations of all analytes in the groundwater samples were below their respective DIVs. Other notable findings include the following:

    - **Arsenic:** was detected in groundwater samples collected from BH/MW1 and the concentrations were found to be above the DTV. This coincides with the detection of arsenic (highest value above DIV) in the soil sample collected from BH/MW1 (2.3 m bgl). It is noted that, as with other metals, arsenic is known to dissolve from soil into groundwater in a process known as leaching.

    - **Barium:** was detected in groundwater samples collected from MW/BH1, MW/BH3 and MW/BH5 above the DTV. The primary source of naturally occurring barium in drinking water results from the leaching and eroding of rocks into groundwater.

    - **Chloroform:** detected in groundwater samples collected from MW/BH8. Chloroform is generally considered to be an anthropogenic (man-made) contaminant (e.g. disinfection by-products commonly produced during the chlorination of water and wastewater). The source of the chloroform detected in MW/BH8 is not currently known. According to the estimated groundwater flow direction in the area, MW/BH8 is observed to be along the hydraulic up-gradient in relation to the Site, but as the area is surrounded by the reservoir water body, the groundwater flow direction (and hence the potential source of the Chloroform) may not be ascertained with high certainty.

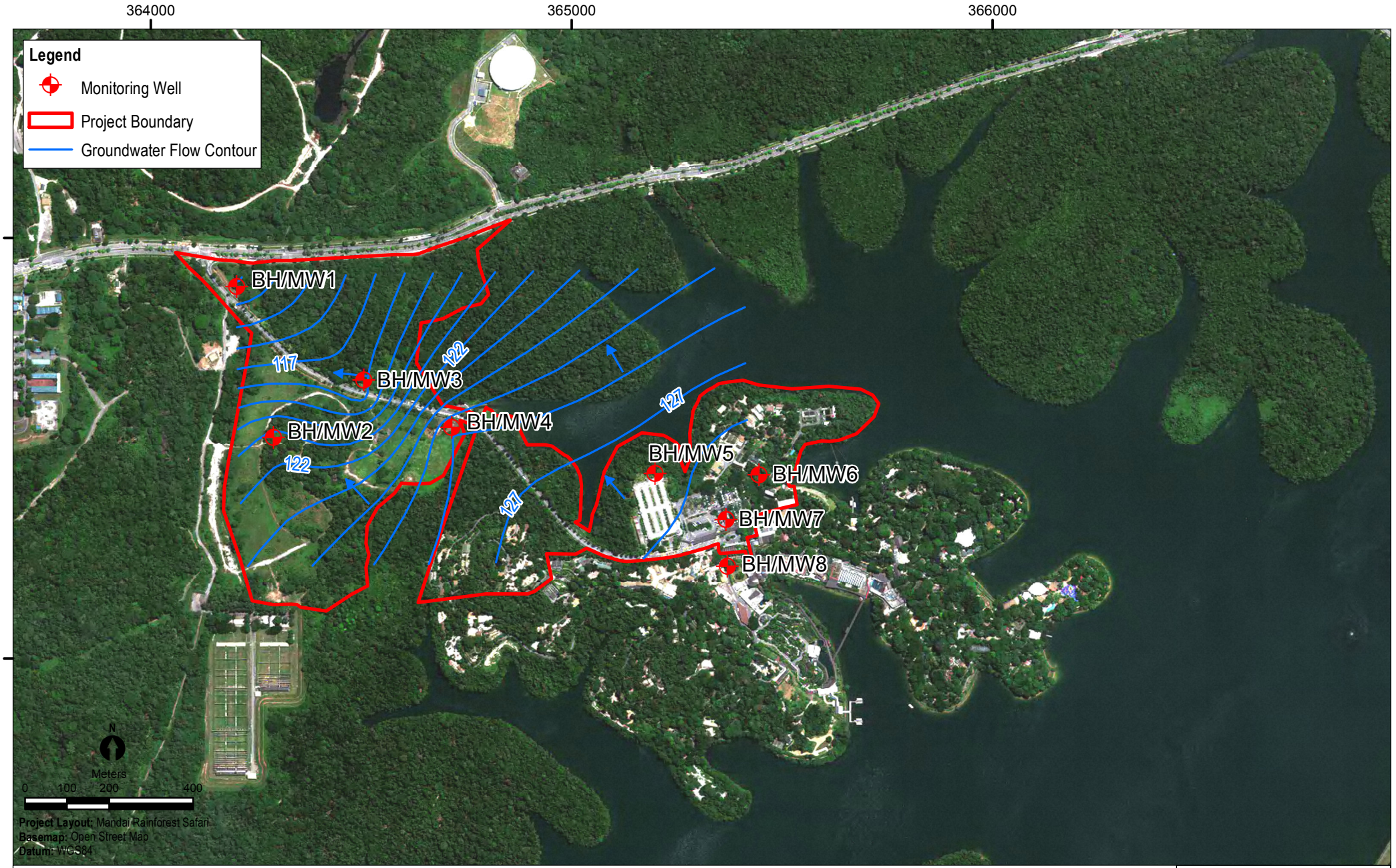

Figure 6.9 Groundwater Flow Contour

Service Layer Credits: World View 2 Imagery

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6.6 BIODIVERSITY

6.6.1 Study Area

The Study Area is defined as the area within which ecological receptors may be adversely affected by Project activities during construction and operation. This includes the AOI of the Project, which encompasses the forests of the CCNR to the east of the Project area due to the connectivity between the areas, and Upper Seletar Reservoir due to the connectivity of aquatic habitats. The areas where biodiversity surveys were conducted are presented in *Figure 6.3*.

6.6.2 Sources of Information

The existing ecological environment of the Study Area was established through consultation, review of existing information, and field surveys. Further details of the sources of information used are as follows:

- Formal meetings with NParks were held to seek their advice on the ecological relationships and species present at the Study Area. Formal requests were also submitted for information including a set of reports detailing the findings of rapid biodiversity assessments held at the Study Area and Lorong Asrama. Formal requests were also sent to WRS for information on wildlife sightings at the Study Area.

- Review of publicly available information to aid development of the Species Database (*Annex 10.0*); Priority Species Profiles (*Annex 11.0*); and Species Habitat Matrix (*Annex 11.1*), including:

  - IUCN Red List of Threatened Species (2015-3);

  - Singapore Red Data Book [36];

  - A Checklist of the Total Vascular Plant Flora of Singapore: Native, Naturalised and Cultivated Species [37];

  - The Digital Nature Archive of Singapore by the Lee Kong Chian Natural History Museum [38];

  - The Plant List, Version 1.1 [39];

  - Plants of Southeast Asia [40]; and

[36] Davison GWH, Ng PKL & Ho HC (ed) 2008. The Singapore Red Data Book. Threatened Plants and Animals of Singapore. 2nd Edition. Nature Society (Singapore) 285pp.

[37] Chong KY, Tan HTW & Corlett RT, 2009. A Checklist of the Total Vascular Plant Flora of Singapore. Native, Naturalised and Cultivated Species. Raffles Museum of Biodiversity Research, National University of Singapore.

[38] Available at http://lkcnhm.nus.edu.sg/dna/

[39] Available at http://www.theplantlist.org/

[40] Available at http://www.asianplant.net/

- Wild Animals of Singapore: A Photographic Guide to Mammals, Reptiles, Amphibians and Freshwater Fishes [41].

- Review of previous reports provided by WRS and NParks including:

  - Biodiversity Impact Assessment for the *River Safari* [42];
  - Springleaf Nature Park Biodiversity Impact Assessment [43];
  - Rapid Biodiversity Assessment of Lorong Asrama [44];
  - Rapid Biodiversity Assessment of Mandai East Camp [45]; and
  - Rapid Biodiversity Assessment of Mandai Firing Range [46];

- Findings from a geospatial assessment using remote sensing within the Study Area to characterise the types and condition of vegetation communities present. This assessment includes a geospatial analysis of WorldView Imagery (dated February 2015) and was supplemented with:

  - LiDAR data files for the first return and ground return provided by the Singapore Land Authority (SLA);
  - Tree data obtained from an arborist assessment of the Project area;
  - Field data obtained during botanical surveys; and
  - Field verification of vegetation zones.

- Consultation with the following ecological experts:

  - Mr Subaraj Rajathurai, on the habitat preferences, threats and conservation rationale of selected species at the Study Area;

  - Dr Chua Siew Chin, on the forest types present in the Study Area and accuracy of remote sensing output; and

  - Dr Mikaail Kavanagh, on bird-plant relationships, various aspects of the biodiversity surveys and results interpretation.

- Surveys of a group of organisms identified to be a reflective representation of the spectrum of biodiversity present within the Study Area, namely: vegetation, terrestrial vertebrates (i.e. mammals, birds, reptiles and amphibians), aquatic fauna (i.e. fish and decapod crustaceans) and invertebrates (i.e. odonates, butterflies, hymenopterans, reduviids, orthopterans). The surveys were conducted between late-March 2015 and October 2015 in

41 Baker N & Lim K, 2012. Wild Animals of Singapore: A Photographic Guide to the Mammals, Reptiles, Amphibians and Freshwater Fishes. Nature Society (Singapore). Draco Publishing. 180pp.

42 Wildlife Reserves Singapore, 2009. Biodiversity Impact Assessment of WRS River Safari Project Site.

43 Subaraj R, 2010. Biodiversity Impact Assessment of Springleaf Nature Area.

44 Natural Areas Survey Team, National Biodiversity Reference Centre, NParks, 2008. A Rapid Biodiversity Assessment of Lorong Asrama.

45 NParks, 2015. Rapid Biodiversity Assessment of Mandai East Camp.

46 NParks, 2015. Rapid Biodiversity Assessment in the Vicinity of Mandai Firing Range.

the Zones previously outlined in *Figure 6.3*. The team of specialists who conducted the surveys are outlined in *Table 6.12* and their full survey reports provided in *Annex 14*.

Table 6.12: Biodiversity Survey Team

Organism Studied	Lead Specialist
Terrestrial vertebrates (mammals, birds, herpetofauna)	Subaraj Rajathurai; Marcus Chua (Camera Trapping)
Flora	Associate Professor Hugh Tan; Louise Neo
Aquatic Fauna	Dr Tan Heok Hui; Lim Kok Peng, Kelvin
Odonates and Butterflies	Subaraj Rajathurai
Aculeate Hymenopterans	John Lee
Orthopterans	Tan Ming Kai
Reduviids	Yeo Huiqing

It is noted that throughout the biodiversity baseline and impact assessment, reference is made to notations for the classification of species derived from the IUCN Red List and the SRDB (*Table 6.13*).

Table 6.13: Notations of Species According to Extinction Risk Classifications

Classification	Singapore Red Data Book	IUCN Red List
Critically Endangered	CR (SRDB)	CR (IUCN)
Endangered	EN (SRDB)	EN (IUCN)
Vulnerable	VU (SRDB)	VU (IUCN)
Near Threatened	NT (SRDB)	NT (IUCN)
Least Concern	LC (SRDB)	LC (IUCN)
Data Deficient	DD (SRDB)	DD (IUCN)

Notes:

(1) Classification of flora species is derived primarily from *A Checklist of the Total Vascular Plant Flora of Singapore: Native, Naturalised and Cultivated Species.* The species classifications found within this document are in line with the information provided in the Singapore Red Data Book. This Checklist offers additional detail on the status of the plant species by listing if it is native, exotic or a weed of uncertain origin. The definitions of these classifications, as per the *Checklist*, are provided below.

(2) Native species are defined as "species that have originated in a given area without human involvement or have arrived there without intentional or unintentional intervention of humans from an area in which they are native". Native species that have been classified as nationally extinct are "non-endemic species that have not been seen in or collected from the wild in the last 30 years". Extant native species in Singapore with more than 1,000 mature individuals are considered common.

(3) Exotic species are defined as "species whose presence is a result of either intentional or unintentional human involvement". These include spontaneous species that have "survived outside cultivation or without direct human care", casuals that "do not form self-replacing populations and rely on repeated introductions/limited asexual reproduction for persistence", naturalised species that "form self-replacing, usually sexually-reproducing populations", and species that "can only be found in cultivation or under direct human care".

(4) Weeds of uncertain origin are "species without biogeographical or historical evidence of being non-native, but are restricted to only human-modified or human-disturbed habitats".

(5) Some species identified on the site have not been assessed against the SRDB or IUCN Red List. These species have been assessed based on input from experts where required.

6.6.3 Biodiversity Context

6.6.3.1 World Wide Fund for Nature (WWF) EcoRegion: Peninsular Malaysian Rainforests

The Study Area is located within the Peninsular Malaysian Rainforests EcoRegion [47]. This EcoRegion is one of the "Global 200" EcoRegions identified as the most crucial to the conservation of global biodiversity. This EcoRegion is located in the Indo-Malayan category and covers approximately 125,614.42 sq Km from Southern Thailand in the North, Peninsular Malaysia and Singapore in the South. The EcoRegion is classified as "Vulnerable".

The EcoRegion once contained a vast tropical forest complex which has now been primarily cleared in lowland areas. Only highland forests and limited areas of lowland forests remain intact, predominantly within Malaysia. The forests in the EcoRegion tend to be dominated by trees from the Dipterocarpaceae family and in general contain a high diversity of tree species. This forest type is characterized by canopies of 24 to 36 m in height with an emergent layer of more than 45 m. This emergent layer comprises largely of Dipterocarp species. The lowland rainforests support a rich diversity of mammal species (195 species); including charismatic species such as the Tiger, Clouded Leopard and Asian Elephant (however these are now locally extinct in Singapore). A large variety of bird species comprising more than 450 species can also be found in this EcoRegion.

Most of these lowland rainforests have been converted to rice fields, plantations (rubber and oil palm), and orchards; an estimated one-fifth of the original forest cover remains, fragmented across the EcoRegion. In Singapore, this EcoRegion has been extensively cleared for urban development. Fragments of this EcoRegion remain within protected areas, including the CCNR (IUCN Category IV) and Bukit Timah Nature Reserve (IUCN Category IV).

6.6.3.2 Key Biodiversity Areas

A Key Biodiversity Area (KBA), which is also an Important Bird Area (IBA), has been identified within the Study Area. No Important Plant Areas (IPA) have been identified near the Project area. While no Alliance for Zero Extinction (AZE) [48] sites have been identified at or near the Project area, a number of potential AZE trigger species may be found. These are species believed to be endemic to Singapore such as the Johnson's Freshwater Crab (*Irmengardia johnsoni*). Further details on the KBA located within the Study Area are as follows:

- ***Important Bird Areas (IBAs): Central Forest.*** This IBA comprises the lowland rainforests of the CCNR and Bukit Timah Nature Reserve (BTNR), occupying a total area of approximately 3,043 ha [49]. These forests are composed of fragmented patches of dryland primary forests, secondary forests at varying stages of maturity, freshwater swamp forest and non-forest vegetation dominated by exotics [50] providing a variety of habitats for an estimated 127 resident bird species [51].

47 World Wide Fund for Nature, 2015. Ecoregions. Available at http://www.worldwildlife.org/biomes

48 American Bird Conservancy, 2013. Alliance for Zero Extinction. Available at http://www.zeroextinction.org/contact.htm

49 LKCNHM, 2015. Central Catchment Nature Reserve. Retrieved from http://lkcnhm.nus.edu.sg/dna/places/details/35

50 Corlett RT, 1997. The Vegetation in the Nature Reserves of Singapore. Proceedings of the Nature Reserves Survey Seminar. Gardens' Bulletin Singapore 49. 147-159.

51 Lim KS, 1997. Bird Biodiversity in the Nature Reserves of Singapore. Proceedings of the Nature Reserves Survey Seminar. Gardens' Bulletin Singapore 49. 225-244.

In addition, the Central Forest sees the arrival of several species of migratory birds throughout the months of September to March due to its location along the East Asian Australasian Flyway. Approximately 72 migrants and eight (8) non-breeding visitors have been recorded from the Central Forest, with new species observed regularly every season [52]. Trigger species for the classification of the Central Forest as an IBA are the Straw-headed Bulbul (*Pycnonotus zeylanicus*) and Brown-chested Jungle Flycatcher (*Rhinomyias brunneata*). The Straw-headed Bulbul is listed as EN as per SRDB and both species are VU on the IUCN Red List.

The Project area is located within the IBA. The current IBA status threat score is "medium", condition score is "near favourable" and action response score is "medium". The key threats identified are human intrusions and disturbance, recreational activities with a slow but significant deterioration.

- ***Important Plant Areas (IPAs)*:** No IPAs are reported in Singapore from the PlantLife organisation. However, based on the vegetation survey findings by the Mandai Biodiversity Team, a total of 219 locally threatened vascular plant species (i.e. VU, EN, CR/SRDB) can be found near and within the Project area. These include rare species such as *Ficus stricta* that had previously been recorded in Singapore in only two sites outside Mandai; and *Shorea ovalis* spp *ovalis*, an IUCN EN species. Some forest patches were also found to possess high proportions of native species, and are provisionally evaluated to be old growth forests.

6.6.3.3 *Areas Important for Watershed Protection*

The Project area is located adjacent to the northern peninsula of the CCNR, which was declared a Municipal Catchment by the colonial government in 1900. This led to the cessation of logging or clearing activities for plantations in order to protect the watershed [53]. Forests subsequently regenerated in heavily disturbed areas, leading to the development of large stands of secondary forest which now form the dominant vegetation type in the CCNR.

6.6.3.4 *Protected Areas: Central Catchment Nature Reserve*

The CCNR is a designated nature reserve in Singapore and protected under the *Parks and Trees Act, 2006*. The CCNR is located adjacent to the Project area and is classified as a Category IV reserve (IUCN).

6.6.3.5 *Protected Areas: Upper Seletar Reservoir*

Upper Seletar Reservoir is part of the Central Water Catchment Area and is thus a designated protected area under the *Parks and Trees Act, 2006* and *Public Utilities (Reservoirs, Catchment Areas and Waterway) Regulations, 2008*.

[52] Lim KS, 1997. Bird Biodiversity in the Nature Reserves of Singapore. Proceedings of the Nature Reserves Survey Seminar. Gardens' Bulletin Singapore 49. 225-244.

[53] O'Dempsey T, 2014. Singapore's Changing Landscape. In Barnard TP, 2014 (ed) Nature Contained: Environmental Histories of Singapore. NUS Press.

6.6.3.6 *Protected Areas: Bukit Timah Nature Reserve*

Established in 1883, the BTNR is a designated nature reserve and protected under the *Parks and Trees Act, 2006*. It contains one of the largest patches of primary lowland rainforest in Singapore, surrounded by secondary forests of varying maturity, freshwater swamp forest and non-forested areas [54]. In 2011, BTNR was designated as an ASEAN Heritage Park. The BTNR and CCNR together form the central forest which has been identified as an IBA. It is classified as a Category IV reserve (IUCN).

The locations of the abovementioned key biodiversity elements are presented in *Figure 6.10*.

6.6.3.7 *Wildlife Corridors*

Wildlife corridors are crucial to maintaining forest connectivity within a fragmented landscape where forest persists within a mosaic of other land uses. These corridors preserve the movement of wildlife between forest patches, thereby maintaining the exchange of genetic material between otherwise isolated populations and key processes such as seed dispersal. These contribute to the regeneration of disturbed forests.

The Mandai area hosts remnant forested areas that form part of the CCNR and adjacent special use areas. The site is connected to other forest remnants within central Singapore, including the Bukit Timah and MacRitchie forests. At a local scale, there are estimated to be eight wildlife corridors within the Study Area [55] as shown on *Figure 6.11*. Barriers to the movement of wildlife exist within the Study Area, namely Mandai Lake Road and a connecting slip road, a raw water discharge point and fences. Examples of wildlife that were observed within the Study Area that are likely to utilise these corridors include larger terrestrial fauna and forest dependent bird species.

[54] Yee ATK, Tan HTW, 2010. The Vegetation History of the Bukit Timah Nature Reserve and the Central Catchment Nature Reserve. Retrieved from http://www.nus.edu.sg/nurop/2010/Proceedings/FoS/Biological%20Sciences/Alex%20Yee%20Thiam%20Koon_U062490J.pdf

[55] Based on consultation with the terrestrial vertebrate specialist

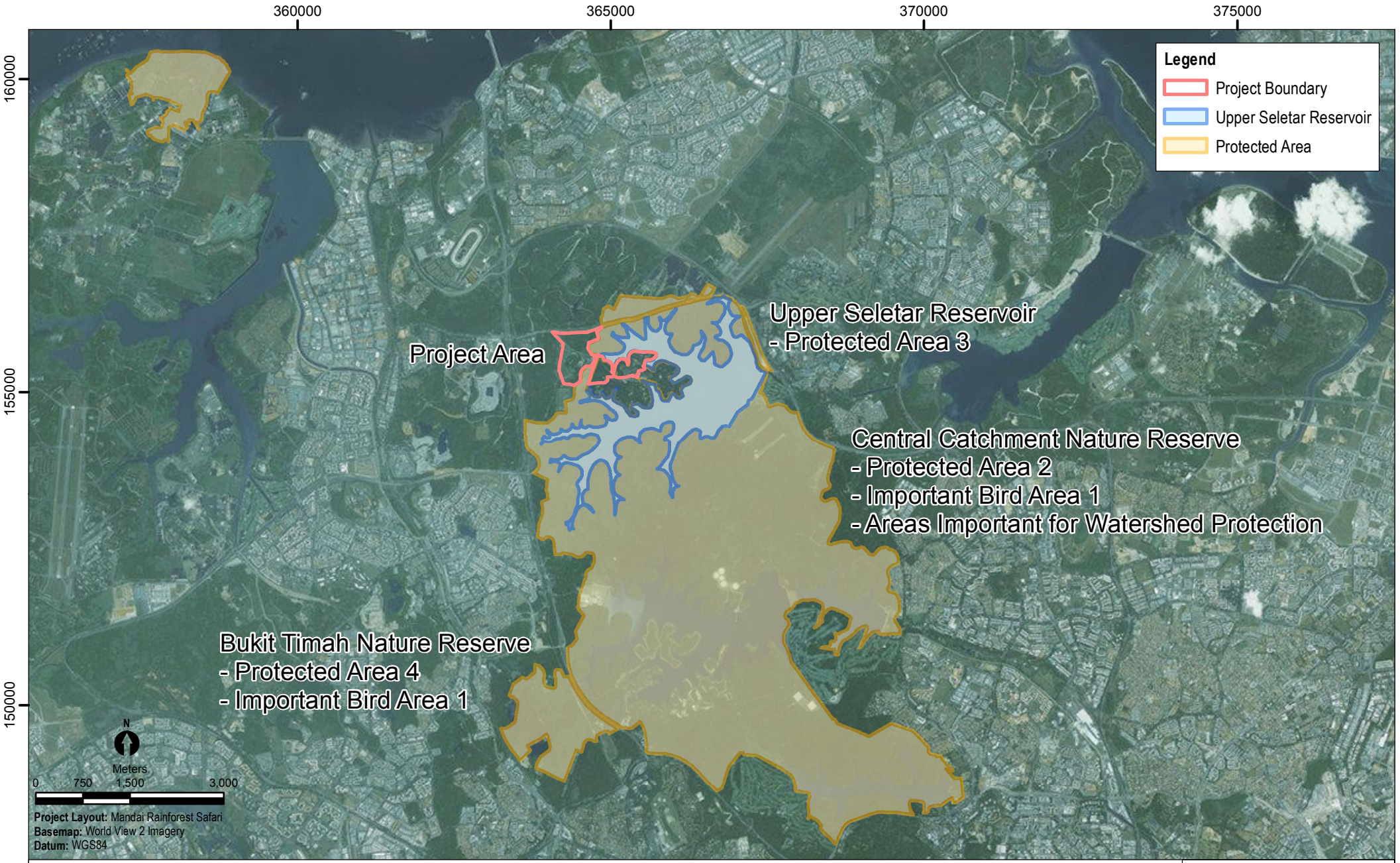

Figure 6.10 Biodiversity Context Elements

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS,

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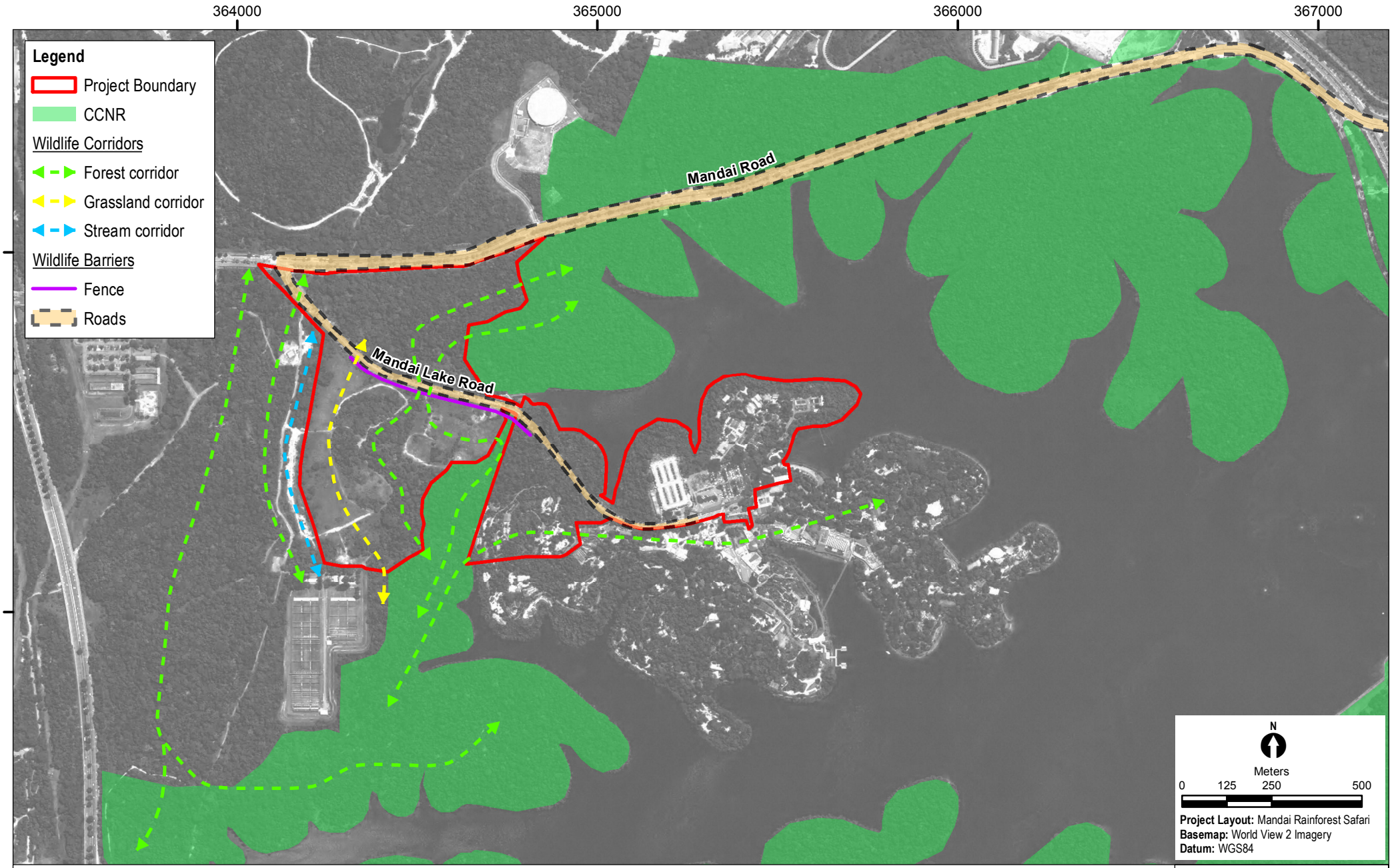

Fig 6.11 Wildlife Corridors Within the Project Area

Service Layer Credits: World View 2 Imagery

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6.6.3.8 *Invasive Species*

Invasive species are exotic species (also known as “alien”, “non-native” or “non-indigenous” species) that have overcome natural dispersal barriers, usually via anthropogenic pathways, to become introduced outside their native range [(56)]. Some exotic species, free from natural selection pressures in their native range, establish quickly under suitable conditions. This may threaten native biodiversity and result in socio-cultural, economic, environmental impacts or harm to human health [(57,58)]. A list of exotic fauna and flora in Singapore, adapted from existing lists [(59,60)], is provided in *Annex 13.0*. This list has been compared against the Global Invasive Species Database (GISD), and studies on exotic species in Singapore, to identify species that have been deemed as invasive or potentially invasive in the Study Area.

6.6.3.9 *Species Identified as Requiring Management*

Species that may require future management were identified in the Project area. Fauna species identified for management lacked natural predators that could keep their population in check; if in large numbers they could result in potential problems to native biodiversity, disrupt ecological processes and pose a nuisance to people. These species are also known from prior accounts of human-wildlife conflict from other parts of Singapore [(61,62)]. Flora species were identified by the vegetation specialists based on their potential to be invasive thereby threatening the native biodiversity of the Mandai area. In addition, the weak wood of *Falcataria moluccana* posed a safety hazard, triggering the need for future management.

The species identified that are candidates for future management include:

- Wild Boar (*Sus scrofa*);
- Sambar Deer (*Rusa unicolor*);
- Long-tailed Macaque (*Macaca fascicularis*);
- Non-native Rodents (Mice and rats)
- *Spathodea campanulata*;
- *Cecropia pachystachya*; and
- *Falcataria moluccana*.

[56] Lodge DM, Williams S, MacIsaac HJ, Hayes KR, Leung B, Richard S, Mack RN, Moyle PB, Smith M, Andow DA, Carlton JT and McMichael A, 2008. Biological Invasions: Recommendations For U.S. Policy And Management. Ecological Applications. 16: 2035–2054.

[57] Sankaran KV and Suresh TA, 2013. Invasive Alien Plants in the Forests of Asia and the Pacific. Food and Agriculture Organization of the United Nations. Regional Office for Asia and the Pacific. Bangkok, 2013. Available at http://www.fao.org/docrep/018/i3276e/i3276e.pdf

[58] IUCN, SSC Invasive Species Specialist Group, 2000. The World Conservation Union, Species Survival Commission (SSC), Guidelines for the Prevention of Biodiversity Loss Caused By Alien Invasive Species. 51st Meeting of the IUCN Council, Gland Switzerland. Available at http://intranet.iucn.org/web~les/doc/SSC/SSCwebsite/Policy statements/

[59] Yeo DCJ and Chia CSW, 2010. Introduced Species in Singapore: An Overview. Cosmos 6(1):23-27.

[60] Lok AFSL, Chong KY, Tan KX and Tan HTW, 2010. Checklist of the Spontaneous Exotic Vascular Plant Flora of Singapore. Cosmos, 6(1): 57–83.

[61] The Straits Times (2015) Humans always at fault in conflicts with macaque population: ACRES. Retrieved from http://www.todayonline.com/singapore/humans-always-fault-conflicts-macaque-population-acres

[62] NParks (2015) Wild Boars: Human-Wild Boar Encounter. Retrieved from https://www.nparks.gov.sg/gardens-parks-and-nature/dos-and-donts/animal-advisories/wild-boars

6.6.4 *Terrestrial Flora*

A total of 523 species of vascular plant were recorded from the entire study area (Zones A, B, D, E and F, *Figure 6.3*). These included 77 CR (SRDB), 60 EN (SRDB), 82 VU (SRDB), and 10 species previously thought to be extinct and rediscovered [(63)]. The forest type adjacent to the reservoir does not differ significantly to the adjacent forest, being mature secondary forest. Some aquatic species such as sedges and grasses are present at the water's edge. The Project area's flora generally differs from the adjacent CCNR in that the CCNR contains more mature forests; however exotic species such as *Durio spp*. are present within the CCNR forests. A gradation exists whereby less mature and more exotic species are present within the Aroject area as the forest progresses further away from the CCNR.

A breakdown of species of conservation interest across the survey zones is presented in *Table 6.14*.

Table 6.14: Nationally Threatened Plants of Conservation Significance in Zones A, B, D, E and F

Zone	Conservation Status[(1)]				Total number of species
	CR	EN	VU	R[(2)]	
A	37	40	54	5	136
B	13	11	13	1	39
D	13	8	21	1	43
E	16	11	21	1	49
F	37	37	53	4	131

Notes:

(1) Based on *Chong et al (2009) A Checklist of the Total Vascular Plant Flora of Singapore: Native, Naturalised, and Cultivated Species.*

(2) R: Rediscovered species erroneously thought to be nationally extinct.

In addition, a total of 152 large native trees (≥ 30 cm DBH) were recorded within the Project Boundaries (i.e. Zones B and D). Of these 152 large native trees, a number have been further identified to be of species of conservation status as summarised in *Table 6.15.* Another survey recorded 2,979 large native trees (≥ 30 cm girth) within three areas in Zone F of which 1,133 are of conservation significance. A breakdown of these findings is also provided in *Table 6.15*.

Table 6.15: Number of Native Large Trees (≥ 30 cm DBH) in Zones B and D

Zone	Total number of large trees (≥ 30 cm DBH/Girth)	Conservation Status of species[(1)]			
		CR	EN	VU	Common
B	83	2	0	8	68
D	69	1	2	6	57
F [(2)]	2,979	208	392	533	1,846

Note:

(1) Based on the Singapore Red Data Book (2008) and *Chong et al (2009) A Checklist of the Total Vascular Plant Flora of Singapore: Native, Naturalised, and Cultivated Species.*

(2) The areas surveyed in Zone F correspond to zones A1B, A1A and A3 in the arboriculture survey report.

[63] These species included (1) *Aquilaria hirta*, (2) *Nephelium ramboutan-ake*, (3) *Rourea acutipetala* ssp. *Acutipetal*, (4) *Dichapetalum sordidum*, (5) *Friesodielsia glauca*, (6) *Grenacheria amentacea*, (7) *Willughbeia coriacea*, (8) *Dioscorea orbiculata* var. *tenuifolia*, (9) *Morinda rigida* and (10) *Freycinetia javanica*

The general characteristics of the vegetation structure across the Study Area are summarised in *Table 6.16* together with mention of presence of potential invasive species. More detailed descriptions of the vegetation characteristics, including the dominant flora species comprising each vegetation type, are listed in *Annex 14.1.*

Table 6.16: Vegetation Types and Characteristics of the Survey Zones

Zone	Vegetation Types and Characteristics	Notable Species
A	• Old or late successional secondary forest *(Areas affected by a major windstorm event in 2011 are currently undergoing natural regeneration and are dense with saplings)*	
B	• Young secondary forest arisen from abandoned cultivation; • Open-canopy local 'scrubland' type vegetation; • Later-successional stage forest; and • Managed vegetation.	*Cecropia pachystachya* (Invasive) *Ficus stricta* (First record in Mandai)
D	• Young secondary forest arisen from abandoned cultivation; • Open-canopy local 'scrubland' type vegetation; and • Later-successional stage forest.	*Cecropia pachystachya* (Invasive)
E	• Young or early successional secondary forest with some characteristics of later successional forest; and • Disturbed areas with a greater number and abundance of non-native species can be found bordering Zone D.	
F	• Old growth forest (forest fragments 1 to 3 outside the *Night Safari* and *Singapore Zoo*) • Spontaneous vegetation (within the *Night Safari* and *Singapore Zoo*)	Dipterocarp species: • *Shorea ovalis* ssp. *ovalis* (EN, IUCN) • *Shorea macroptera* • *Hopea spp.*

Some key findings of the botanical survey include a rediscovery of 10 species that were formerly believed to be extinct as presented in *Table 6.17*. The survey also identified a large *Ficus stricta* individual, the first record of the plant in Mandai (all other records known from Changi and Pulau Ubin). Additionally, the survey identified three fragments of old growth forests within Zone F, one of which had three large individuals of S*horea ovalis* spp. *ovalis* (EN/IUCN).

Table 6.17: Location of Flora Species Previously Identified to be Locally Extinct

Zone	Rediscovered Species [1]
A	• *Dichapetalum sordidum* • *Friesodielsia glauca* • *Grenacheria amentacea* • *Rourea acutipetala* ssp. *acutipetala* • *Willughbeia coriacea*
B	• *Nephelium ramboutan-ake* [2]
D	• *Rourea acutipetala* ssp. *acutipetala*
E	None
F	• *Dioscorea orbiculata* var. *tenuifolia* • *Morinda rigida*
Fragment 1 (Zone F)	• *Freycinetia javanica* • *Rourea acutipetala* ssp. *acutipetala*
Total	**9 species**

Notes:
[1] All Rediscovered species are naturally occurring individuals unless otherwise stated.
[2] Species persists from cultivated stock.

The relative proportions of native and non-native species per zone are presented in *Annex 14.1 Figure 20.* It is noted that every zone harbours exotic species, although this is much lower in Zones A and E. The botanical specialists had also highlighted three invasive tree species, *Spathodea campanulata*, *Cecropia pachystachya* and *Falcataria moluccana* as targets for management.

Based on *Annex 13.0*, Invasive Species List, these three species are found to be listed on the GISD, and *Spathodea campanulata* has been assessed to be one of the top 100 worst invasive alien species globally. It is noted however, that there are studies showing these naturalised exotics have benefited local biodiversity. In particular, mature *Falcataria moluccana* groves have been observed to support a diversity of bird species and serve as nesting sites for locally endangered species such as the Grey-Headed Fish Eagle (*Icthyophaga ichthyaetus*) and Changeable Hawk Eagle (*Nisaetus cirrhatus*) [64].

In addition to the abovementioned survey, a broad-based biodiversity survey of the Upper Seletar Reservoir commissioned by the PUB in 2009 recorded one hundred and seventy (170) plant species around edges of the reservoir, of which one hundred and seven species (107) are of conservation concern. These are largely situated within the CCNR and adjacent special use areas. The study also observed that the vegetation around the southern, western and northern shores of the reservoir comprised mainly old secondary forest; the northwest portion possesses a 'partially manicured shoreline interspersed with a more natural shoreline consisting of disturbed vegetation' and is part of the Singapore Zoological Gardens. Areas with more natural shorelines were found to be dominated by *Dillenia suffruticosa* overhanging the water.

[64] Tan KH, nd. The Status and Distribution of Changeable Hawk Eagle (*Nisaetus cirrhatus*) In Singapore. Available at https://singaporebirdgroup.files.wordpress.com/2015/06/the-status-and-distribution-of-changeable-hawk-eagle-2.pdf

6.6.4.1 *Arboriculture Survey*

An arboriculture survey was conducted in the Project area (i.e. Zones B, D) and Fragments 1, 2 and 3 in Zone F (being the forests north and south of Mandai Lake Road on the eastern side of the CCNR and the patch of vegetation beside the Upper Seletar Reservoir to the west and north of the current carpark facility for the *Singapore Zoo*). The proportion of native species recorded in these zones by the arborist supports the conclusions reported by the vegetation survey. The proportions of native species that are of conservation interest per zone are also similar to the findings of the vegetation survey with the exception of Zone D (*Figure 6.3*). Some discrepancies are expected due to the different survey techniques adopted by both teams and different survey objectives.

Table 6.18: Arboriculture Survey and Vegetation Survey Findings

Zone	Percentage of Native Species [1]		Percentage of Native Species of Conservation Significance [2]	
	Arboriculture Survey	Vegetation Survey	Arboriculture Survey	Vegetation Survey
B	78.5 %	75 %	73 %	75 %
D	69 %	62 %	51 %	41 %
Fragment 1 [3]	85 %	97 %	73 %	75 %
Fragment 3 [4]	86 %	-	70 %	-

Notes:

(1) The percentage of native species was calculated as the percentage of native species over the total number of species recorded from the zone.

(2) The percentage of native species of conservation concern was calculated as the number of native species of conservation significance over the total number of native species recorded.

(3) Fragment 1 was surveyed by the arborists as part of a larger zone which included planted landscapes. This larger zone is listed as A1B in the arboriculture survey report.

(4) Fragment 3 is listed as A3 in the arboriculture survey report. A comparison of findings from the arboriculture survey and vegetation survey for Fragment 3 could not be provided as the vegetation survey was not conducted in the fragment.

(5) Data for Fragment 2 could not be provided as a breakdown of the findings at the fragment was not defined in the arboriculture survey report.

(6) Fragments 2 and 3 are two of three small fragments of spontaneous vegetation located along the western boundary of Zone F. Fragment 3 is located south of Mandai Lake Road and abuts the Night Safari on the south and the CCNR on the west. Fragment 2 is located north of Mandai Lake Road (opposite to Fragment 3).

Remote sensing was used to define vegetation zones and tree height across the site and included input from the botanical survey and data obtained from the arborist survey. This information was field verified by Dr Chua Siew Chin in October 2015.

Table 6.19 outlines the vegetation classifications used within the Study Area. *Figure 6.12* shows the vegetation classifications within the Study Area. *Figure 6.13* shows the tree height distribution across the site derived from LiDAR data provided by SLA.

Table 6.19: Vegetation Classifications within the Study Area

Vegetation Zone	Description	Average Height (metres)	Area (hectares)
Grassland	Predominately dominated by grass species of both native and non-native in origin. The area is open with few emergent canopy species. Grasslands were observed to a height of approximately 80 cm in places across the Study Area.	0.83	7.73
Managed Vegetation	Vegetation managed by humans through control measures such as mowing and pruning. This vegetation is both native and non-native in origin.	3.75	14.03
Mature Secondary Forest	Forested areas that have regrown on land that has undergone some form of disturbance, which is distinct in structure and species composition from the original forest of the area. The forest has a diverse structure with a distinct canopy and understorey.	12.96	0.33
Mature Secondary/ Disturbed Primary Forest	Forested areas regrown after clearing or major disturbance events. However, some trees or patches remain that would constitute a primary condition. The trees or patches of vegetation classified as primary forest would have remained extant during clearing or disturbance events. The forest has a diverse structure with a distinct canopy and understorey.	12.89	4.9
Scrubland	Vegetation dominated by mid-storey or dense understorey species. The canopy is dominated by non-native species with single emergent large native trees.	3.45	6.56
Young Secondary (Native Dominated) Forest	Forested areas that have regrown and are in an early successional stage of growth and is primarily dominated by species native in origin. The land has undergone some form of prior disturbance, which is distinct in structure and species composition from the original forest of the area.	15.14	2.68
Young Secondary (Non-native Dominated) Forest	Forested areas that have regrown and are in an early successional stage of growth and is primarily dominated by species non-native in origin. The land has undergone some form of prior disturbance, which is distinct in structure and species composition from the original forest of the area.	12.05	13.13
		Total	49.36

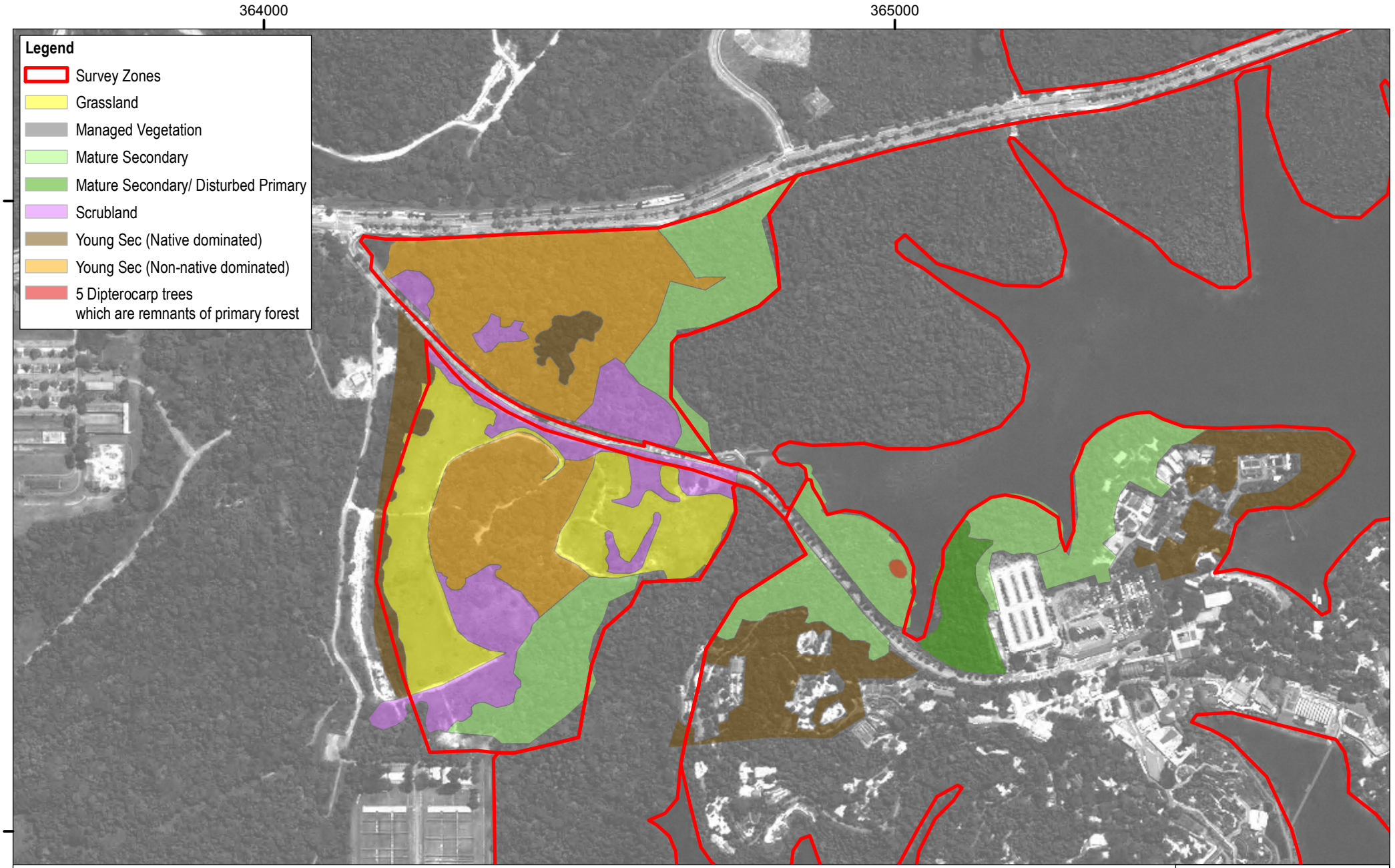

Figure 6.12 Vegetation Classifications within the Project Boundary

Service Layer Credits: World View 2 Imagery

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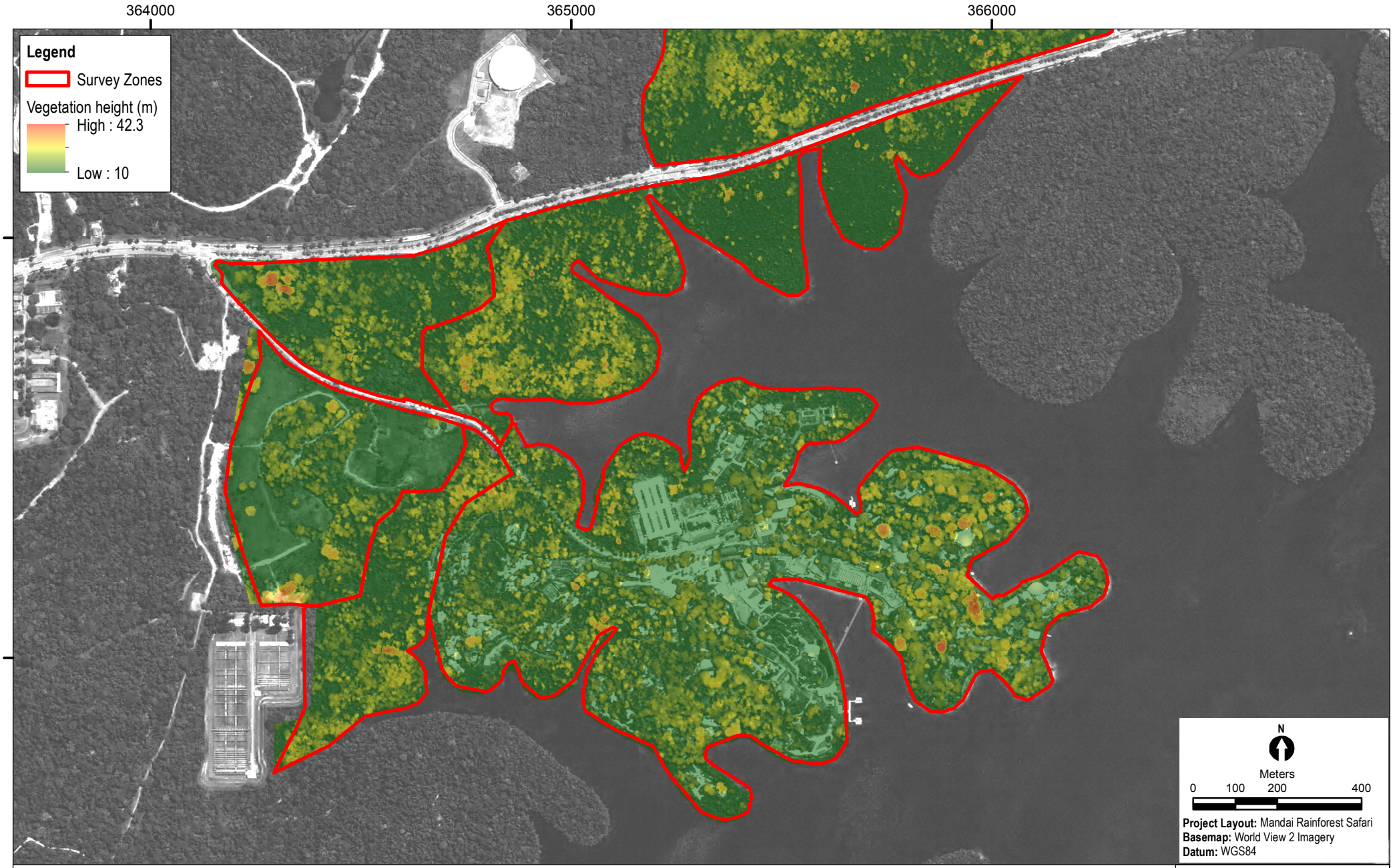

Figure 6.13 Tree Height Distribution Across the Study Area

Project Layout: Mandai Rainforest Safari
Basemap: World View 2 Imagery
LiDAR: Singapore Land Authority (SLA)
Datum: WGS84

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6.6.5 Terrestrial Vertebrates

The numbers of terrestrial vertebrate species recorded from the Study Area from late-March to October 2015 are presented in *Table 6.20*.

Table 6.20: Number of Terrestrial Vertebrate Species

	Number of Species found per Zone[1]						Number of species in survey area
	A	B	D	E	F	H	
Terrestrial Vertebrates[2]	11	8	9	10	8	6	15
Bats	1	2	6	0	5	2	8
Avifauna	63	49	88	99	100	38	123
Herpetofauna	21	24	19	22	36	12	53

Notes:
(1) Includes only wildlife that has been identified down to species or subspecies level.
(2) Excluding bats, avifauna and herpetofauna. These are presented separately in subsequent rows.

6.6.5.1 Mammals

The survey recorded a total of 23 species of mammals and bats; 5 are listed as locally threatened (CR, EN or VU) in the SRDB. There are also a number of species listed on the IUCN Red List. A summary of locally and globally threatened/near threatened species is presented in *Table 6.21* and *Figure 6.14*.

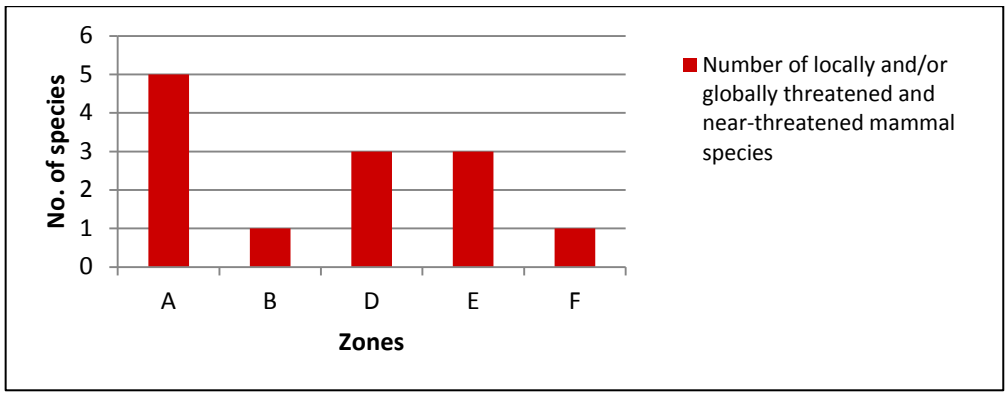
Table 6.21: Locally or Globally Threatened/Near-Threatened Mammal Species

Species (Common Name)	Species (Scientific Name)	SRDB	IUCN	Zone Found
Sunda Pangolin	*Manis javanica*	CR	CR	A, D, E
Banded Leaf Monkey	*Presbytis femoralis* spp. *femoralis*	CR	NT	A
Lesser Mousedeer	*Tragulus kanchil*	CR	LC	A, B, E
Lesser Bamboo Bat	*Tylonycteris pachypus*	CR	LC	D, F
Horsfield's Flying Squirrel	*Iomys horsfieldii*	EN	LC	A, H
Sambar Deer	*Rusa unicolor*	-	VU	A, B, D, E

A finding of particular interest is the observation of a few individuals of Banded Leaf Monkey (*Presbytis femoralis* spp *femoralis*) in Zone A. While the species is found in Indonesia, Singapore and the Malay Peninsula, subspecies *femoralis* is found only in southern Peninsula Malaysia (Johore) and Singapore. A study in 2010 indicated that a single population of 40 individuals exists in Singapore. While successful breeding cycles of this population have been observed [65], studies in 2014 revealed low genetic variability within the population thereby reducing their potential to adapt to disease outbreak or environmental changes. The species is restricted to the CCNR in Singapore and sightings have been made in the forests at Mandai, Upper Peirce Reservoir and Lower Peirce Reservoir.

[65] Ang A, Ismail MRB, Meier R, 2010. Reproduction and Infant Pelage Colouration of the Banded Leaf Monkey (Mammalia: Primates: Cercopithecidae) in Singapore. The Raffles Bulletin of Zoology. 58(2): 411-415.

Figure 6.14: Mammal Species of Conservation Significance per Zone



In terms of habitat specialisation and dependence, six mammal species are forest specialists while four are woodland dependent. Detailed results of the surveys are appended in *Annex 14-2* and *Annex 14-3.*

6.6.5.2 Birds

The survey recorded 123 species of birds; of this, 21 are listed as locally threatened (CR, EN or VU), or near-threatened in the SRDB. A number of bird species are also Globally Threatened/ Near Threatened as per the IUCN Red List. A summary of locally and globally threatened/near threatened birds is presented in *Table 6.22* and *Figure 6.15.*

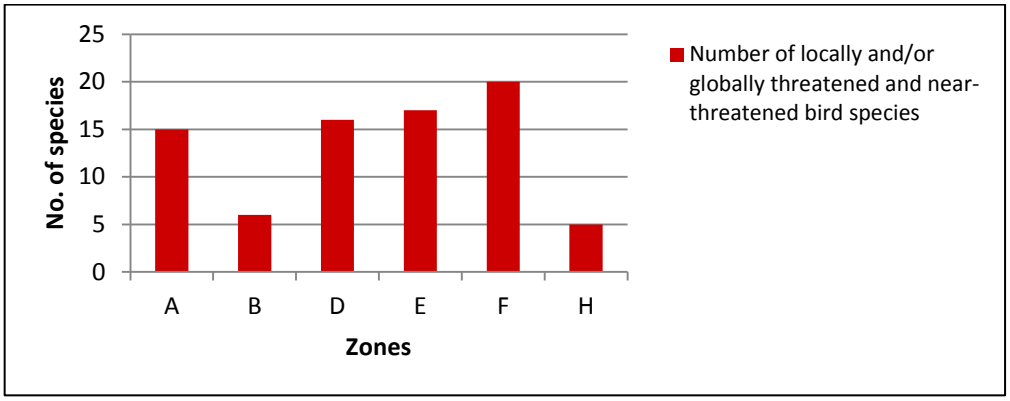
Table 6.22: Locally or Globally Threatened/Near-Threatened Bird Species

Species (Common Name)	Species (Scientific Name)	SRDB	IUCN	Zone Found
Resident, Native				
Blue-eared Kingfisher	*Alcedo meninting*	CR	LC	A, F
White-rumped Shama	*Copsychus malabaricus*	CR	LC	E
Grey-Headed Fish Eagle	*Ichthyophaga ichthyaetus*	CR	NT	A, D, E, F
Buffy Fish Owl	*Ketupa ketupu*	CR	LC	A
Black-crowned Night	*Nycticorax nycticorax*	CR	LC	A, D, E, F, H
Mangrove Pitta	*Pitta megarhyncha*	CR	NT	A, D, E
Blue-Rumped Parrot	*Psittinus cyanurus*	CR	NT	F
Crested Serpent Eagle	*Spilornis cheela*	CR	LC	E
Spotted Wood Owl	*Strix seloputo*	CR	LC	E, F
Drongo Cuckoo	*Surniculus lugubris*	CR	LC	A, D, E ,F
Purple Heron	*Ardea purpurea*	EN	LC	A, B, D, E, F
Violet Cuckoo	*Chrysococcyx*	EN	LC	A, D, E, F
Oriental Magpie-Robin	*Copsychus saularis*	EN	LC	D, E, F
Red Junglefowl	*Gallus gallus*	EN	LC	A, B, D, F
Blue-crowned Hanging	*Loriculus galgulus*	EN	LC	D, E, F
Changeable Hawk Eagle	*Nisaetus cirrhatus*	EN	LC	A, B, D, E, F, H
Red-eyed Bulbul	*Pycnonotus brunneus*	EN	LC	D, F
Straw-Headed Bulbul	*Pycnonotus zeylanicus*	EN	VU	A, B, D, E, F
Thick-billed Green-Pigeon	*Treron curvirostra*	EN	LC	A, D, E, F
Red-legged Crake	*Rallina fasciata*	VU	LC	D, E, F, H
Grey Heron	*Ardea cinerea*	VU	LC	A, F
Black-headed Bulbul	*Pycnonotus atriceps*	CR	LC	F
Chestnut-bellied Malkoha	*Phaenicophaeus*	-	NT	B, D, E, F, H
Short-tailed Babbler	*Malacocincla malaccensis*	-	NT	A, E, F, H

Species (Common Name)	Species (Scientific Name)	SRDB	IUCN	Zone Found
Red-Crowned Barbet	*Megalaima rafflesii*	-	NT	A, B, D, E, F
Long-tailed Parakeet	*Psittacula longicauda*	-	NT	A, B, D, E, F, H
Non-Native				
Milky Stork	*Mycteria cinerea*	-	EN	A, D, E, F
Painted Stork	*Mycteria leucocephala*	-	NT	E
Red-breasted Parakeet	*Psittacula alexandri*	-	NT	D
Migratory				
Brown-chested Jungle Flycatcher	*Rhinomyias brunneata*	-	VU	F

17 bird species are considered forest specialists whereas 32 are regarded as woodland dependent species. Detailed results of the bird surveys are appended in *Annex 14-2*.

Figure 6.15: Bird Species of Conservation Significance per Zone



6.6.5.3 *Herpetofauna*

The surveys from late-March 2015 to September 2015 recorded a total of 53 species of amphibians and reptiles. Species that are listed on the SRDB and IUCN Red List are presented in *Table 6.23* and *Figure 6.16*. Detailed results of the herpetofauna surveys are appended in *Annex 14.4*.

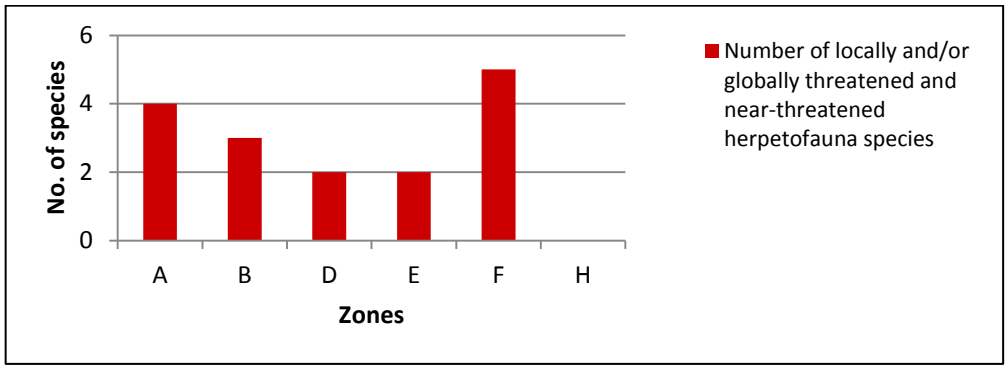
Table 6.23: Locally or Globally Threatened/Near-Threatened Herpetofauna Species

Species (Common Name)	Species (Scientific Name)	SRDB	IUCN	Zone Found
Native				
Tokay Gecko*	*Gekko gecko*	CR	-	F
Malayan Racer	*Coelognathus flavolineatus*	EN	LC	A, E
King Cobra	*Ophiophagus hannah*	EN	VU	F
Gold-ringed Cat Snake	*Boiga dendrophila*	VU	DD	E
Blue Coral Snake	*Calliphis bivirgatus*	VU	-	F
Twin-barred Tree Snake	*Chrysopela pelias*	VU	LC	F
Golden-eared Rough-sided Frog	*Hylarana baramica*	VU	LC	A
Spotted Tree Frog	*Nyctixalus pictus*	VU	NT	A, B, E
Malayan Box Terrapin	*Cuora amboinensis*	-	VU	A, B, F
Malayan Giant Frog	*Limnonectes blythii*	-	NT	A, B, D, E, F, H
Malesian Frog	*Limnonectus malesianus*	-	NT	A

Species (Common Name)	Species (Scientific Name)	SRDB	IUCN	Zone Found
Non-Native				
Giant Leaf Terrapin	*Heosemys grandis*	-	VU	D

Notes:
*The Tokay Gecko is native to Singapore but existing populations in the Mandai area are believed to be of non-native genetic stock. This species will be a potential candidate for management.

Figure 6.16: Herpetofauna Species of Conservation Significance per Zone



6.6.5.4 Habitat Associations

Terrestrial vertebrates, birds and herpetofauna recorded were observed to be associated with a number of habitat types present in the Study Area as summarised in *Table 6.24.* The vegetation classifications used to define the habitat types are shown in *Table 6.25*.

Table 6.24: Potential Species-Habitat Associations within the Study Area

Habitat Type	Terrestrial Vertebrates and Bats	Birds	Herpetofauna
Primary Forest/ Secondary Forest	• Lesser Mousedeer • Sambar Deer • Sunda Pangolin • Lesser Bamboo Bat • Greater Bamboo Bat • Horsfield's Flying Squirrel • Banded Leaf Monkey	• Yellow-eared Spiderhunter • Violet Cuckoo • White-rumped Shama • Blue-crowned Hanging Parrot • Red-crowned Barbet • Blue-rumped Parrot • Red-eyed Bulbul • Crested Serpent Eagle • Chestnut-winged Babbler • Drongo Cuckoo • Thick-billed Green Pigeon • Spotted Wood Owl ^ • Changeable Hawk Eagle ^ • Straw-Headed Bulbul ^ • Chestnut Bellied Malkoha *(Recorded in 2008, 2014)*	• Singapore Bent-toed Gecko • Red-necked Bronzeback • Black Bearded Flying Dragon • Striped Sun Skink • Red-tailed Racer • Lowland Dwarf Gecko • King Cobra • Wagler's Pit Viper • Spotted Tree Frog • Blue-necked Keelback ^ • Blue Malayan Coral Snake ^ • Lim's Black-Spotted Sticky Frog # • Tokay Gecko +
Grassland	• Sambar Deer • Sunda Pangolin	• Lesser Coucal # • Scaly-breasted Munia # • Chestnut Munia # • Baya Weaver #	• King Cobra • Striped Bronzeback # • Painted Bronzeback #
Forested Freshwater Habitat		• Masked Finfoot ~ • Grey-headed Fish Eagle ~ • Blue-eared Kingfisher ~ • Purple Heron ~	• Malayan Flatshell Terrapin~ • Bornean Giant River Terrapin~

Habitat Type	Terrestrial Vertebrates and Bats	Birds	Herpetofauna
		• Buffy Fish Owl ~ • Black Crowned Night Heron~ • Red-legged Crake *(Recorded in 2014)*~	• Yellow-ringed Cat Snake~ • Golden-eared Rough-sided Frog~ • Masked Rough-sided Frog #~ • Black-eyed Litter Frog #~ • Copper-cheeked Frog #~ • Malesian Frog #~
Open/ Man-made Freshwater Habitat		• Purple Heron~ • Grey Heron~ • Black Crowned Night Heron~ • Grey-Headed Fish Eagle~	

Notes:
^ These species have been identified as woodland specialists, and may have adapted to a certain level of disturbance.
# Identified by the specialist but are not listed on the SRDB.
+ The specialist has advised that this species may not be of native genetic stock and management techniques may be required.
* Exotic species
~ These species are likely to inhabit water edges along the shores of the Upper Seletar Reservoir

Table 6.25: Vegetation Groupings Relating to Habitat Types within the Project Area

Habitat Type	Associated Vegetation Types
Disturbed Primary forest habitat	• Mature Secondary/Disturbed Primary Forest
Secondary forest habitat	• Mature Secondary Forest • Young Secondary (Native Dominated) Forest • Young Secondary (Non-native Dominated) Forest
Grassland habitat	• Grassland • Managed Vegetation
Forested freshwater habitat	• Mature Secondary Forest within riparian areas • Young Secondary (Native Dominated) Forest within riparian areas • Young Secondary (Non-native Dominated) Forest within riparian areas
Open man-made freshwater habitat	• Upper Seletar Reservoir

Table 6.24 shows that the habitats found within the Study Area are utilized extensively by several species of wildlife spanning different taxa. In addition, some species are associated with more than one habitat type e.g. the Sunda Pangolin (*Manis javanica*) is associated with both primary/secondary forest and grassland. In view of these findings, the impact assessment will proceed to consider these species-habitat associations holistically.

6.6.5.5 *Species Mobility Within the Project Area*

Data related to the mobility of priority species in *Tables 6.21, 6.22* and *6.23* were reviewed to gain insight into existing and potential movement patterns of wildlife within the Study Area. Data reviewed included zones in which species were observed; roadkill data; habitat requirements; foraging patterns; and locomotion. A screening was then conducted to identify species that are most likely to utilise the proposed Eco-link to traverse Mandai Lake Road. These species are presented in *Table 6.26.*

Table 6.26: Mobility Information

Habit Category	Mobility Categories	Number of Species	Species Examples
Ground-dwelling	Highly Mobile	5	• Sambar Deer • Sunda Pangolin • Red Junglefowl
	Mobile	6	• King Cobra • Striped Sun Skink
	Limited Mobility	4	• Lim's Black-spotted Sticky Frog • Golden-eared Rough-sided Frog
Arboreal	Highly Mobile	1	• Long-tailed Macaque
	Mobile	14	• Banded Leaf Monkey • Sunda Slow Loris • Twin-barred Tree Snake
	Limited Mobility	1	• Spotted Tree Frog
Flying	Highly Mobile	6	• Straw-headed Bulbul • Blue-crowned Hanging Parrot • Lesser Bamboo Bat
	Mobile	10	• Chestnut-bellied Malkoha • Black-headed Bulbul
	Limited Mobility	4	• Buffy Fish Owl • Blue-eared Kingfisher
Total Number of Species		**51**	

The data shows that the majority of priority mammal and bird species are already residing on both sides of Mandai Lake Road, in particular key species of conservation concern such as the Sunda Pangolin (*Manis javanica*) and Lesser Mousedeer (*Tragulus kanchil*). Roadkill records[66] of the Sunda Pangolin along Mandai Lake Road show that individuals are moving between the areas. Highly mobile species that have been identified as requiring management i.e. Sambar Deer (*Rusa unicolor*) and the Wild Boar (*Sus scrofa*) are also present on both sides of Mandai Lake Road and are actively traversing between the two areas.

There are a number of species that are only found on one side of Mandai Lake Road. These comprise the majority of amphibian species (with the exception of the Malayan Giant Frog *Limnonectus blythii*), strict forest dependent mammals such as the Banded Leaf Monkey (*Presbytis femoralis*) and Horsfield's Flying Squirrel (*Iomys horsfieldii*), and reptiles with small ranges such as geckos and lizards. Locomotion, habitat requirements and diets of these species were reviewed to enable provision of habitats on the Eco-link that would encourage their movement across it.

[66] WRS Roadkill Data

6.6.6 *Invertebrates*

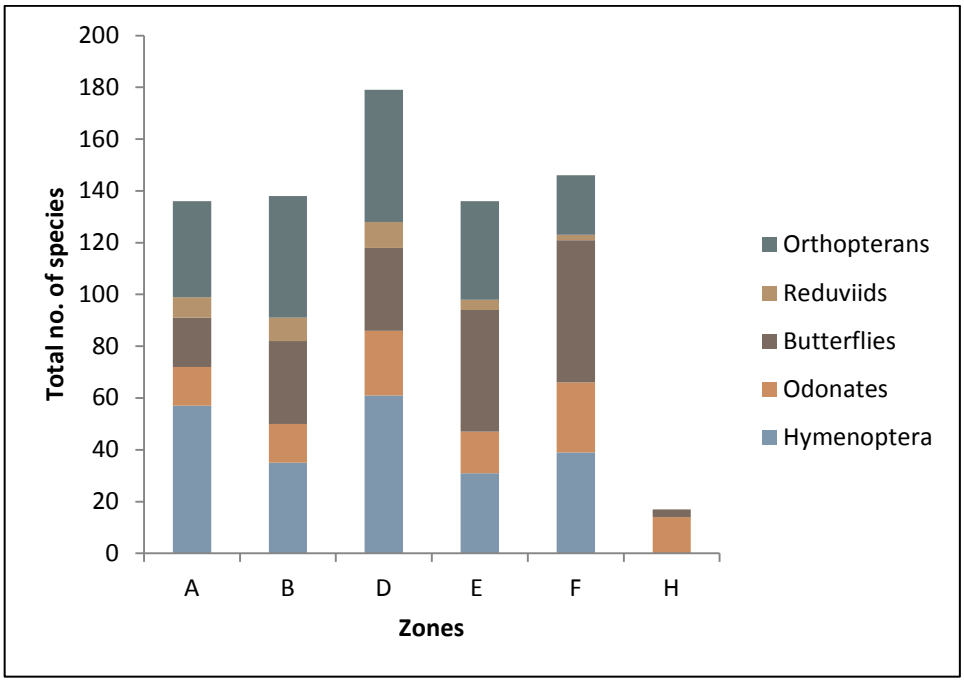
The numbers of invertebrate species recorded in the survey area from late-March to October 2015 are presented in *Table 6.27* and *Figure 6.17*.

Table 6.27: Number of Invertebrate Species Observed

	Number of Species[1]						Total Number of Species from Survey Area
	A	B	D	E	F	H[2]	
Hymenopterans	57	35	61	31	39		114
Odonates	15	15	25	16	27	14	45
Butterflies	19	32	32	47	55	3	99
Reduviids	8	9	10	4	2		20
Orthopterans	37	47	51	38	23		86

Notes:
(1) Includes only wildlife that has been identified down to species or subspecies level.
(2) Surveys of Zone H will not include these invertebrate groups.

Figure 6.17: Number of Invertebrate Species per Zone



6.6.6.1 *Hymenopterans*

As presented in *Table 6.27*, a total number of 114 species were recorded from the entire survey area. Key characteristics of each zone that were deemed to contribute significantly to the diversity of the aculeate hymenopteran community are also noted in *Table 6.28*. The specialist had also highlighted 10 species of conservation significance (refer to *Annex 14.5*) based on rarity (i.e. observation frequency) and degree of restriction (i.e. restricted to a few specific localities in Singapore or to a specific habitat).

Table 6.28: Habitat Descriptions and Notable Plant Species for Hymenopterans

Zone	Habitat Descriptions	Notable Plant Species
A [(1)]	Largely forest.	*Melastoma malabathricum; Leea indica; Mussaenda frondosa; Vitex trifolia; Leea rubra; Tabernaemontana* sp.
B	Forest habitat similar to Zone A.	Durian and starfruit trees; Heliconia (favoured nectar plant); *Dracaena fragrans* (preferred nesting site for some social wasps); *Syzygium* sp. trees
D	Varied habitat, from forest to open sandy areas and grassland.	Feeding on flowers of *Bidens pilosa, Dillenia suffruticosa, Sphagneticola trilobata* and *Mimosa* sp.
E	Mainly forest with few flowering plants apart from along main road and scattered areas bordering Zone D.	-
F[(2)]	Some forest bordering reservoir and roadside vegetation.	Cultivated flowering plants: *Cuphea hyssopifolia*, *Antigonon leptopus, Hamelia patens,* and *Tabernaemontana* sp.

Notes:
(1) For Zone A, most species recorded at forest edge, near water's edge.
(2) For Zone F, several solitary hymenopteran species observed building nests in and around various man-made structures such as roofs and ledges of pavilions and shelters.

6.6.6.2 Odonates

A total of forty-five (45) species of odonates were recorded in the Study Area from the survey conducted between late-March 2015 and September 2015. Four species are listed as CR in the SRDB. These are the Handsome Grenadier (*Agrionoptera sexlineata*), Sultan (*Camacinia gigantea*), Grey Sprite (*Pseudagrion pruinosum*) and Bronze Flutterer (*Rhyothemis obsolescens*). Ten species are considered forest dependents and one species a woodland specialist. Detailed results of the odonate surveys are appended in *Annex 14.6.*

6.6.6.3 Butterflies

A total of ninety-five (95) species of butterflies were recorded in the Study Area during the survey conducted between late-March 2015 and September 2015. Eighteen (18) species are considered forest dependent and ten (10) are woodland specialists. Six (6) of these species are listed on the SRDB, with 1 NE (rediscovered at the site), 1 CR, 2 VU and 2 Data Deficient species. These species are summarised in *Table 6.29* and detailed results of the butterfly surveys are appended in *Annex 14.7*.

Table 6.29: Locally Threatened Butterfly Species Recorded

Species (Common Name)	Species (Scientific Name)	SRDB	Zone Found
Formosan Swift	*Borbo cinnara*	NE	D, E
Pygmy Posy	*Drupadia rufotaenia*	CR	A
Common Rose	*Pachliopta aristolochiae*	VU	E, F
Common Birdwing	*Troides helena cerberus*	VU	F
Sky Blue	*Jamides caeruleus*	DD	A
Perseoides Bush Brown	*Mycalesis perseoides*	DD	A, B
Line Forest-skimmer or Pale-faced	*Cratilla lineata*	CR	F

Note:
These species have not yet been assessed by the IUCN Red List.

6.6.6.4 Reduviids

In total, twenty (20) species from seven (7) subfamilies were recorded from the five survey zones between April 2015 and September 2015. Zone D exhibited the highest species richness with ten species over seven subfamilies. The least number of species was recorded from Zone F with two species and could be due to the manicured environment area surveyed (*Singapore Zoo* and *Night Safari*). Based on an extrapolation of survey findings, 47 to 48 species of reduviids are estimated to be present in the Study Area. Statistical interpretation of the survey findings found that the species compositions in Zones A, B, D and E are highly similar, with the exception of a few species that are unique to each zone. This could however, be a function of the sample size. A notable finding was *Tribelocephala* cf. *indica* which is potentially a first record of the genus in Singapore. Detailed survey findings are presented in *Annex 14.8.*

6.6.6.5 Orthopterans

Out of the 86 species recorded in the Study area between April 2015 and September 2015, 32 are considered rare in Singapore due to low occurrence and restricted distribution. Ten species are potentially endemic to Singapore and of this number 6 are rare. Statistical interpretation of the survey findings reveals that Zone A has the most distinct community structure, whereas Zones B and D are likely to exhibit similar community structures of orthopterans. The diversity of orthopterans in Mandai is evaluated as being healthy based on the lack of invasive species. Detailed survey findings are presented in *Annex 14.9*.

6.6.6.6 Habitat Associations

Invertebrates recorded were observed to be associated with a number of habitat types present in the Study Area. These associations are detailed in *Table 6.30*.

Table 6.30: Potential Species-Habitat Associations within the Study Area

Habitat Type	Odonates	Butterflies	Reduviids	Hymenopterans
Secondary forest	• Spoon-tailed Duskhawker • Handsome Grenadier • Dark-tipped Forest Skimmer • Bronze Flutterer • Grey Sprite • Sultan	• Spotted Judy • Yellow Chequered Lancer • Quaker • Pygmy Posy • Perseiodes Bush Brown • Sky Blue • Horsfield's Baron • Banded Demon • Rustic Cruiser • Archduke • Purple Duke • Lesser Harlequin		• *Eustenogaster hauxwelli* • *Ceratina perforatrix* • *Xylocopa caerulea* • *Polistes meadeanus* • *Megachile stulta* • *Apis cerana* • *Ceratina lieftincki* • *Nomia incerta* • *Ropalidia sumatrae*
Swamp forest/pond	• Telephone Sylva • Scarlet Pygmy			

Habitat Type	Odonates	Butterflies	Reduviids	Hymenopterans
	• Sapphire Flutterer			
Open/ Man-made Freshwater Habitat	Banded Skimmer			
Forest streams	Common Flashwing			
Urban/Cultivated vegetation				• *Polistes Sagittarius* • Potter wasps • Mud dauber wasps • *Campsomeris* sp.
Open country (ie grass and shrubland)		All species in Zone D except Horsfield's Baron and Banded Demon.		
Microhabitat				
Tree bark (mature trees)			*Acanthaspis inermis*(1)	
Leaf litter			*Tribelocephala* cf. *indica*	
Banana plants			*Agyrius* cf. *podagricus*	

Note:
(1) Listed as an example in the specialist report and not recorded in checklist.

6.6.7 Aquatic Fauna

6.6.7.1 Aquatic Habitats at Sampling Locations

A total of fourteen (14) sampling points were established in four zones (A, D, F and H from May 2015 to September 2015). The aquatic habitats in Zones A and F were found to be connected to the Upper Seletar Reservoir and observed to be reservoir inlets. The aquatic habitats at Zone H used to comprise streamlines prior to the impoundment of Seletar River to form the Upper Seletar Reservoir. Presently, it comprises mostly stagnant water pools. The streams and sampling areas are described in *Table 6.31.* The sampling locations are presented in *Figure 6.18.*

Table 6.31: Sampling Locations and Environmental Conditions

Zone	Aquatic Sampling Reference	Location	Description
A	Mandai03, Mandai04, Mandai05, Mandai13	Further eastern inlet stream	Two sections were observed: a headwater section, and a clear flowing water section. The headwater section (Mandai 03, Mandai 04) comprised stagnant pools of water over sandy substratum with roadside debris. Closed canopy of oil palms observed. The clear flowing water section (Mandai 05) comprised a sandy, silt and clay bottom with roadside debris. Partial canopy of riparian vegetation and oil palm observed.
	Mandai06	Inner inlet stream	Observed to be stagnant clear water over submerged leaf litter, clay and silty bottom. Closed canopy of riparian vegetation observed.
	Mandai07	Innermost inlet stream next to discharge point along Mandai Lake Road	Found to be a dried up swampy area next to the raw water discharge point leading into Upper Seletar Reservoir.
D	Mandai08, Mandai09	Area D Stream	An open country stream running parallel to the western boundary of the Bird Park. Clear flowing water over a sandy mud base with overgrown bank vegetation.
	Area D Stream	Area D Stream	Open country stream with clear flowing water over sandy mud base; overgrown bank vegetation.
	Area D Stream (Cyc)	Under cycling track	Small stream cutting under cycling track next to the unnamed road along the western boundary of the Bird Park. Possessed shaded clear water pools, slow flowing over a sandy base. Bank vegetation is generally overgrown.
	Area D (Upstream), Area D (Downstream)	Unnamed stream	Clear flowing stream over sand and silt bottom, open country stream.
F	Mandai16	Swampy inlet (Night Safari)	Shallow stream, swampy area over silty and clay bottom. Partial canopy of riparian vegetation.
H	Mandai14	Swampy inlet near Lorong Lada Hitam	Clear tannin stained water. Swampy area over silty and deep leaf litter bottom. Partial canopy of riparian vegetation with swamp forest floral elements (e.g. *Lasia spinosus*) growing along the water margin.
	Mandai15	Swampy inlet further from Lorong Lada Hitam	Murky water, swampy area, over clayey and silty bottom. Open canopy of riparian vegetation. More exposed and displayed signs of recreational fishing observed from presence of monofilament lines, discarded netting material and fish traps.

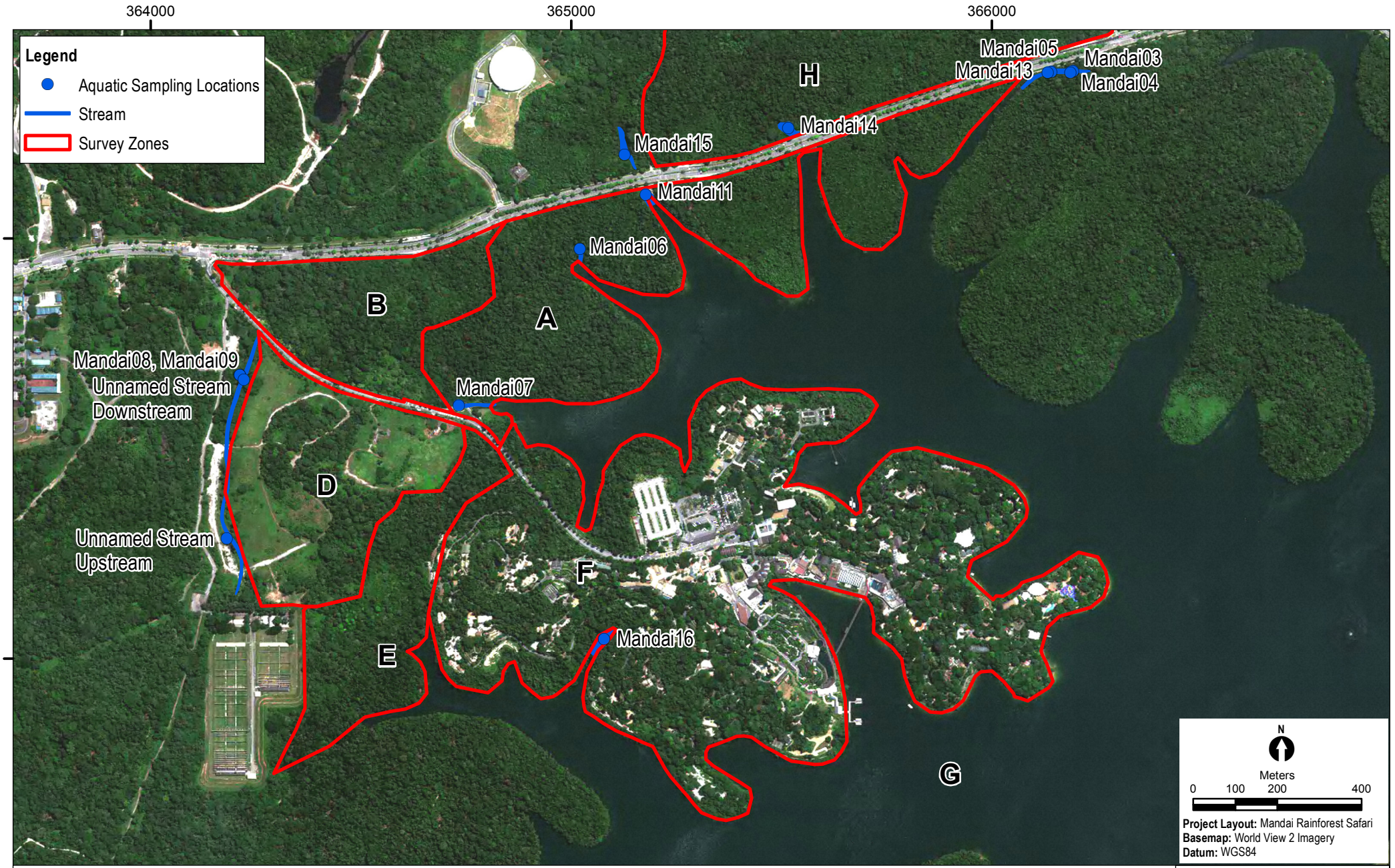


Figure 6.18 Aquatic Sampling Locations

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Environmental Resources Management

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6.6.7.2 Fish

Twelve (12) native and ten (10) exotic fish species were recorded across all zones from May 2015 to September 2015. Amongst the native species recorded, four are known to be associated with forest habitats (*Rasbora einthovenii*, *Rasbora elegans*, *Betta pugnax* and *Channa lucius*). Fish associated with forest habitats were not recorded from Zone D.

6.6.7.3 Decapod Crustaceans

Three (3) native and three (3) exotic species have been found in the Study Area. Native species found include the Atyid Shrimp (*Caridina johnsoni*), Johnson's Freshwater Crab (*Irmengardia johnsoni*) and Peracca's Land Crab (*Geosesarma perracae*). Johnson's Freshwater Crab (*Irmengardia johnsoni*) is endemic to Singapore, and listed as VU on the IUCN Red List and EN on SRDB.

A summary of the fish and decapod crustacean findings from the survey area is presented in *Table 6.32.* Detailed findings can be found in *Annex 14.10*.

Table 6.32: Summary of Aquatic Survey Findings

Zone	Native		Non-native		Conservation Status of Native Species (number of species)
	Fish	Crustacean	Fish	Crustacean	
A	8	2	5 (38%)[1]	2 (50%)[1]	• Restricted and Rare (2) • Restricted and Common (2) • Widespread and Uncommon (1) • Widespread and Common (5)
D	3	0	3 (50%)[1]	0	• Widespread and Uncommon (1) • Widespread and Common (2)
F	5	2	3 (38%)[1]	2 (50%)[1]	• EN (SRDB), VU (IUCN), Endemic (1) • Restricted and Rare (1) • Restricted and Common (3) • Widespread and Common (2)
H	6	0	2 (25%)[1]	1	• Restricted and Rare (1) • Restricted and Common (3) • Widespread and Uncommon (1) • Widespread and Common (1)

Note:
(1) Percentage of non-native species out of total number of species recorded

It is noted that a broad-based biodiversity study of Upper Seletar Reservoir was commissioned by the PUB in 2009 and studies of the aquatic fauna (including aquatic molluscs, decapod crustaceans, fish, aquatic insects and plankton) were conducted. The following were recorded: Nine (9) species of molluscs of which seven (7) were native; six (6) species of decapod crustaceans of which four (4) were native, including the EN/SRDB Johnson's Freshwater Crab (*Irmengardia johnsoni*); twenty-one (21) species of fish of which eight (8) are native; forty-seven (47) aquatic insect species, all of which are native including three (3) are

nationally endangered species (odonates *Pseudothemis jorina*, *Rhyothemis obsolescens* and *Prodasineura verticalis*); ten (10) and twenty-six (26) genera of cyanobacteria and non-cyanobacterial phytoplankton respectively; and six (6) zooplankton taxa. Some of the exotic species were likely to have been introduced to the Upper Seletar Reservoir via the ornamental fish trade, or potentially transferred within the untreated water pumped from the Kranji Reservoir or the Tebrau River in Johor, Malaysia.

6.6.7.4 Aquatic Habitats and Hydrological Features

The types of aquatic habitats present in the Study Area were derived from the observations of aquatic habitats listed in *Table 6.31*, which characterized the habitats mainly by three parameters, the (i) speed of water flow, (ii) type of substratum, (iii) canopy cover of riparian vegetation. Based on this understanding, and supplemented by existing classifications of aquatic habitats in Singapore [(67)], the types of aquatic habitats present are:

- Clear flowing streams (shaded);
- Clear flowing streams (non-shaded, i.e. open country streams);
- Reservoir inlets, headwater streams;
- Stagnant pools;
- Swamp; and
- Dry swamp.

The location of these aquatic habitat types are shown in *Figure 6.19*.

[67] Yeo DCJ, Wang LK & Lim KKP ed. (2010) Private Lives: An Expose of Singapore's Freshwaters. The Raffles Museum of Biodiversity Research. p258.

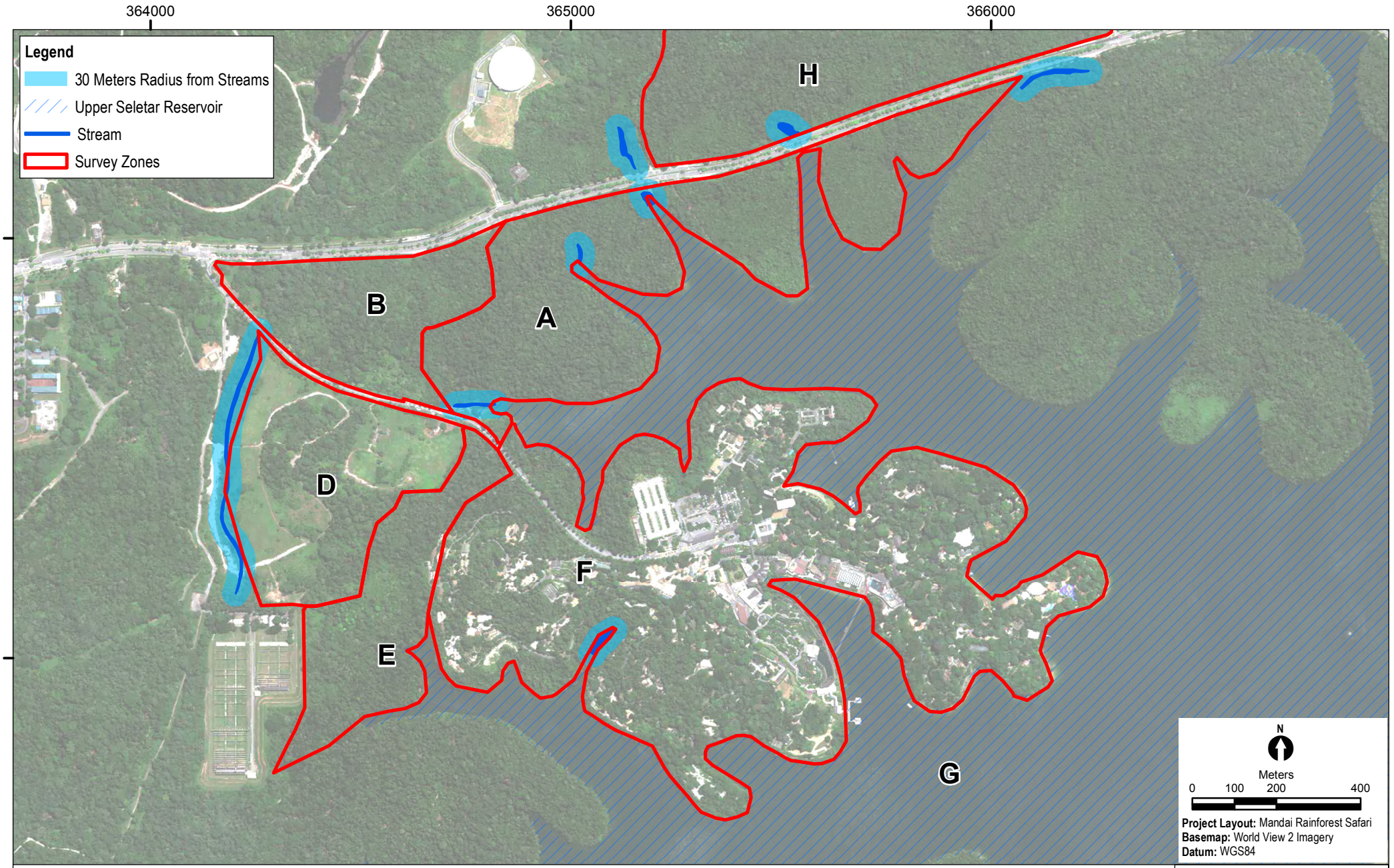

Figure 6.19 Aquatic Habitat Distribution within the Study Area

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Environmental Resources Management

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6.6.8 Priority Biodiversity Values

6.6.8.1 Central Catchment Nature Reserve

The CCNR is home to some of the few remnant stands of primary forest in Singapore, and several other vegetation types including tall secondary forest, marshland and swamp forest. It is also known to support a rich diversity of organisms comprising an estimated 185 birds [68], 44 mammals, 72 reptiles, 25 amphibians and all 34 native freshwater fish species in Singapore [69]. Flora surveys in 1997 recorded a total of 1,525 native vascular plant species from the CCNR and BTNR [70]. Compared to the most current list of vascular plant flora (2,145 native species), the nature reserves harbour approximately 71% of indigenous plant species in Singapore [71]. These are evidence for the CCNR's important role as a stronghold for biodiversity in Singapore.

6.6.8.2 Threatened and/or Unique Ecosystems

Nee Soon Swamp Forest

The only remaining substantial patch of freshwater swamp habitat in Singapore, Nee Soon Swamp Forest (NSSF), can be found within the CCNR. It supports the richest diversity of native freshwater organisms, and more than 700 vascular plant species has been recorded from the area. In addition, the NSSF is the only or main habitat for an estimated 16% of the total fauna of Singapore. This includes the Swamp Forest Crab (*Parathelphusa reticulata*) which is endemic to Singapore. A review of a map of the vegetation types of the CCNR shows that the NSSF is not located [72] within the Study Area [73], however this ecosystem is included given its conservation importance in Singapore.

Primary Dryland Forest

A total of 200 ha of primary dryland forest can be found embedded in a mosaic of secondary forests and non-forested areas in the CCNR. This forest type is characterised by a dominance of trees from the Dipterocarpaceae family [74]. Similar to NSSF, these are the last remaining fragments of primary forests in Singapore that were protected from clearance in the 1900s due to the establishment of the Municipal Catchment. This is an important vegetation type as it is often found, in comparison with other forest types, to support the richest diversity of native plants, exhibit the most complex forest stratification [75], and serve as an important

68 Lim KS (1997) Bird Biodiversity in the Nature Reserves of Singapore. Proceedings of the Nature Reserves Survey Seminar. Gardens' Bulletin Singapore. 49. 225-244.

69 Nature Society Singapore, 2013. Discussion and Position Paper, Cross island Line. Retrieved from http://www.nss.org.sg/documents/(NSS)%20Cross-Island%20Line%20Position%20Paper.pdf

70 Chew PT, Suran S, and Ibrahim A (1997) Checklist of Vascular Plants in the Nature Reserves of Singapore. Proceedings of the Nature Reserves Survey Seminar. Gardens' Bulletin Singapore. 49. 161-223.

71 Given the flora survey was conducted in 1997 and the total vascular flora list was generated in 2009, there are likely to be discrepancies due to the lag time between both. However, this resource still offers a means to evaluate the importance of the CCNR as a stronghold for biodiversity in Singapore.

72 According to the Singapore Encyclopedia of Biodiversity (2011), the NSSF is bounded on the north by the Executive Golf Course, on the east by Seletar Expressway and Old Upper Thomson Road, and to the south by Upper and Lower Peirce Reservoirs and on the west by the southern-most tributary of the Upper Peirce Reservoir

73 Ng PKL, Corlett RT, Tan HTW ed (2011) Singapore Biodiversity – An Encyclopedia of the Natural Environment and Sustainable Development. Raffles Museum of Biodiversity Research. 552pp.

74 Ng PKL, Corlett RT, Tan HTW ed (2011) Singapore Biodiversity – An Encyclopedia of the Natural Environment and Sustainable Development. Raffles Museum of Biodiversity Research. 552pp.

75 Ng PKL, Corlett RT, Tan HTW ed (2011) Singapore Biodiversity – An Encyclopedia of the Natural Environment and Sustainable Development. Raffles Museum of Biodiversity Research. 552pp.

seed source for the regeneration of surroundings forests. A review of *Figure 6.12*, and with reference to the Vegetation Map of BTNR and CCNR [76] shows that there are no primary dryland rainforest patches in the survey area. However, it is noted that the vegetation survey had found three fragments of old growth vegetation containing mature, globally threatened Dipterocarp species.

Stream Ecosystems

Several of Singapore's streams have been modified into artificial environments such as canals, or lost due to impoundment and flooding for the creation of reservoirs. However, there are a number of forest streams that prevail; these are typically small and shallow (rarely deeper than 1m), slow flowing, soft and mildly acidic with pH ranging from 5.5 to 6.0. These streams are well shaded by forest canopy and riparian vegetation. Forest streams, together with freshwater swamps, are strongholds of native freshwater diversity. Open country streams run through areas that have formerly been cleared but have since regenerated i.e. scrubland. While these streams have not been modified, they are less shaded and support hardier species such as catfish, snakeheads, swamp eels and exotic species [77]. The surface water streams listed in *Section 6.4* and sampled during the aquatic fauna survey comprise modified streams, open country streams and forest stream/swampy habitats.

6.6.8.3 Priority Species

A species database, provided in *Annex 10.0*, was developed to contain all the species recorded from the biodiversity surveys conducted in and around the Project area in 2008, 2014 and 2015. It was augmented with data from NParks from a series of rapid biodiversity surveys conducted in the Mandai locality, including one conducted in Lorong Asrama. From this database, a list of priority species was generated that included species that were expected to be more sensitive to the potential impacts from the Project. The priority species were selected if they met either of the following criteria:

- Listed on the IUCN Red List or the SRDB as CR, EN or VU;
- Migratory or restricted range species; or
- Species of interest identified within the Project area.

The priority species selected and taken forward for consideration in the impact assessment are outlined in *Annex 11,0*.

[76] Yee ATK, Tan HTW, nd. The Vegetation History of the Bukit Timah Nature Reserve and the Central Catchment Nature Reserve. Department of Biological Sciences, The National University of Singapore.

[77] Lim KKP and Ng PKL, 1990. A Guide to the Freshwater Fishes of Singapore. Singapore Science Centre, Singapore. 160 pp.

6.6.8.4 Priority Habitats

Similar to the priority species, priority habitats were determined based on the baseline findings and taken forward for consideration in the impact assessment. The priority habitats identified were as follows:

- Vegetation located within the CCNR, and immediate buffer area;
- Habitats associated with species of conservation significance as outlined in *Annex 11.0*;
- Remnant primary and secondary forests; and
- Riparian areas.

Species that may potentially be associated with these priority habitats have been detailed in *Table 6.24* and *Table 6.26*. This promotes an understanding of the types of species that may be affected indirectly by Project activities if priority habitats are impacted. The abovementioned priority habitats are presented in a habitat map (*Figure 6.20*). This map will be complemented by the potential species-habitat associations for further consideration in the impact assessment.

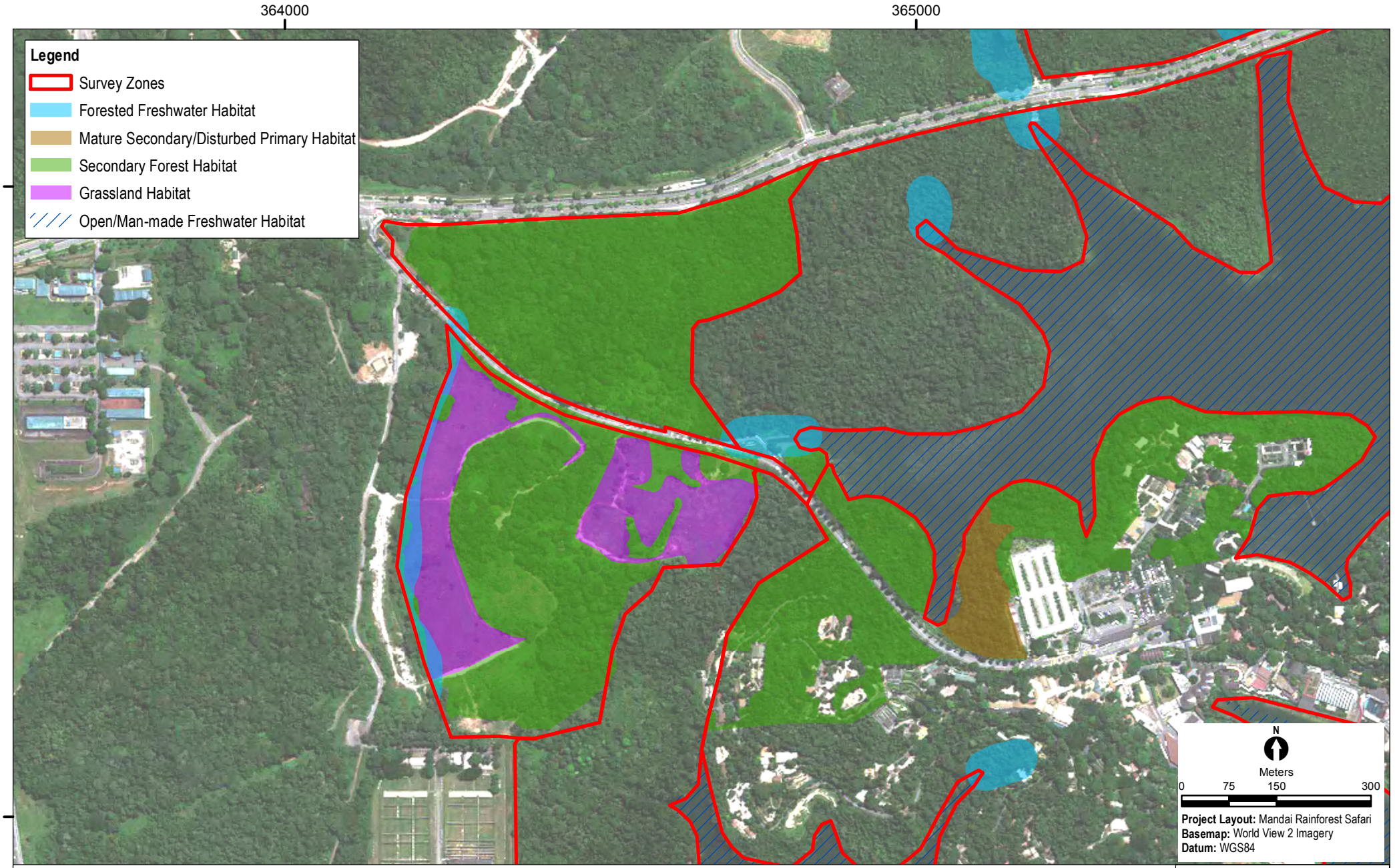


Figure 6.20 Habitat Map

Service Layer Credits: World View 2 Imagery

Environmental Resources Management

ERM

7 STAKEHOLDER ENGAGEMENT

Stakeholder engagement is an integral part of the EIA process. It enables the sharing of information and knowledge, and facilitates the building of relationships for a collaborative approach to problem-solving. For this Project, a systematic process was undertaken to first develop an understanding of the issues, identify stakeholders, and then create and maintain stakeholder relationships through designated resources. Processes were then built around Project milestones which allowed stakeholders to understand, absorb, respond and interact with the project development.

7.1 PURPOSE AND OBJECTIVES

Stakeholders are defined as "*persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively*" [(1)]. The main objectives of stakeholder engagement are to:

- Ensure that adequate information is provided in a timely manner to those interested in or affected by the Project;
- Ensure that identified stakeholders are provided with sufficient opportunity to voice their opinions and concerns; and
- Ensure that stakeholder feedback is received and taken into account in Project decisions.

7.2 REGULATORY FRAMEWORK

There is currently no regulatory framework for stakeholder consultation for developments of the nature of this Project in Singapore. The approach to stakeholder engagement has therefore been informed by the following:

- Project requirements;
- International best practice; and
- MPH's understanding of stakeholder expectations.

7.2.1 International Best Practice

In the absence of a legal requirement or framework to guide public consultation for such projects, ERM has followed its internal Impact Assessment Standard which is generally consistent with most international standards such as the World Bank and IFC performance standards. For example, the Project stakeholder engagement plan was designed to support the EIA process in accordance with ERM's Impact Assessment Standard, which requires the recording of all stakeholder consultation outcomes and the consideration of stakeholder concerns in the screening and scoping phases of the EIA.

[(1)] *Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets*, International Finance Corporation, 2008.

7.2.2 MPH's Understanding of Stakeholder Expectations

The Project stakeholder engagement plan was developed with the understanding that while the Project must obtain the requisite formal approvals by the relevant government agencies to proceed in accordance with the laws and regulations of the jurisdictions in which the Project is located, it is also important to gain informal approval from other Project stakeholders. This "social licence to operate" [(2)] is defined by the expectations of the community for best-practice social and environmental stewardship. Processes were therefore developed to continually monitor, receive and incorporate stakeholder feedback into the Project decision making process.

7.3 CONTEXT OF STAKEHOLDERS IN SINGAPORE

To establish the context of stakeholders in Singapore, a desktop review was undertaken of media articles and publications pertaining to the proposed Project, including the NSS Discussion and Position Paper [(3)]. In addition, ERM facilitated an internal workshop with MPH to identify Project stakeholders and their key concerns.

7.3.1 Identified Stakeholders

Project stakeholders identified were grouped in the following categories:

- Government Authorities for EIA;
- Other Government Authorities;
- Key Non-Governmental Organizations (NGOs), Green Groups and Individuals;
- Other NGOs, Green Groups and Individuals;
- Technical Experts;
- Persons of Influence;
- Blue Groups;
- Heritage Groups;
- General Public;
- Media; and
- Social Media.

7.3.2 Identified Stakeholder Concerns

Key issues were identified through historical engagement with stakeholders, secondary data review, the stakeholder mapping workshop and lessons learnt from observations of other EIA projects involving stakeholder engagement in Singapore. These are mapped to the respective stakeholder categories, as presented in *Table 7.1*.

[(2)] "Social license to operate" refers to the level of acceptance or approval by a project's stakeholders and is based on the idea that organisations require not only government permission but also "social permission" to conduct their business.
[(3)] Nature Society (Singapore) (2008) **Report on the Singapore Tourism Board (STB) Project at Mandai.** Retrieved from http://www.nss.org.sg/documents/Compiled-Report%20on%20the%20STB%20Project%20at%20Mandai%20Road[1].2008%20(Original%20Report)%20doc.pdf

Table 7.1: Stakeholder Categories and Issues Mapping

Stakeholder Category	Key Environmental Issues / Interests
Internal Stakeholders	• Health and safety throughout the Project lifecycle including potential outbreak of bird flu. • General community unrest, petitions and representations. • Lack of local resources / expertise for implementation of recommended measures. • Impacts to existing attractions (e.g. animals, existing utilities). • Failure to attract more tourists. • Balance of economic and environmental sustainability. • Management of carbon footprint. • Operational / institutional structure. • Desire to be part of a world class project. • Contribution to conservation and local society. • Strive to meet the United Nation standard - Vision 4 Biodiversity. • Consistent external messaging. • Single unifying vision for the project with practical desired project outcomes. • Clear and transparent processes, roles and responsibilities for members of EIA working group. • Sufficient provision for supporting facilities and infrastructures in master / design plan.
Agencies in-charge / Government Authorities for EIA / Other Government Authorities	• Develop attractions' appeal to visitors and locals. • Public engagement. • Close proximity to sensitive land uses e.g. Central Catchment Nature Reserve, Upper Seletar Reservoir, special use areas. • Potential impact to existing infrastructure due to increase in vehicular traffic. • Impacts to long-term transportation planning. • Impacts to the environment and biodiversity. • Conserving green spaces. • Specific requirements and guidelines for issues to be addressed in the EIA. • Transparency of the EIA process and level of participation. • Impacts to water quality.

Key NGOs, Green Groups and Individuals / Other NGOs, Green Groups and Individuals	• Impacts to flora and fauna including:
	  • Loss of buffer zone and connectivity of nature reserve fragment
	  • Increase of vehicular traffic resulting in fauna injury / mortality
	  • Introduction of non-native species
	  • Management of existing large wild mammals (e.g. leopard cats, mouse deer, sambar deer)
	• Siltation of Upper Seletar Reservoir.
	• Air and noise emissions from construction.
	• Development footprint and intensity.
	• Preservation and integration of existing natural features.
	• Transparency of the EIA process and level of participation.
	• Impacts to existing biota / animals in the existing attractions.
	• Concerns on increase in human traffic during operations.
	• Increase in public awareness about nature and conservation.
	• Enhancement of natural environment at Mandai.

Stakeholder Category	Key Environmental Issues / Interests
Technical Experts	• EIA procedure, approach and content. • Input to dedicated subject-matter area. • Ability to meet zoo community best practice standards in conservation contribution, animal ethics and welfare (WAZA).
Persons of Influence	• Stakeholder consultation. • Failure or success of the Project. • Potential for conflicting views and interests.
Blue Groups	• Impacts to surface water bodies and habitats associated.
Heritage Groups	• Impacts to cultural heritage.
General Public	• Impacts to the surrounding area and environment. • Establishment of world-class nature-themed attraction. • Accessibility and affordability of attractions. • Attractiveness and relevance of the attractions. • Availability of green public spaces for recreation and education.
Media / Social Media	• Project updates. • Potential project benefits or impacts. • EIA findings. • Construction and environmental impacts.

7.4 EIA ENGAGEMENT ACTIVITIES

7.4.1 Consultation Activities Undertaken to Date

Prior to the inception of the EIA, MPH undertook a number of informal one-on-one consultations with selected individuals; a formal engagement session with representatives from local NGOs and green groups; and had meetings with relevant government authorities, for their inputs in the scope of the EIA and selection of the EIA consultant. The engagement process was structured and standardised following the inception of the EIA. Key NGOs, green groups and individuals are engaged on a regular basis throughout the Project by sharing Project information and soliciting feedback on the Project design and implementation. MPH intends to disclose the Project EIA findings to the public.

7.4.2 Key Findings for the Impact Assessment

A summary of the key concerns highlighted during the abovementioned consultation activities, and which pertain to the Project, is presented in *Table 7.2*, along with the corresponding report references which addresses the concern.

Table 7.2: External Stakeholder Concerns & Report Reference

No.	Stakeholder	Concerns	Report Reference
1	Agencies in-charge / Government Authorities for EIA / Other Government Authorities	• Ecosystem effects within the Project area and CCNR due to introduction and containment of exotic flora and fauna, removal of existing habitats etc. • Sensitivity of water features within the Project area and AOI and their susceptibility to sedimentation due to erosion risk and any unplanned events. • Noise and light impacts from construction and operations. • Pressure on Mandai Lake Road and Mandai Road due to increased visitation. • Design of developments to overcome site constraints (e.g. land size, close proximity to CCNR, presence of existing structures such as PUB discharge outlet).	• Chapters 8 & 9
2	Key NGOs, Green Groups and Individuals / Other NGOs, Green Groups and Individuals	• The design and strategy for the wildlife crossing between the fragments of CCNR. • An increase in animal escapees and invasive species in view that the ecosystem within the CCNR has been impacted due to the past animal escape incidents from the Zoo. • Sensitivity of the ecosystem within the CCNR due to potential trespass if proper fencing is not implemented between the Project area and CCNR. • Conservation / management of important flora and fauna currently residing within the Project area. • Findings of baseline survey may not represent the actual site conditions due to limited spatial and temporal coverage.	• Chapters 8 & 9

7.5 DISCLOSURE AND PLANNED FUTURE CONSULTATION ACTIVITIES

7.5.1 Objectives of Disclosure

The disclosure of this report provides the opportunity for MPH to communicate the Project activities, implementation schedules, associated risks, impacts, benefits and mitigation measures. MPH is committed to maintain its ongoing program of consultation and disclosure and will:

- Maintain regular communications with relevant stakeholders;
- Ensure a grievance mechanism is developed to provide a platform for stakeholders to voice their concerns and any complaints throughout Project implementation;
- Ensure complaints are addressed in a timely manner and in accordance to the established process; and
- Continually monitor implementation to determine the effectiveness of mitigation measures.

7.5.2 Recommended Future Consultation Activities

Recommended future consultation activities including disclosure of this report, and Project roles and responsibilities are summarised in *Table 7.3.*

Table 7.3: Recommended Future Consultation Activities

No.	Description (Stakeholder Category)	Disclosure Method	Project Roles & Responsibilities
1	Disclosure of key findings from Project EIA (Key government authorities)	Submission of Project EIA report to key government authorities	• Submission of EIA report and liaison with agencies in-charge to consolidate comments
2	Disclosure of key findings from Project EIA (members of the public)	Disclosure of Project EIA Report	• Issuance of public announcements via various media (MPH) • Maintenance of Project grievance mechanism (MPH Social Media Team) • Response to stakeholder concerns consolidated during the disclosure period (MPH Project Team)
3	Provision of Project details e.g. proposed schedule for shifting of Jurong Bird Park (Key government authorities, Key NGOs, Green Groups and members of public)	Consultation meeting with key government authorities, Media announcement, MPH website	• Undertake consultation meetings with relevant agencies to coordinate on scheduling and solicit feedback (MPH Project Team) • Issuance of letters, notices, media and online announcement (MPH Social Media Team)
4	Update on Project progress and EMMP implementation (Key government as appropriate and Key NGOs, Green Groups)	Consultation meetings	• Undertake consultation meetings with relevant agencies and Green Groups (MPH Project Team)
5	Findings of Post-	Consultation	• Share findings of post-construction

No.	Description (Stakeholder Category)	Disclosure Method	Project Roles & Responsibilities
	construction environment monitoring	meetings	environment monitoring with relevant agencies and Green Groups (MPH Project Team)

7.6 MPH GRIEVANCE MECHANISM

MPH has developed a dedicated Project Website (**www.mandai.com**) for dissemination of project-relevant information. The website also serves as a platform that allows public to provide feedback and enquiries associated with the Project. At the time of writing, it is understood that MPH was in the process of developing formal protocol for handling of feedback during the construction and operational phases of the Project.

7.7 MONITORING & EVALUATION

The implementation of the Project stakeholder engagement plan will be reviewed at regular intervals throughout the Project to monitor and evaluate the continued effectiveness of planned consultation activities. Reviews will be designed to:

- Assess the adequacy of information provided, as well as methods and mechanisms of communication with stakeholders;
- Determine perceptions the stakeholders have of MPH's environmental and social performance; and
- Ensure that concerns or suggestions relating to environmental mitigation or enhancement measures are considered and adopted, where appropriate.

8 CONSTRUCTION PHASE IMPACT ASSESSMENT

8.1 AIR QUALITY

8.1.1 Impact to Human Receptors from Dust Emissions

Dust is usually categorised into three size classifications or fractions:

- Total Suspended Particulate (TSP) – Particles of less than 50 µm in aerodynamic diameter;
- PM_{10} - Particles of less than 10 µm in aerodynamic diameter; and
- $PM_{2.5}$ - Particles of less than 2.5 µm in aerodynamic diameter.

Of these size fractions, only PM_{10} and $PM_{2.5}$ have the potential to enter the human respiratory system. Of respirable size fractions, dust generated from construction activities typically comprises PM_{10}. Studies show that 85 – 90% of such particles will be particle size range between 2.5 and 10 µm [(1)]. For the purposes of this assessment, dust will therefore be assessed in terms of PM_{10}.

8.1.1.1 Sources

Dust generating activities during the Project construction phase are likely to include the following:

- Earthworks such as land clearance and topsoil removal for the preparation of construction work areas; excavation for underground structures such as carparks at the *East* and *West Arrival Nodes* and *Planet Explorer/Sri Seletar Point;* and grading of sloped areas for the *Eco-Link* and within the work areas for the *Rainforest Park North, Rainforest Park South* and *Bird Park*;

- Demolition of the existing multi-storey carpark and structures within the existing WRS operated areas such as those associated with the WTP, staff quarters, nursery and quarantine area;

- Concrete and asphalt breaking and shallow excavation works associated with utility and infrastructure diversions;

- Stockpiling of spoil and demolition waste within the construction work areas;

- Movement of construction vehicles and plant on unpaved surfaces within the construction work areas prior to reinstatement of road surfaces, building or landscaping works; and

- Soil and/or construction material being tracked out by vehicles leaving the Project construction area along Mandai Lake Road and Mandai Road.

[1] Institute of Air Quality Management (2014) Guidance On The Assessment Of Dust From Demolition And Construction.

8.1.1.2 Receptors

Dust levels generally decrease exponentially over distance due to re-deposition[(1)], notwithstanding other influencing factors such as air stability (wind), topography and the presence of trees or structures. There is currently limited evidence on the distance over which dust impacts might occur [(1)]. For the purpose of this study, reference has been made to best practice guidance which provides conservative estimates based on the experience of air quality practitioners within the Institute of Air Quality Management (IAQM) and the Greater London Authority. The human receptors that would likely be exposed to increased dust levels from the construction activities associated with the Project are therefore defined as any human receptor within 350 m of the Project boundary or 50 m from any unpaved access route within 500 m of the Project boundary[(1)]. From a review of the land uses within and surrounding the Project site, the above mentioned receptors would include visitors and staff within the WRS site. Flora and fauna within the CCNR and buffer zone is also considered sensitive to elevated dust levels from construction activities.

Personnel within the existing WRS site typically work in outdoor conditions. Daytime work - 002shifts are typically between 8.30 am to 6 pm daily for the *Singapore Zoo*, and 9 am to 6 pm for the *River Safari*. Although the *Night Safari* operates from 7.30 pm to midnight, it is noted that daytime maintenance and preparation works would begin in the evening. It is therefore conservatively assumed that workers may be exposed to dust levels for eight hours or more within a day. Based on the sensitivity criteria for air sensitive receptors (ASRs) (*Annex 2*), WRS personnel are therefore assessed to be of **Medium** sensitivity to dust generated from construction activities.

Due to the phased operation of the existing *Singapore Zoo* and *River Safari* attractions in the daytime, and the *Night Safari* in the night, it is conservatively assumed that it is possible for visitors to spend more than eight hours within the WRS site. Due to the spread of the excavation and demolition sites within the *Singapore Zoo*, it is possible that visitors may be within 350 m of construction activities regardless of the visitor's location within the WRS site. Furthermore, visitors to the WRS site include particularly sensitive receptors such as young children and elderly, who may be susceptible to elevated levels of PM_{10}. Visitors to the existing WRS operated areas are therefore assessed to be of **High** sensitivity to dust generated from construction activities.

8.1.1.3 Impacts

Increased dust levels may lead to acute health effects to human receptors, such as irritation of the respiratory system. Dust deposition may also lead to soiling of existing structures leading to nuisance effects on human receptors such as the visitors to the WRS sites. Dust deposition may also affect flora in the CCNR by coating leaves and impairing photosynthesis.

From a review of the conceptual Project design and site walkover, existing structures within the WRS site such as the multi-storey carpark, staff quarters and buildings associated with the nursery, quarantine area and the WTP would need to be demolished. These buildings are largely constructed of concrete and will potentially generate a large amount of dust during demolition. Details to inform the total volume of the buildings marked for demolition was not available at the time of writing. However, given the above, the volume of building to be demolished is conservatively estimated to be more than 50,000 m^3.

A certain amount of clearance of vegetation will be undertaken to accommodate the new attractions. While the exact area of clearance is currently unknown, it is expected that clearance along with excavation of topsoil for the underground structures will likely expose an area of approximately 10,000 m^2 which will be susceptible to mobilisation by wind. The volume of excavated material, as estimated in *Table 2.2*, is anticipated to be approximately 1,435,000 m^3. Soil samples indicate that the Project area is predominantly underlain by clay, which has a small grain size and is therefore prone to mobilisation when dry and exposed to windy conditions, or when there is vehicular movement over unpaved roads within the construction work areas.

Buildings to be constructed will include the *Eco-Lodge;* and within the *Rainforest Park North*, *Rainforest Park South*, *Planet Explorer/ Sri Seletar Point* attractions, as well as carpark facilities and other indoor amenities at the *West* and *East Arrival Nodes*. It is assumed that concrete will be the main fabric of the buildings constructed, however a concrete batching plant will not be required. Pre-mixed concrete will be transported to the construction site as required.

Higher wind speeds typically occur during Singapore's monsoonal periods. Dust emissions due to re-entrainment from wind are therefore likely to be attenuated by rainfall associated with thunderstorms characteristic of the NE and SW monsoon seasons. In consideration of this influencing factor and the magnitude criteria defined for air quality (*Annex 2*), the magnitude of impact of dust generated from demolition, construction and earthworks during the Project construction phase is evaluated to be **Medium**. Taking into account the **High** sensitivity of the visitors and **Medium** sensitivity of the WRS personnel, the significance of dust impacts is assessed to range from **Moderate** (for WRS personnel and flora in the CCNR) to **Major** (for visitors to the WRS site).

8.1.1.4 Mitigation

Measures to avoid, minimise, and limit the magnitude of dust impacts caused by the Project's construction phase are outlined in *Table 8.1*. Mitigation includes construction management best practices, monitoring, and general housekeeping activities.

Table 8.1: Mitigation Measures for Dust Generation

Phase / Activity	Specific Actions
General Management & Planning	• Phase dust generating activities such as land clearance, demolition works, earthworks and building construction at the various construction packages to minimise the area of ground exposed and the volume of soil and construction material handled at any one time. • Ensure availability of water (potable from PUB mains supply) for dust suppression at suitable locations in particular the excavation and demolition sites. Where water suppression is to be carried out at locations near a surface waterbody (e.g. during demolition of the existing staff quarters), plan the sequence of construction such that the perimeter drain will still be in place to capture surface runoff from use of dust suppression. • Follow the approved Environmental Management and Monitoring Plan throughout the pre-construction and construction activities. • Workers to undertake proper housekeeping of the site and roadways linked to the entrances of the various construction worksites e.g. Mandai Lake Road, at the end of each day. This is to ensure that roadways, vehicle wheels and equipment tracks are clear of dust or mud, and that appropriate barriers, tarpaulin covers/erosion blankets have been repaired and/or reinstated. • Implement the following management measures to limit generation of dust during all construction works.

Phase / Activity	Specific Actions
Earthworks	• Locate stockpiles and worksite entrances as far as possible from and downwind of the WRS sites. • Avoid stockpiling at areas within 100 m north of the WRS sites and CCNR boundary. • Cover stockpiles with well-maintained tarpaulin when not in use or as soon as practicable, in particular during dry periods such as the late NE monsoonal period (late January to early March). • Stockpiles to be maintained below a maximum height of 2 m. • To minimise the volume of spoil stockpiled, schedule removal of spoil or waste material by licensed third party at least every 5 days. Scheduling should also ensure that imported soil will be stockpiled for less than 5 days on site prior to backfilling works. • Wherever reasonable and practicable, cleared vegetation in particular sloped areas, should be covered with mulch or erosion control blankets to control erosion of exposed soil. • Re-vegetate exposed ground as soon as possible to stabilize surfaces and minimise re-entrainment of dust. • Use water suppression during excavation and earth handling at exposed areas in the event of rainfall of less than 0.25 mm in a 24 hour period and gusting or sustained wind speeds of greater than 19 kph. The use of these thresholds is based on the Australian National Pollutant Inventory guidance [2]. The occurrence of low rainfall and windy conditions at these defined thresholds will lead to fugitive emissions due to wind erosion from active stockpiles. • Water suppression at the *West* and *East Arrival Nodes* is to be controlled to the minimum necessary to reduce excess water runoff that may enter drainage infrastructure. This will be achieved by visual inspection to ensure that that there is no visible sign of runoff from sprayed areas. The drainage infrastructure for the Project will have zero discharge to Upper Seletar Reservoir, including during the construction phase.
Demolition	• Adopt manual or mechanical methods for the demolition of buildings and structures and avoid the use of blasting. • Use dust suppression methods such as misting during demolition works in dry conditions. • Enclose the buildings to be demolished and use demolition chutes and demolition waste receptacles. • Demolition chutes should be covered with tarpaulin when not in use, and scheduled for collection and offsite disposal once every 5 days.
Transportation	• Apply water to roads at a rate of 2 litres/m^2/hour prior to and during truck use in dry conditions. • Vehicles to pass through a wheel wash upon entry and exit of the construction work areas. • Undertake twice daily checks of Mandai Lake Road and sections of Mandai Road being used as the haul route for accidental spillage of spoil/earth being tracked out of the Project area. • Clean up any spoil/earth spillage onto the haulage routes immediately.

[2] Commonwealth of Australia (January 2012) National Pollutant Inventory – Emission Estimation Technique Manual for Fugitive Emissions. Version 2.0 pp 21. Retrieved from http://www.npi.gov.au/system/files/resources/c6afec68-468c-d994-41d7-bcd8c8b1bcbe/files/ffugitive.pdf

Phase / Activity	Specific Actions

Monitoring	• Continuously monitor PM_{10} levels at one location upwind and one location downwind of worksites. Should measurements indicate that dust levels generated from the worksite is approaching Singapore ambient air quality target for 24 hour PM_{10}, i.e. 50 µg/m^3, mitigation measures shall be undertaken including but not limited to:
	  • Employ or increase water suppression to dust generating activity.
	  • Reduce the number of dust generating activities being undertaken.
	
	Note: Dust generation from the work area is indicated by low measurements upwind and high measurements downwind of the Project site boundary. If both upwind and downwind measurements are high, it is likely that ambient dust levels are due to contributing sources outside the Project Study Area, e.g. transboundary haze.
	
	• Contractor EHS team to undertake visual inspections daily to ensure that tarpaulin covers, erosion blankets, covers for dump trucks, hoarding along the boundary of the construction site and other dust control measures, are in good condition and that improperly positioned or damaged covers/barriers are replaced in a timely manner.
	• Contractor EHS team to undertake visual inspections of WRS buildings and vegetated areas downwind of stockpiles/earthworks/demolition site, at least once weekly, to determine if there are signs of dust deposition from the construction site. Where dust deposition is evident on building facades or on flora, Contractor EHS team to spray down with water and implement appropriate corrective actions to reduce the source of dust in a timely manner.

Management of Implementation	• Contractor EHS team to undertake daily inspection of construction area against management and monitoring measures defined in the Project EMMP. • Maintain a complaints procedure to log and track response to complaints received from stakeholders. • Maintain records of ambient dust measurement and checklist of the EMMP actions used across the Project area on a daily basis during construction.

8.1.1.5 Residual Impacts

Dust generated from construction activities can be managed by implementation of the aforementioned measures during the pre-construction and construction activities. With reference to the criteria outlined in *Annex 2*, the magnitude of residual impact following implementation of mitigation measures is therefore assessed to be **Small**. Combining the sensitivity of **Medium** for WRS site personnel, workers and flora and **High** for visitors to the WRS site, the significance of residual impact is therefore **Minor** (for WRS personnel and flora) to **Moderate** (for visitors to the WRS site). A summary of the impact assessment before and after implementation of dust mitigation measures is presented in *Table 8.2* and the management and monitoring measures are also captured within the EMMP chapter (*Chapter 10*) for ease of reference and implementation during the construction phase.

Table 8.2: Impact Assessment Summary

Criterion	Rating	Comment
Elevated Dust Levels Due to Construction Activities		
Nature	Negative	Generation of dust
Type	Direct	Suspended dust particles may lead to or exacerbate health impacts on sensitive receptors, in particular for the young, the elderly and those suffering from respiratory conditions. Dust deposition may soil buildings and impair the ecological function of flora in vegetated areas.
Duration	Long-term	The total duration of construction works is estimated to be 6 years.
Extent	Local	PM_{10} generated by construction activities will generally be deposited within 350 m of the Project site boundary.
Scale	-	Total volume of buildings to be demolished and constructed is estimated to be ~ 50,000 m^3. The total area of land to be cleared is estimated to be ~10,000 m^2, and the total volume of soil to be excavated is estimated to be approximately 1,435,000 m^3.
Frequency	Frequent	Dust generating activities will be undertaken at different stages throughout the Project construction phase.
Magnitude	Medium	The buildings that will be demolished (total volume of buildings to be demolished estimated ~ 50,000 m^3) will be made of concrete, which has the potential for dust release. The total area of land that will be cleared is estimated ~10,000 m^2 and the Project area is predominantly underlain by clay, which is prone to entrainment when dry.
Receptor Sensitivity	Medium High	Sensitivity of WRS site personnel/workers and flora in vegetated areas is Medium as they may be exposed to dust levels for 8 hours or more. Sensitivity of visitors to the WRS site/existing attractions is High as visitors will include receptors that are susceptible to an increase in PM_{10} (e.g. young children and elderly). Demolition and excavation sites will be located within the WRS sites and it is conservatively assumed that some visitors may be exposed to dust levels for more than 8 hours.
Significance	Moderate Major	Medium receptor sensitivity for WRS site personnel/workers and flora in vegetated areas combined with a Medium magnitude of impact gives rise to an impact of Moderate significance. An impact of Major significance results from the combination of High receptor sensitivity for visitors to the WRS site and Medium magnitude of impact.
Residual Impact Magnitude	Small	Mitigation measures will minimise the amount of dust that will be generated from construction activities, as well as the extent of the dust dispersion.
Residual Impact Significance	Minor to Moderate	Application of mitigation measures will reduce the magnitude of impact. Residual impact significance therefore Minor (for WRS personnel and flora in vegetated areas) to Moderate (for visitors to the WRS site).

8.1.2 Impact to Human Receptors due to Increased Vehicular Emissions

Diesel powered construction vehicles and equipment used on site and vehicles accessing the construction work area will give rise to the emission of CO, $PM_{2.5}$, PM_{10} and NO_2. In Singapore the maximum sulphur content of fuels used in road and off-road applications is

restricted to 10 ppm, therefore the emission of SO_2 is not expected to be significant from these sources.

8.1.2.1 Sources

Increased vehicular emissions during the Project construction phase are anticipated due to the following:

- Daily transportation of workers to and from the construction worksites via diesel lorries along Mandai Lake Road and Mandai Road;
- Transportation of raw materials, construction waste, excavated spoil etc. to and from the construction worksites via dump trucks; and
- Use of diesel operated construction equipment, such as piling rigs, geotechnical equipment and generator sets etc.

8.1.2.2 Receptors

Studies show that the concentrations of species from vehicular emissions are directly associated with distance from the roads, the concentrations reduce as the distance increases. The distance for which the concentrations of species reduce to background levels depends on a number of factors including background concentrations, pollutant characteristics, wind speeds and wind directions. For most gaseous and particulate species, concentrations reduce significantly within 200 m on the upwind side and between 300 m and 500 m on the downwind side of highways and major roads [(3)].
Based on review of the land use within 500 m of the construction work area and Mandai Lake Road and Mandai Road, receptors to vehicular emission mainly comprises of WRS personnel and visitors with sensitivity assessed to be **Medium** and **High**, respectively.

8.1.2.3 Impacts

Construction vehicles and equipment engine exhaust emissions include CO, $PM_{2.5}$, PM_{10} and NO_2. These substances have been identified as 'criteria pollutants' by the United States Environmental Protection Agency (USEPA) on account of their effect on human receptors in particular those who are more susceptible to air quality changes such as asthmatics, children and the elderly; and the prevalence of these substances in the urban ambient environment[(4)].

Such emission will arise at construction work areas and where diesel fuelled construction equipment and generator sets will be used. Emission will also be generated due to an increase in light duty vehicles (LDVs) [(5)] and heavy duty vehicles (HDVs) [(6)] moving along the existing road network (i.e. Mandai Road and Mandai Lake Road). Apart from movement of vehicle and equipment, traffic congestion due to any road diversions could also lead to increased vehicular emissions. According to the *Vehicle Emissions Fact Book* published by

[3] Health Effect Institute (2010) **Traffic-Related Air Pollution: A critical review of the literature on emissions, exposure and health effects.** Retrieved from http://pubs.healtheffects.org/getfile.php?u=553

[4] USEPA (2015) **Six Common Air Pollutants.** Retrieved from http://www3.epa.gov/airquality/urbanair/

[5] Light Duty Vehicles: Cars and small vans <3.5t gross vehicle weight

[6] Heavy Duty Vehicles: Goods vehicles or buses >3.5t gross vehicle weight)

the United States Federal Highway Administration (FHWA), "Emissions rates are higher during stop-and-go, congested traffic conditions than free flow conditions operating at the same average speed"[7].

At the time of writing, details pertaining to construction equipment and vehicles were not available to inform a detailed assessment. Considering the level of information available, a screening assessment was therefore carried out using the approach outlined in *IAQM Land-Use Planning & Development Control: Planning for Air Quality*[8]. The approach evaluates a change of traffic flows against the criteria presented in *Annex 2, Table A2.1.3*.

As opposed to a detailed assessment, the impact of the screening assessment is defined in a broad nature as *Insignificant* and *Potentially Significant*. Broadly speaking, the *Insignificant* criterion may be viewed as being similar to the Negligible and Low magnitudes. Impact magnitude beyond the definition of *Insignificant* should not automatically be construed as significant; it merely means that the impact may potentially be *Significant*. The screening assessment does not take into account receptor sensitivity as the outcome is to determine if further assessment is needed before a judgment can be conclusively made. Although vehicular emission comprises of various sources as aforementioned, the screening assessment was only conducted for the estimated change of LDV traffic flows as this was the only information available at the conceptual stage.

The calculation of change of LDV traffic flows requires two main components, namely the average daily number of workers and the average daily number of trips. The construction works will be carried out as multiple works packages, with an estimated 1,500 workers per works package. There may be multiple works packages underway concurrently and the estimated peak construction workforce is estimated to be 6,000 workers. The average daily number of workers during each construction year was derived considering the scale of the construction activities (i.e. types of construction activities and numbers of construction days). The daily number of trips assumes that workers will be transported to the construction site by vehicles with a capacity of 25 workers per vehicle.

Table 8.3 presents the estimated change of daily LDVs during the construction period between 2016 and 2022.

Table 8.3: Estimated Change of Daily LDVs between 2016 and 2022

Year	Average Daily Number of Workers	Average Daily Number of Trips	Variance from previous year
2016	1,500	120	-
2017	3,000	240	120
2018	4,879	390	150
2019	6,759	541	150
2020	6,937	555	14
2021	3,925	314	-241
2022	3,000	240	-74

7 FWHA (2015) **Transportation Air Quality Facts and Figures January 2008.** Retrieved from https://www.fhwa.dot.gov/environment/air_quality/publications/fact_book/page15.cfm

8 IAQM (2015) **Land-Use Planning & Development Control: Planning for Air Quality.**

Year	Average Daily Number of Workers	Average Daily Number of Trips	Variance from previous year
2023	1,500	120	-120

Source: MPH, 2015

The lorries that will be used for transportation of workers fall into the category of 'LDVs'. Based on *Table 8.3*, it is estimated that daily transportation of workers would result in 120 to 150 additional LDVs every year for the first five years. The number of LDVs will decline from 2021 onwards. As per the screening assessment criteria (*Annex 2.0*), the impact due to vehicular emissions from increased LDV traffic flow is therefore assessed to be **Insignificant**.

As the screening assessment was only carried out for LDVs and was based on preliminary information available at the time of writing, it is recommended that the screening assessment to be revisited in particular when the information associated with HDVs becomes available. In the case where the screening assessment for HDVs is found to be potentially significant, a detailed assessment should be carried out. In addition to the above, the best practice mitigation measures outlined in *Table 8.4* should be implemented.

Table 8.4: Best Practice Mitigation Measures for Vehicular Emission

Phase / Activity	Specific Actions
General Management & Planning	• Follow the approved Environmental Management and Monitoring Plan throughout the pre-construction and construction activities.
Transportation	• Minimise traffic delays caused by movement of construction vehicles, by planning transport route and period that avoid congested areas and peak hours. • Control queuing or parking of vehicles outside the construction work area, both before the construction work area opens and during work hours.
Use of diesel fuelled construction equipment	• Vehicles and equipment should not be left idling when not in use. • Avoid use of diesel or petrol powered generators by using mains electricity or battery powered equipment where possible and if safety concerns can be overcome.
Maintenance & Monitoring	• All equipment and machinery used at the construction or demolition worksites should be maintained and operated in a manner such that they will not give rise to smoke emissions, and will comply with the regulation. • Install exhaust after-treatment system for large vehicles with power output over 37 kW. • Implement regular checks of vehicles to ensure that emissions are within the prescribed limits.

A summary of the impact assessment is presented in *Table 8.5*.

Table 8.5: Impact Assessment Summary

Criterion	Rating	Comment
Increase in Vehicular Emission due to use of Diesel Powered Equipment and Vehicles		
Nature	Negative	Vehicular emission of CO, $PM_{2.5}$, PM_{10} and NO_2.
Type	Direct	Direct health impacts to sensitive receptors, in particular those that are susceptible to air quality changes such as the young, the elderly and those suffering from respiratory conditions.
Duration	Long-term	The total duration of construction works is estimated to be at least

Criterion	Rating	Comment
Increase in Vehicular Emission due to use of Diesel Powered Equipment and Vehicles		
		6 years.
Extent	Local	The concentrations of gaseous and particulate species from vehicular emission will reduce within 500 m from the roads and the construction work area.
Scale	-	Transportation of workers, raw material, construction waste etc will mainly be along Mandai Lake Road and Mandai Road. The use of diesel fuelled equipment will be within the construction work area.
Frequency	Frequent	Workers will be transported to and from the construction work area on a daily basis. The frequency for transportation of raw material and waste is undetermined at this stage. Different types of diesel fuelled equipment will be used throughout the construction stage.
Magnitude	Insignificant	The yearly variance for the annual average daily traffic of LDVs is less than the threshold limit of 500 throughout the construction period.
Receptor Sensitivity	High Medium	Sensitivity of visitors to the Zoo is High as the visitors will include receptors that are susceptible to vehicular emissions (e.g. young children, elderly). Sensitivity of Zoo personnel is assessed to be Medium as they will generally be healthy adults.
Significance	Insignificant	Insignificant impact given that the annual variance for the annual average daily traffic of LDVs throughout the construction period is expected to be lower than the threshold limit of 500. The screening assessment does not consider receptor sensitivity.

8.1.3 Impact to Human Receptors from Cumulative Air Impacts

The construction works scheduled to begin at the end of 2016 will coincide with some committed construction activities identified in *Chapter 6, Section 6.1.2*. Cumulative impacts to air could therefore arise during any periods where construction activities overlap with committed developments in the Project area. Cumulative air quality impacts may be generated from the following committed developments:

- Mandai depot;
- Springleaf MRT Station;
- Woodlands South MRT Station;
- Singapore Power Cable Tunnel Project; and
- Sewer works along Mandai Road.

8.1.3.1 Sources

The main sources of air emissions from construction sites are expected to be similar to the Project and these are:

- Generation of dust from ground disturbance activities such as excavation, land clearance, demolition etc; and

- Vehicular emissions due to the use of diesel powered construction equipment and vehicles.

8.1.3.2 Receptors

Receptors that will be affected by cumulative air impacts from the Project and the committed developments are WRS personnel and visitors. Based on discussion under *Section 8.1.1*, the sensitivities of visitors and WRS personnel are evaluated as **High** and **Medium**, respectively**.**

8.1.3.3 Impacts

As impacts of dust and vehicular emissions are typically restricted to within 350 m and 500 m from the construction sites, only the Mandai depot and proposed sewer works along Mandai Road may result in cumulative impacts with the Project due to their proximity to the Project area. Air emissions from these construction sites are however, unlikely to affect the sensitive receptors since they are located more than 500 m from the WRS site. It is believed that the baseline monitoring results have accounted for air emissions from the Mandai depot and sewer works as the construction works were observed to be ongoing during the baseline monitoring for the Project. The baseline monitoring results demonstrated higher measurements at survey point nearest to the committed developments (i.e. AQ 01, see *Figure 6.5*) and gradually decreased at survey points further away.

The Mandai depot is scheduled to be completed in 2019 and the sewer works in 2017 Q4 and thus the period where the construction of these developments are overlapping with the Project will be short. Furthermore, the overlap period will be during the finishing phase of these developments, when only light construction activities typically occur, such as renovation, testing and commissioning. Consequently, air emissions from these developments are not expected to be significant.
Considering the above, cumulative air impacts from the committed developments and the Project are assessed to be of **Negligible** magnitude. Combined with the sensitivities, the overall impact significance is considered **Negligible**. The impact assessment summary is outlined in *Table 8.6*.

Table 8.6: Impact Assessment Summary

Criterion	Rating	Comment
Cumulative Air Quality Impacts Due to the Overlap in Construction Period Between Committed Developments and the Project Construction Activities		
Nature	Negative	Generation of dust and vehicular emissions.
Type	Direct	Direct exposure to dust and substances emitted from construction vehicles and equipment.
Duration	Short term	Short term for not more than two years when the construction of committed developments and the Project coincide.
Extent	Local	Effects will be on human receptors within 350 m to 500 m from the construction sites.
Scale	-	Based on the monitoring results and the locations of the Mandai depot and sewer works, air emissions from these construction sites have slight impacts on the air quality of the Project site however are unlikely to affect receptors within the WRS site.
Frequency	Frequent	Daily when the construction of the Mandai depot and sewer works coincide.
Magnitude	Negligible	Mandai depot and sewer works are located more than 500 m from sensitive receptors (i.e. WRS site). Construction works for Mandai depot and sewer works will be towards the latter finishing works stage when impacts to air are typically less.

Criterion	Rating	Comment
Cumulative Air Quality Impacts Due to the Overlap in Construction Period Between Committed Developments and the Project Construction Activities		
Receptor Sensitivity	High Medium	Demolition and excavation sites will be located within the WRS sites and some visitors, who may include receptors that are susceptible to an increase in PM_{10} (e.g. young children, elderly), may be exposed to dust for more than 8 hours. Sensitivity of Zoo personnel is Medium as they may be exposed to dust levels for 8 hours or more.
Significance	Negligible	Negligible magnitude of impact due to distance from the Project area and timescale of potential cumulative development works.

8.2 SURFACE WATER

8.2.1 Impact to Surface Water from Construction Activities

8.2.1.1 Sources

Based on the scoping study, project description, and typical construction methods, impacts to surface water quantity and quality during the construction phase could arise from the following activities and conditions:

- Potential impacts on surface water quality and quantity arising from site runoff and site discharges:
  - Land clearance and grading for preparation of construction work areas;
  - Diversion of underground utilities (exclude existing drainage and sewer line);
  - Demolition of existing facilities;
  - Storage of fuel, chemicals, construction waste and stockpiling of spoil;
  - Excavation for development of underground structures;
  - Construction of aboveground and underground structures;
  - Modifications to surface and perimeter drains at the Project area; and
  - Installation of the new *Boardwalk*.
- Unplanned events:
  - Overflow of surface runoff from surface water drainage within the Project area caused by a major rainfall event that exceeds the design capacity of the drains. The surface runoff overflowing into the reservoir could carry animal wastes and pathogens that are detrimental to the Upper Seletar Reservoir, which is a drinking water reservoir;
  - Firefighting – firewater runoff; and
  - Leakage or spillage of fuels, chemicals, fertilisers, waste materials, etc. stored on the Project site during construction that could enter streams or the reservoir.

8.2.1.2 Receptors

The Scoping Study for the Project identified the Upper Seletar Reservoir and streams within the Sungei Mandai Water Catchment Area as the surface water sensitive receptors due to their proximity to the Project area. Upon further review of the site setting in conjunction with the Project concept plan and key construction areas, surface water receptors to potential water quality impacts associated with the construction works were identified as:

- Upper Seletar Reservoir, a drinking water supply and also part of the gazetted CCNR;
- A small stream located north of Mandai Lake Road, within the CCNR (see *Figure 6.7*); and
- The unnamed stream parallel to the western boundary of the Project area and Sungei Mandai to the north of the Project boundary.

For the purposes of this assessment, the sensitivity of the receptors to surface water impacts from the Project is **High** as the Upper Seletar Reservoir, Sungei Mandai, the small stream located north of the Mandai Lake Road and the unnamed stream are within water catchment areas and serve critical water supply functions. A High sensitivity is also attributed considering the ecological sensitivity of these receptors, which are within the CCNR. The unnamed stream is the largest on the development site and contains a diversity of important habitats, including riparian vegetation, fast flowing water and pools. This attracts a variety of species reliant on water environments for their lifecycle.

8.2.1.3 Impacts

The *Eco-Lodge*, *Planet Explorer* and *Sri Seletar Point*, the existing WTP, *Boardwalk* and upgrading works to the existing WRS stormwater drainage infrastructure are in close proximity to Upper Seletar Reservoir. With the exception of the stormwater drainage infrastructure (and *Boardwalk* which will be constructed on top of it), all other construction will be setback a minimum of 15 m from the Upper Seletar Reservoir. Construction activities will involve demolition, land clearance and grading and then ongoing construction activities for the new attractions over the course of the construction period (approximately 6 years). Given the volume of rain during the monsoon seasons in Singapore, flushing of demolition material, surface soil erosion, wastes and potentially hazardous material (e.g. oils and fuels from equipment and machinery such as piling rigs, geotechnical equipment etc. or waste from demolition of the existing WTP) could occur and flow into Upper Seletar Reservoir. This could result in sediment loading and discharge of construction waste and hazardous parameters (e.g. hydrocarbons) into Upper Seletar Reservoir.

An unnamed stream is located within approximately 25 m of the western boundary of the Project area. The northern section of this, as shown on *Figure 8.1,* is in close proximity to the *West Arrival Node* which will involve construction of a new car park, elevated deck, event space, F&B facilities etc. Similar to the activities in proximity to Upper Seletar Reservoir, sediment loading from clearance and erosion and discharge of construction waste and hazardous materials during construction period could impact the unnamed stream. Disposal of dewatered groundwater generated from the carpark excavations in this area may also be

an issue, in particular, as a relatively large volume would require management and offsite disposal may not be feasible.

Changes to surface water quality within the Study Area may also arise from chemical and waste storage and handling during the pre-construction and construction stages. The construction of underground carparks and other underground structures often requires the excavation to be dewatered. This activity could modify groundwater flow (discussed further in the subsequent section) and the base flow component of surface streams.

The Project includes construction of a new *Boardwalk* around the perimeter of the *Singapore Zoo*. This will however, be pre-cast and pre-fabricated off site and installed directly onsite. Considering its proximity to the Upper Seletar Reservoir, there may be impacts associated with sediment runoff from the *Boardwalk* installation to the Upper Seletar Reservoir; however, this is considered to be minimal given the concept design outlined in *Chapter 2*.

Unplanned events such as hazardous material leakage from machinery, e.g. fuel from piling rigs and geotechnical equipment; and overflow of the existing surface runoff infrastructure from the existing WRS operated areas caused by a major rainfall event could also impact surface water quality.

Figure 8.1: Study Area Showing the Water Surface Features in the Project Boundary

The high rainfall experienced in Singapore coupled with the scale of construction give rise to a potentially **Large** magnitude impact.

8.2.1.4 Mitigation

Mitigation included in *Table 8.7* includes both measures to be incorporated into detailed design and specific requirements for individual project components.

Table 8.7: Mitigation Measures for Surface Water Construction Phase

Phase / Activity	Specific Actions
General Management & Planning	• Phase activities such as land clearance, demolition works, earthworks, and building construction to minimise the area of ground exposed and the volume of soil and construction material handled at any one time. • Adequate sediment and turbidity control methods approved by a Qualified Erosion Control Professional (e.g. sedimentation ponds) will be applied to all earthmoving and excavation activities within 250 m of Upper Seletar Reservoir, the unnamed stream along the Project western boundary or other surface water features in the Project area, to prevent sediment from entering streams and other surface water bodies. • Follow the approved Environmental Management and Monitoring Plan throughout the pre-construction and construction activities. • Waste management measures should include provisions to contain and dispose of construction wastes by third party waste contractors; prohibit waste discharge to ground or any surface watercourse; and practise recycling as far as practicable. • Implement a regular maintenance program to all equipment and machinery to prevent fuel spillage or leakage during construction activities. • Protect surface water sources during construction by ensuring portable sanitary facilities provided for workers are located away from surface water courses and managed by a licensed third party waste contractor. • Properly store and manage hazardous materials used during construction activities. Strategically locate areas for temporary storage of hazardous materials away from surface water resources (at least 100 m away) and preferably down topographic gradient of watercourses. Chemicals and fuels must be properly labelled and stored in bunded areas on pallets. Storage of hazardous materials on-site should be limited to minimise the impact of any spillage or mitigation failure. • Consider the use of recharge wells during excavation of the carparks so as to limit potential groundwater drawdown and subsequent water level impacts to the unnamed stream. • Develop a spill management plan and ensure all construction workers are adequately trained in its implementation. Spill management measures to include: leaks from WTP pipework during decommissioning; from machinery and equipment; spills as a result of accidental damage to other underground structures uncovered during excavation works. • The existing drain will remain in place and operational at all times while upgrading works are being carried out. • Implement a continued Surface Water Monitoring Programme at key outfall points to surface watercourses in the Project area. Design of surface water monitoring programme should be developed once the detailed design and construction plan are in place to ensure coverage of key discharge points agreed with PUB. Parameters monitoring and frequency will be in accordance with the baseline surface water quality sampling completed for the EIA. • An Earth Control Measures (ECM) plan, designed and endorsed by Qualified Erosion Control Professionals, will be registered with PUB and implemented prior to the start of any construction work. This will include temporary bunding around the wastewater treatment plant development areas.

Phase / Activity	Specific Actions
Soil Investigation (SI) works	• Provide spill kits and secondary containment trays at each SI worksite. • Use hand fuel transfer pump and pipes equipped with flow control valves on for refuelling operations.
Demolition and Earthworks	• Locate temporary stockpiles of spoil as far as possible from drainage swales (at least 100 m away) and preferably down topographic gradient of watercourses. For example, avoid stockpiling next to streams such as the unnamed stream to the west of the *Bird Park*. • Cover temporary stockpiles with tarpaulin when not in use. • Protect and armour excavated material disposal areas to prevent erosion in the streams. • Re-vegetate exposed ground as soon as possible to stabilise surfaces. • Control water suppression during excavation and earth handling to minimise excess water and sediment disposal into surface water. • Runoff laden with silt will be channeled to the ECM treatment plants and subsequently discharged into a PUB-approved discharge point after treatment. • Discharge of pumped dewatered groundwater or other wastewater from excavations to Upper Seletar Reservoir and the unnamed stream will be strictly prohibited due to ecological sensitivities. Discharge will either be to temporary storage tanks for removal by third party licensed wastewater collector; or to a temporary treatment system prior to discharge to a discharge point agreed with PUB. • Provide spill kits in case of a leak or spill from equipment or machinery, including during decommissioning of the existing WTP and installation and commissioning of the new WTPs. • Prohibit illegal disposal of construction waste by using licensed third party waste contractors. • Disposal of construction wastes into streams, stormwater channels or Upper Seletar Reservoir will be strictly prohibited. • Minimise soil exposure time during construction activities.
Transportation	• Inspect and schedule preventive maintenance to all vehicles used to transport excavated and construction material. • Vehicles used to transport spoil to have tarpaulin securely covering load. • Vehicles should pass through a bunded wheel wash station upon exiting the construction work areas in order to control and manage wastewater and sediment. • Twice daily checks of Mandai Lake Road and sections of Mandai Road drains for high sediment deposition or spills from truck traffic. • Vehicle maintenance and mechanical repairs are to occur in dedicated, designed locations, bunded to capture and control oil, grease, and other spills to prevent flow into surface water resources.
Monitoring	• Continue monitoring surface water quality initiated during the concept design stage and compare results with baseline conditions, as defined in the EIA. Monitoring locations to be ascertained in conjunction with the detailed design and construction plan, to ensure that key discharge points to surface water courses (as agreed with PUB) are monitored only.
Management of Implementation	• Contractor EHS team to undertake daily inspection of construction area against management and monitoring measures defined in the Project EMMP. • Maintain a procedure to log and track complaints from stakeholders and the Contractor's responses.

8.2.1.5 *Residual Impacts*

Implementation of the mitigation outlined is intended to reduce the magnitude of the impact from **Large** to **Small** and the overall impact significance to **Moderate**.

A summary of the impact assessment before and after implementation of mitigation measures is presented in *Table 8.8*.

Table 8.8: Surface Water Construction Phase Impact Assessment Summary

Criterion	Rating	Comment
Surface Water Quality and Quantity due to Construction Activities		
Nature	Negative	Potential changes in surface water quality due to land clearing, excavation, dewatering, improper storage of materials, and other unplanned events
Type	Direct	Construction activities directly affect surface water resources, quantity and quality
Duration	Long term	Estimated 6 years of construction activity
Extent	Regional	Surface water resources migrate beyond the Project boundaries
Scale	-	Project boundary consists of 6% of Sungei Mandai catchment and 8% of the Upper Seletar Reservoir catchment. Construction areas in close proximity (<25 m) from Upper Seletar Reservoir and the unnamed stream. Scale potentially significant if not managed well.
Frequency	Frequent	Estimated 6 years of construction activity with clearing and dewatering throughout the Project boundaries. Given the high frequency of precipitation in Singapore, this impact is given a "frequent" rating. Additionally, groundwater dewatering as part of sub-surface construction may occur frequently, concurrently with or without precipitation.
Magnitude	Large	The high rainfall coupled with the scale of the construction activities give rise to an impact of potentially Large magnitude.
Receptor Sensitivity	High	The Upper Seletar Reservoir, Sungei Mandai, the small stream located north of the Mandai Lake Road and the unnamed stream are within water catchment areas and serves critical water supply functions and considering the ecological sensitivity of these receptors, which are within the CCNR.
Significance	Critical	A large magnitude of impact prior to application of mitigation measures combined with a High sensitivity.
Residual Impact Magnitude	Small	Numerous mitigation measures outlined in *Table 8.7* are considered to reduce the magnitude of impact to Small.
Residual Impact Significance	Moderate	Residual impact significance of Moderate since WRS perimeter cut-off drain will remain in place while upgrading work is undertaken.

8.3 SOIL & GROUNDWATER

8.3.1 Impact to Soil and Groundwater from Construction Activities

Based on the results of the Scoping Study as summarised in *Chapter 5*, the types of Project-related impacts on soil and groundwater resources that will be considered in this assessment include:

- Potential impacts on groundwater quality arising from site runoff and site discharges;
- Potential impacts on the existing groundwater elevation and flow, due to construction of underground structures; and
- Unplanned events such as accidental spills and overflow of stormwater drainage system and ancillary facilities due to major rainfall events and overflows from the WTP.

Changes to the soil and groundwater quality within the Study Area may arise from chemical and waste storage and handling during the pre-construction (geotechnical investigation etc.) and construction stages. The construction of underground carparks and other underground structures will likely require the excavation to be dewatered. This activity could modify groundwater flow and the base flow component of surface streams. This may cause secondary effects on groundwater-dependent vegetation and any surface waterbodies hydraulically connected to the intercepted groundwater.

8.3.1.1 Sources

Construction activities causing impacts to soil and groundwater resources are likely to include the following:

- Land clearance and grading for preparation of construction work areas;
- Diversion of underground utilities (exclude existing drainage and sewer lines);
- Demolition of existing facilities;
- Excavation for development of underground structures;
- Construction of aboveground and underground structures; and
- Leakage or spillage of fuels, chemicals, fertilisers, waste materials, etc. stored on the Project site during construction that could enter the groundwater aquifer.

8.3.1.2 Receptors

The Scoping Study for the Project identified the Upper Seletar Reservoir and streams within the Sungei Mandai Water Catchment Area as the surface and groundwater sensitive receptors due to their proximity to the Project area. Soil and groundwater receptors in the Study Area therefore consist of the following:

- Upper Seletar Reservoir, a drinking water supply; and
- Streams in the Sungei Mandai Water Catchment.

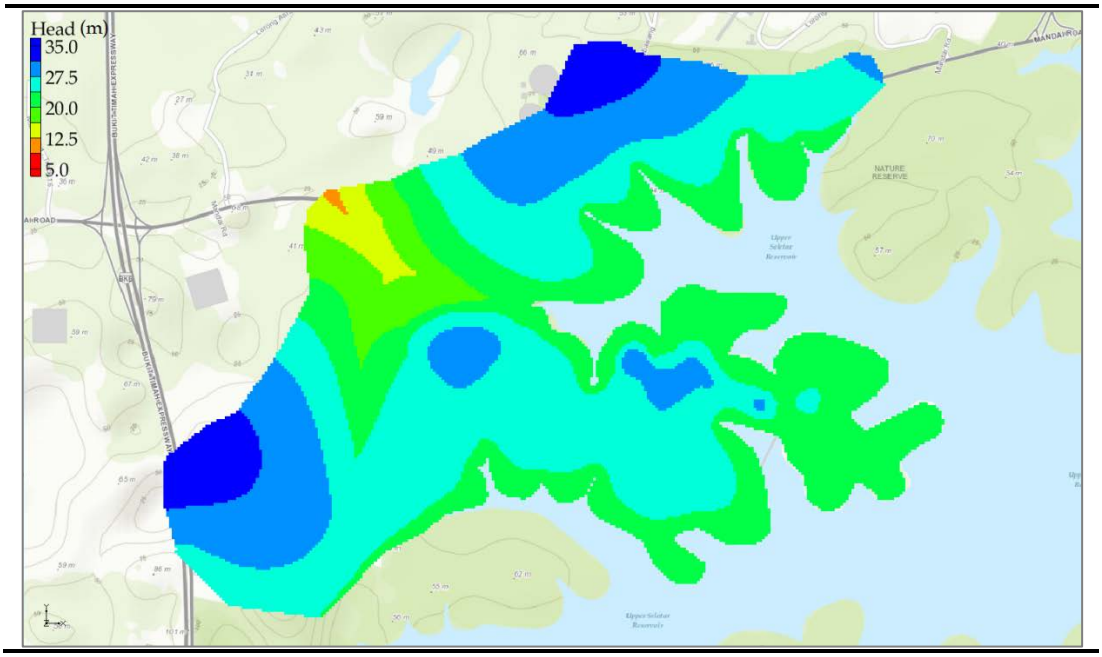
For the purposes of this assessment, the sensitivity of the receptors to soil and groundwater impacts from the Project are evaluated to be **Low** on the west side of the project where surface and groundwater naturally migrate to the northwest, and **High** on the east side of the Project, on the peninsula of land surrounded on three sides by the Upper Seletar Reservoir (direct and unimpeded connection to a drinking water supply).

8.3.1.3 Impacts

The primary potential groundwater impact in and around the Project area will be changes to the elevation of the groundwater table. Groundwater elevations in the area are generally correlated to topographic elevations. Water initially enters the surficial aquifer from rainfall infiltration and it flows downgradient, from higher elevations to lower elevations. Groundwater in the Study Area flows to one of two sinks: directly into the Upper Seletar Reservoir or as base flow to the streams in the Sungei Mandai Catchment.
In order to characterise the groundwater table in the Study Area, a GMS/MODFLOW conceptual groundwater model was created using available data. Elevations of the computed water table were verified with available borehole water level observations collected for the baseline. At the time of the surveys, the average depth to groundwater at MW1 through MW8 (see *Figure 6.*9) was approximately 4 meters. The aquifer was modelled as a single silt-sand layer with hydraulic conductivity ranging from 0.0095 to 0.5 m/day. Measured soil profiles were used as inputs to the GMS/MODFLOW model. Various vertically averaged hydraulic conductivities from soil profiles were used where data were appropriate and available, resulting in a spatially heterogeneous layer. Spatially varying hydraulic conductivities were applied throughout the model domain to calibrate the model to observed water table elevation data.

The boundary condition at the reservoir shoreline was set to a constant head elevation of 22.5 meters above sea level (masl). At the watershed divide, a no-flow boundary condition was set. A value of 11.0 masl was used at the end of the stormwater drain to the south of Mandai Lake Road to induce flow in the model towards the northwest. A percentage (25%) of total annual precipitation (2,339 mm) was applied at the ground surface as recharge. *Figure 8.2* shows a contour map of groundwater elevations under existing conditions.

Figure 8.2: Groundwater elevation contours under existing conditions (GMS/MODFLOW)



Carparks and other underground structures have been proposed in the conceptual design of the Project. From a groundwater perspective, several Project activities may impact groundwater. During the construction phase, these activities include:

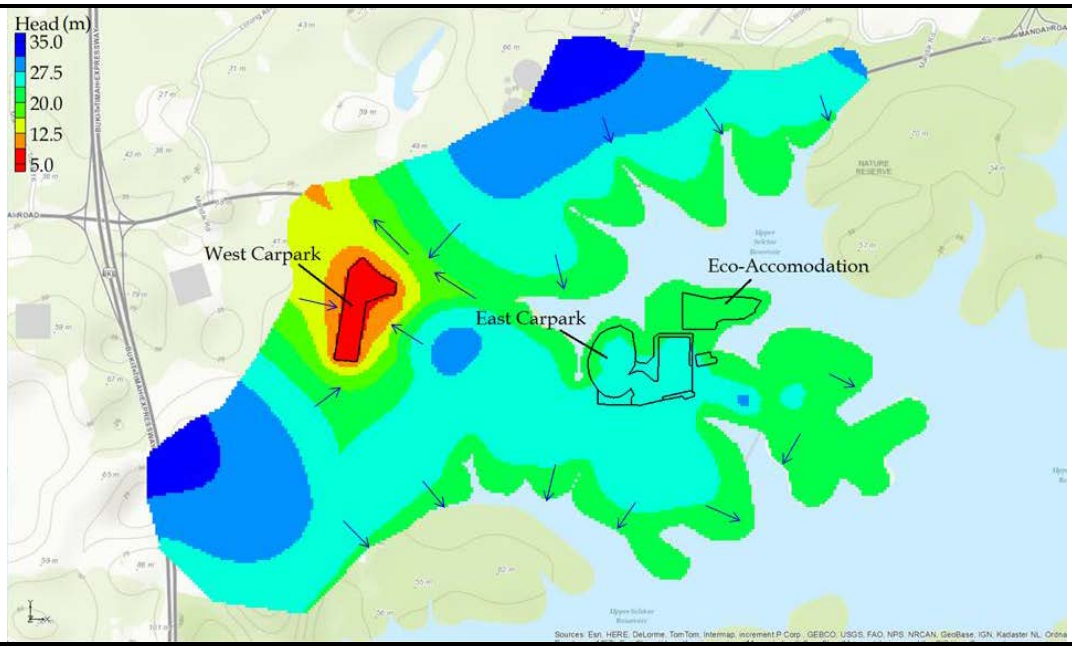
- Excavation and dewatering of underground carparks; and
- Excavation and dewatering of other underground structures.

Dewatering will be required to depress the groundwater elevation below the floor elevation of some structures to allow construction in dry conditions. These activities were input to the model as internal boundary conditions. The groundwater model was run with the addition of the proposed underground carparks and structures. A contour map of groundwater during the construction phase is shown in *Figure 8.3*. Existing groundwater elevations, construction groundwater elevations, the difference in elevations, and the pumping flow rates required to dewater the structure excavations are summarised in *Table 8.9.*

Results of the modelling show that Project construction activities will lower groundwater levels beneath and adjacent to the proposed underground structures. Model results indicate that during construction, groundwater will continue to flow towards the Upper Seletar Reservoir in the eastern portion of the Study Area. In the western portion of the Study Area, groundwater will flow into the Sungei Mandai Catchment area. Generally, a lowered groundwater table will result in less base flow entering surface drainage channels, such as the unnamed stream to the west of the Project Area, and therefore reduced flow in these channels but modelling indicates that the direction of groundwater flow will not be affected. There are not anticipated to be impacts to any natural streams within the CCNR as a result of groundwater drawdown. The quality of the dewatered groundwater is expected to be relatively benign (see baseline water quality data in *Chapter 6*), resulting in minor water quality impacts.

Considering the influencing factors and the magnitude criteria defined for water resources in *Annex 2*, the magnitude of soil and groundwater impacts caused by the Project's construction phase is evaluated to be **Medium** in the western portion of the Study Area and **Small** in the eastern portion of the Study Area. While the scale of the impact in the east is less than the west, the sensitivity in the east is greater than that in the west. Given the **High** sensitivity of the receptors in the east and the **Low** sensitivity in the west, the significance of the soil and groundwater impacts are assessed to be Moderate in the east and Minor in the west.

Figure 8.3: Groundwater Elevation Contours During Construction Dewatering.



Note: Location of basements outlined in black

Table 8.9: Ground Surface, Groundwater, and Basement Elevations at Proposed Carparks

Location	Approximate Ground Surface Elevation (mRL)	Approximate Groundwater Elevation (mRL)	Basement Bottom Elevation (mRL)	Reduction in Groundwater Elevation (m)	Pumping Rate to Maintain Head at Basement (m^3/day)
West Carpark	122	117.9	107.9	10.0	956
East Carpark	134	130.7	125.5	5.2	66

Notes:
m^3/day = meters cubed per day; mRL = mean reservoir level 100 m greater than mean sea level.

The connectivity between groundwater and surface waterbodies is implied in the groundwater maps provided, *Figure 8.2* and *Figure 8.3*. Flow is from areas with high water table elevation to low, with ultimate sinks at the Upper Seletar Reservoir and the streams to the northwest of the project area. Areas of impact are 1) downgradient of the actual construction activities that interrupt the flow of groundwater and 2) downstream of the groundwater dewatering disposal location. All significant physical water receptors have been identified in this assessment. Secondary effects on human health, flora, fauna and ecosystem services provided by the resource are identified and assessed in their respective sections of this EIA.

8.3.1.4 Mitigation

Measures to avoid, minimise, and limit the magnitude of soil and groundwater impacts caused by the Project's construction phase are outlined in *Table 8.10*. Mitigation includes construction management best practices, monitoring, and general housekeeping activities.

Table 8.10: Mitigation Measures for Soil and Groundwater Construction Phase

Phase / Activity	Specific Actions
General Management & Planning	• Phase activities such as land clearance, demolition works, earthworks, and building construction to minimise the area of ground exposed and the volume of soil and construction material handled at any one time. • Adequate temporary waste storage facilities will be located a minimum of 100m away from surface water features and on hardstanding. There should also be frequent waste collection and removal of waste from the site to prevent contamination of groundwater. • Implement a regular maintenance program to all equipment and machinery to prevent fuel spillage or leakage during construction activities. • Protect groundwater sources during construction by ensuring sanitary facilities for workers are available. Waste from such facilities (if temporary and not connected to PUB mains sewerage system / or the existing WTP) should be managed by a licensed third party waste contractor. • Properly store and manage hazardous materials used during construction activities. Locate areas for temporary storage of hazardous materials away from groundwater resources. Chemicals and fuels must be properly labelled and stored in bunded areas on pallets. Spill kits should be provided and all personnel managing hazardous materials should be adequately trained in hazardous material handling and disposal. Such spill kits should also be available where equipment and machinery is temporarily stored and used.
SI works	• Provide spill kits and secondary containment trays at each SI worksite. • Use hand fuel transfer pump and pipes equipped with flow control valves on for refuelling operations.

Phase / Activity	Specific Actions
Demolition and Earthworks	• Locate temporary stockpiles of spoil as far as possible from excavations. Note stockpiles should be downwind and as far as possible from the CCNR and surface water features to minimise creation of dust affecting the CCNR and potential runoff to surface watercourses. • Cover temporary stockpiles with tarpaulin when not in use. • Re-vegetate exposed ground as soon as possible to stabilise surfaces. • Control water suppression during excavation and earth handling to minimise excess water. • Provide spill kits in case of a leak or spill from equipment or machinery. • Prohibit illegal disposal of construction waste by using licensed third party waste contractors. • Discharge of pumped dewatered groundwater from excavations to Upper Seletar Reservoir and the unnamed stream (due to ecological sensitivities) will be strictly prohibited. Discharge should either be removed by third party licensed wastewater collector, or to a drainage discharge channel agreed by and in accordance with PUB discharge requirements, e.g. the large stormwater drain on the northern side of Mandai Lake Road. • Spill management measures to be implemented throughout construction works and include: leaks from WTP pipework during decommissioning; from machinery and equipment; spills as a result of accidental damage to other underground structures uncovered during excavation works.
Transportation	• Inspect and schedule preventive maintenance to all vehicles used to transport excavated and construction material. • Vehicles used to transport spoil to have tarpaulin securely covering load. • Vehicles should pass through a bunded wheel wash station upon exiting the construction work areas. Wastewater within wheel wash to be managed by a third party licensed waste contractor or tested and discharged to an agreed PUB discharge point in accordance with PUB effluent discharge requirements. • Twice daily checks of Mandai Lake Road and sections of Mandai Road drainage channels for high sediment deposition or spills from truck traffic. • Vehicle maintenance and mechanical repairs are to occur in dedicated, designed locations, bunded to capture and control oil, grease, and other spills to prevent infiltration into groundwater resources.
Monitoring	• Monitor groundwater quality and water levels up and down groundwater flow gradient of the excavation areas. Where feasible, groundwater should be monitored in similar areas to the EIA baseline (where in proximity to excavations) and results compared with the baseline conditions, as defined in the EMMP.
Management of Implementation	• Contractor EHS team to undertake daily inspection of construction area against management and monitoring measures defined in the Project EMMP. • Maintain a procedure to log and track complaints from stakeholders and the Contractor's responses.

8.3.1.6 *Residual Impacts*

Soil and groundwater impacts from construction activities can be managed by implementation of the mitigation measures listed in *Table 8.10*. Protection of groundwater resources is imperative due to the connectivity of groundwater at the eastern portion of the site to the Upper Seletar Reservoir. The magnitudes of residual impacts following implementation of mitigation measures are unchanged, and therefore remain as **Minor** for the western portion and **Moderate** for the eastern portion of the Study Area. A summary of the impact assessment criteria including the implementation of mitigation measures is presented in *Table 8.11*.

Table 8.11: Soil and Groundwater Construction Phase Impact Assessment Summary

Criterion	Rating	Comment
Groundwater Quality and Water Table Levels		
Nature	Negative	Decrease in groundwater table elevations, potential changes in groundwater quality due to excavation, dewatering, improper storage of materials, and other unplanned events
Type	Direct	Construction activities directly affect groundwater resources, quantity and quality
Duration	Long term	Estimated 6 years of construction activity
Extent	Regional	Groundwater resources migrate beyond the Project boundaries
Scale		5 to 10 ha of drawdown, approximately 5 m of drawdown at the West Carpark 1 to 5 ha of drawdown, approximately 1 m of drawdown at the East Carpark
Frequency	Frequent	Estimated 6 years of construction activity with clearing and dewatering throughout the Project boundaries
Magnitude	Medium	West side of the Study Area – due to area and depth of drawdown
	Small	East side of the Study Area – due to area and depth of drawdown
Receptor Sensitivity	Low High	West side – groundwater is not hydraulically connected to drinking water supply (Upper Seletar Reservoir). Pumping of surface water back to Upper Seletar Reservoir is considered High sensitivity in the surface water assessment. East side – direct and unimpeded hydraulic connection to drinking water supply (Upper Seletar Reservoir)
Significance	Minor Moderate	West side East side
Residual Impact Magnitude	Medium	West side – mitigations do not change the residual impact magnitude but the implementation of a groundwater quality monitoring programme and best practices related to protection of groundwater quality provides additional warning of impacts greater than expected and allows the opportunity to apply additional corrective actions.
	Small	East side – mitigations do not change the residual impact magnitude but the implementation of a groundwater quality monitoring programme and best practices related to protection of groundwater quality provides additional warning of impacts greater than expected and allows the opportunity to apply additional corrective actions.
Residual Impact Significance	Minor Moderate	West side – due to low sensitivity of resource East side – due to high sensitivity of resource

8.4 NOISE & VIBRATION

8.4.1 Impact to Human Receptors from Noise Emissions

8.4.1.1 Sources

Noise will be generated from the following sources during the construction activities:

- Operation and movement of heavy vehicles such as lorries, crane lorries for transportation of equipment and materials, and dump trucks for transportation of soil and waste material from the worksite;
- Operation of construction equipment and vehicles including those which will emit noise from engines, or from safety alarms such as those triggered by reverse movement of vehicles;
- Demolition of existing multi-storey carpark, wastewater treatment plant, staff quarters and other structures at the back-of-house area within the WRS site, involving concrete breaking, the dropping of debris from height through chutes etc; and
- Piling works, which may generate metal-on-metal noise, to be undertaken at the following locations:
    - Building foundations, posts for enclosures and security fencing and the acoustic barrier within *Rainforest Park North*;
    - Building foundation and posts for large and small aviaries within the *Bird Park*;
    - Building foundations and posts for large netted enclosures within the *Rainforest Park South*;
    - Bridge columns for the *Eco-Link*;
    - Building foundations for the *Eco-Lodge* and *Planet Explorer/Sri Seletar Point*;
    - Retaining walls for the underground carparks at the *West* and *East Arrival Nodes*; and
    - Columns (small) for the *Boardwalk*.

8.4.1.2 Receptors

In general, noise is attenuated over distance from the source due to the dissipation of sound energy through the atmosphere. Using established formulae for sound propagation over distance and considering typical noise levels generated from construction equipment [9], it is estimated that noise from the Project construction worksites will attenuate to below 50 dB(A), the most stringent construction noise criterion, within 2,000 m of the Project boundary[10], assuming no screening from topography and ground cover. From a review of the land uses within and around the Project area, noise sensitive receptors (NSRs) within 2,000 m of the Project boundary include:

- Visitors and staff within the WRS site;

[9] SPRING Singapore (2014) **Code of Practice for Noise Control on Construction and Demolition Sites.** Singapore Standard SS 602:2014.

[10] It is important to note that the assessment methodology adopted is conservative in that it considers natural noise attenuation only and has not incorporated any screening due to topography or vegetation.

- Personnel temporarily residing within the special use areas, approximately 1 km and 390 m respectively from the Project area;

- Residential areas located between 1.8 km to 2 km from the Project area, such as Segar Grove and Century Grove housing estates and public housing estates along Woodlands Street 41;

- Schools such as the Singapore American School and Singapore Sports School, located approximately 1.9 km from the Project area; and

- Fauna within the Project Area (refer to *Section 8.5.13* for further details)

8.4.1.3 Impacts

Noise can lead to annoyance due to interference with communication or disturbance to receptors involved in leisure activities, as well as sleep disturbance [(11)]. The effects of noise may vary with the individual receptor and is dependent on many factors such as the activity that the receptor is engaged in, as well as the duration of noise exposure. For the purpose of this study, noise impacts were assessed considering local regulatory limits and international guidelines summarised in *Table 8.12*, as well as the duration of noise exposure of receptors. The assessment criteria are presented in *Section A2.2.1 of Annex 2*. It is noted that noise and vibration impacts can also occur on fauna within the Project Area. These impacts can cause disturbance and displacement of resident fauna (refer to *Section 8.5.13* for assessment of noise and vibration on fauna)

Table 8.12: Applicable Noise Limits for Identified Receptors

Types of Receptor	Applicable Noise Limits			
	Worksite Operational Period			Parameter
	Day (7 am – 7 pm)	Evening (7 pm – 10 pm)	Night (10 pm – 7 am)	
Visitors and staff within the WRS site	85 [(1)]			dB(A)
Schools i.e. Singapore American School, Singapore Sports School	**60** [(2)]	**50**		$L_{eq-12hr}$, dB(A)
	75	**55**		$L_{eq-5\ min}$, dB(A)
Office building within WRS site and residential areas located more than 150 m of the Project Boundary, i.e. residential areas within the special use areas, Segar Grove, Century Grove, HDBs along Woodlands St 41	**75**	**65**		$L_{eq-12hr}$, dB(A)
	90	**70**	**70**	$L_{eq-5\ min}$, dB(A)

Notes:

(1) With reference to HSE UK guidance note on noise levels at which speech intelligibility will be affected.

(2) Values in **bold** indicate regulatory limits in accordance with the Second Schedule of the *Environmental Protection and Management (Control of Noise at Construction Sites) Regulation, 2008*.

Source: Health and Safety Executive UK, nd [(12)]

[11] World Health Organization (1999) **Guidelines for Community Noise.** Retrieved from http://www.who.int/docstore/peh/noise/guidelines2.html

[12] Health and Safety Executive UK (nd) **Appendix 1: Determining Risk.** Retrieved from http://www.hse.gov.uk/foi/internalops/og/og-00050-appendix-1.pdf

Information on the type, placement, number and operational sequence of construction equipment and vehicles is not available at this stage of the Project. For the purpose of this assessment, noise levels generated at the identified receptors were therefore predicted in accordance with the approach recommended in British Standard *BS 5228-1:2014, Annex C* for estimating noise from individual construction equipment and plant teams; whereas reference was made to the British Standard *BS 5228-1:2014, Annex F* for estimating noise generated from vehicles along a haul road [13]. It is noted that attenuation due to topography and ground cover will not be taken into account in the calculation. Noise predictions are therefore conservative.

Predicted Noise at the Project Boundary

For receptors located within a short distance of the construction worksites, noise levels experienced by the receptors will be dominated by the nearest noise source. Noise levels at close proximity to the Project boundary were therefore calculated assuming one of the noisiest single items of equipment (i.e. jack hammer) operating continuously very close to the worksite boundary. Noise specifications for each construction equipment/vehicle were taken from the British Standard *BS 5228:2014* [12]. Where a range of sound power levels was presented, the higher value was taken to remain consistent with a conservative approach. The identified construction equipment/vehicles and the assumed noise specifications are presented in *Table 8.13*.

Table 8.13: Typical Construction Equipment/Vehicle & Associated Noise Specifications

No.	Equipment / Vehicle	A-weighted Sound Pressure Level at 10 m, $L_{p,10m}$ [dB(A)]
1	Excavator	86
2	Dump truck	92
3	Generator	74
4	Road Ripper	83
5	Materials hoist	68
6	Air compressor	79 [1]
7	Jack hammer	95
8	Concrete saw	87
9	Grinder	80
10	Crane	82
11	Bar Bender & Cutter [2]	80
12	Lorry	83
13	Compactor and Roller	80
14	Vibratory Poker	78
15	Water Pump	81
16	Paver	84
17	Water Cart	83
18	Bulldozer	86

Notes:
(1) Calculated from guidance value for air compressor in Singapore Standard *SS 602:2014 Annex E, Table 5*.
(2) Assumed similar to that of a grinder.

Sources: British Standard Institute, 2014 [12]; *SPRING Singapore, 2014* [8]

Noise levels due to operation of construction equipment within the Project boundary are predicted to exceed the guideline value of 85 dB(A) for WRS visitors and staff within 32 m of

[13] British Standard Institute (2014) **Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1: Noise.** BS 5228-1:2014.

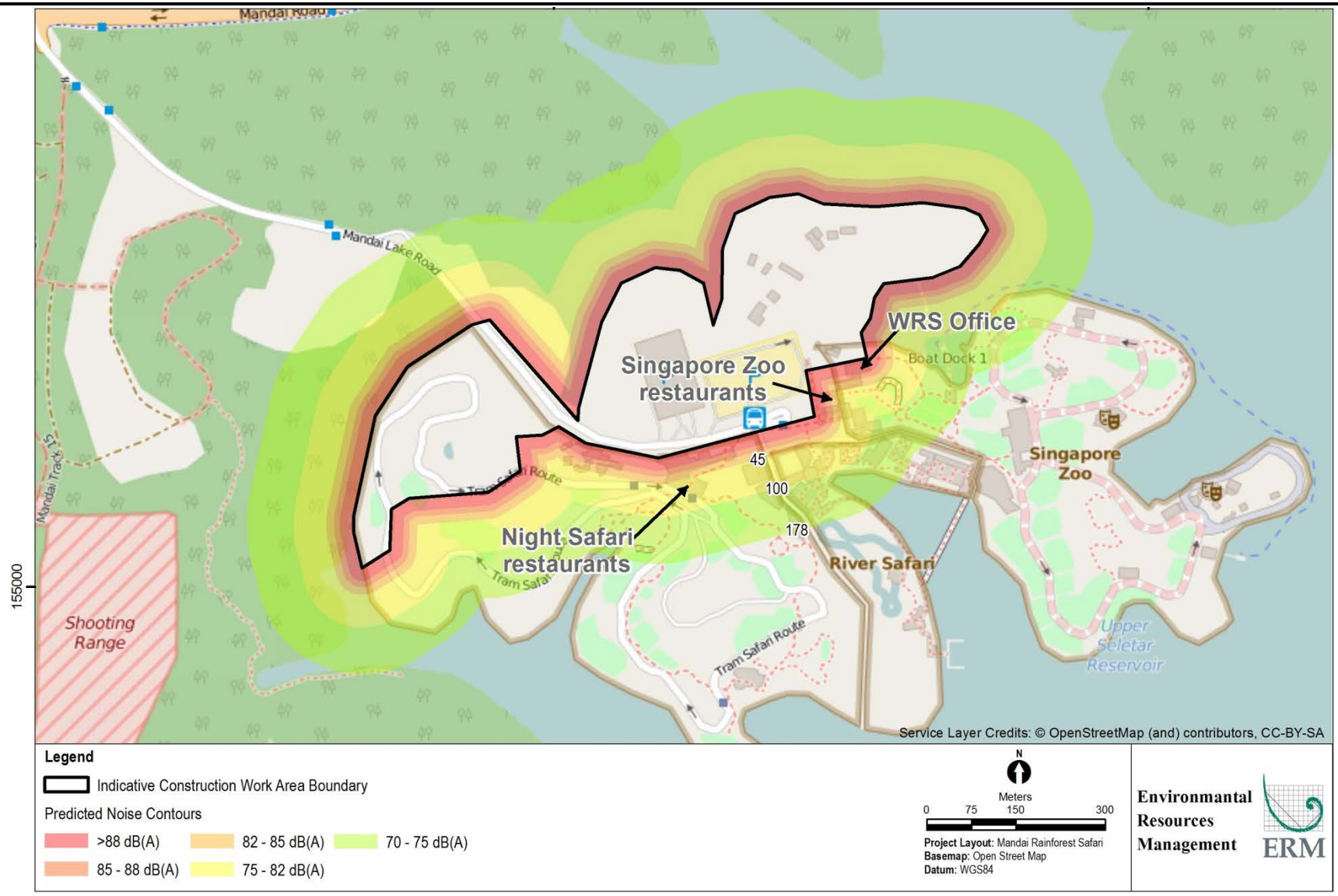
the Project boundary. Noise levels exceeding the guideline value of 85 dB(A) by more than 3 dB(A), i.e. > 88 dB(A) are estimated for WRS visitors and staff within 22 m of the Project boundary. The predicted noise contours are presented in *Figure 8.4,* and indicate that visitors and staff within the following WRS areas may be exposed to high noise levels during construction works:

- Corporate office building near the *Singapore Zoo* entrance;
- Restaurants at the *Singapore Zoo* entrance; and
- Restaurants at the *Night Safari* Entrance Courtyard.

Baseline noise measurements were undertaken at the *Singapore Zoo* entrance and were found to be more than 10 dB(A) below the predicted noise levels, i.e. short-term baseline noise levels at NL13 (see *Figure 6.6*) were measured between $L_{Aeq,15min}$ 66 to 70 dB(A) in the daytime. Baseline noise levels at the *Singapore Zoo* entrance were primarily due to human traffic and activity at the dining atrium. Baseline noise levels at the *Night Safari* Entrance Courtyard are expected to be similar as similar activities were observed during the daytime operating hours between 5.30 pm and 6 pm. Noise generated from construction equipment and vehicles, which may be characterised by low frequency humming, metal-on-metal noise or high frequency beeping, would therefore be heard distinctly by human receptors at these areas.

It is noted however that the noise prediction assumes that construction vehicles or equipment will be continuously operating at the Project boundary. In reality, these are likely to be highly mobile within the construction work area; noise levels will be lower when construction activities are undertaken at a greater distance from receptors near the Project boundary. In addition, construction vehicles and equipment will also be operational for shorter periods of time. For example, the bulldozer which generates high noise levels will likely be operational only during site clearance, which occurs in the initial phase of construction. Only WRS staff stationed in the buildings listed above may therefore be significantly impacted by construction noise whilst working close to the Project boundary.

Figure 8.4: Noise Contours from the Operation of Construction Equipment / Vehicles



As the detailed construction programme has not been finalised at this stage, this has been classed as a "long-term" duration of exposure, as a conservative assumption. Staff located elsewhere within the Zoo are not predicted to be significantly impacted. Visitors to the WRS site will not be expected to stay within the affected WRS sites for more than a few hours at a time. Visitors will therefore be exposed for a short-term period, i.e. not more than one day. The magnitude of impact for WRS staff and visitors in close proximity to the construction boundary is summarised in *Table 8.14*.

Table 8.14: Impact Magnitude & Significance due to Noise near to Project Boundary

Receptor	Predicted Noise Levels, dB(A)	Duration of Exposure	Impact Magnitude	Impact Significance
WRS staff ≤ 22 m of the Project boundary	≥ 88	Long term	**Large**	**Major**
WRS staff > 22 m but ≤ 32 m of the Project boundary	85 ≤ x < 88		**Medium**	**Moderate**
WRS staff > 32 m of the Project boundary	< 85		**Negligible to Small**	**Negligible to Minor**
WRS visitors ≤ 22 m of the Project boundary	≥ 88	Short term	**Large**	**Moderate**
WRS visitors > 22 m but ≤ 32 m of the Project boundary	85 ≤ x < 88		**Medium**	**Minor**
WRS visitors > 32 m of the Project boundary	< 85		**Negligible**	**Negligible**

Predicted Noise along Access Roads

For noise generated by vehicles moving along Mandai Lake Road and Mandai Road, the following assumptions were made to predict levels at receptors in close proximity to the haul roads, i.e. WRS staff and visitors and the adjacent special use areas:

- Number of vehicle movements = 240 return trips for transportation of workers, assuming 6,000 workers on site during peak construction, and a capacity of 25 workers per vehicle;
- Number of dump truck movements = 10 per hour; and
- Speed of lorry / dump truck will be as per the speed limit for heavy vehicles = 60 km/hr.

Noise generated from the movement of construction vehicles along haul roads were predicted to be between 66 and 69 dB(A) for WRS staff and visitors within 10 m of Mandai Lake Road; and between 58 and 61 dB(A) for residents at the special use areas located within 60 m of Mandai Road. Predicted levels are more than 3 dB(A) below the applicable limits for WRS staff and visitors, and residents at the special use areas.

The locations within the WRS site in close proximity to Mandai Lake Road comprise the bus/coach stop, and drop off points for taxis, as well as walkways between the *Singapore Zoo*, *River Safari* and *Night Safari* attractions. WRS staff and visitors are unlikely to be stationed at these locations for more than an hour at a time. The duration of their exposure to noise generated by passing construction vehicles is therefore likely to be short term. Predicted

noise levels from the haul road will be more than 10 dB(A) below the applicable limits at most receptors and will therefore not contribute to an exceedance during construction.

Predicted Noise from Demolition and Piling Works

For noise impacts at receptors located further from the Project area boundary, as well as receptors identified in close proximity to the Project boundary, a team of construction vehicles/equipment were assumed for the following construction activities:

- Demolition of the multi-storey carpark and structures at the back-of-house area of the WRS site; and
- Piling works at the various worksites.

These activities were identified as worst case scenarios as these phases of construction are expected to generate the highest levels of noise. The construction programme indicates that piling works may occur concurrently at the *Bird Park*, *Rainforest Park North* and *East Arrival Node*; piling rigs at these worksites were therefore modelled as part of the worst case scenario. It was assumed that one piling rig would be operating at any one time at each worksite. In addition, it was assumed that a larger hydraulic hammer piling rig (4 tonnes) would be required for installation of piles for structures such as retaining walls, building foundations and bridge columns. . Placement of the rigs was selected to enable modelling of the rig at closest proximity to surrounding receptors in order to predict the highest noise levels expected when piling works are at their closest (i.e. a worst case scenario).

The list of construction equipment associated with the above activities, and their associated noise specifications, are presented in *Table 8.15.*

Table 8.15: Construction Teams & Associated Noise Specifications for Demolition and Piling Works

No.	Construction Equipment / Vehicle	Quantity	% On Time	A-weighted Sound Pressure Level at 10 m, $L_{p,10m}$ [dB(A)] [(1)]	Total Sound Power Level, L_w [dB(A)]
Demolition					
1	Tracked excavator fitted with breaker	1	75	90	121
2	Tracked excavator	2	100	86	
3	Pneumatic breaker	1	75	83	
4	Gas cutter	1	20	79	
5	Hand-held hammer	1	20	81	
Piling					
6	Hydraulic hammer piling rig (1 tonne)	1 per worksite	75	77	105
7	Hydraulic hammer piling rig (4 tonne)	1 per worksite		88	115
8	Power pack	1 per rig	100	69	97

Notes:

(1) Reference made to the index of site equipment for the relevant construction activities summarised in *Annex C* of British Standard BS5228-1:2014.

Sources: British Standard Institute, 2014 [(12)]

Predicted noise levels at the identified NSRs are presented in *Table 8.16*. Indicative areas that may be impacted are shown in *Figure 8.5*, *Figure 8.6* and *Figure 8.7.*

Table 8.16: Predicted Noise Levels at NSRs for Demolition and Piling Works

No.	Receptor	Predicted Noise Levels [(1)]	Applicable Noise Limits
1	*Demolition works*		
1.1.1	WRS staff and visitors ≤ 17 m from Project boundary	≥ 88	$L_{Aeq,12\ hr}$ - 85
1.1.2	WRS staff and visitors > 17 m but ≤ 24 m from Project boundary	85 ≤ x < 88	
1.1.3	WRS staff and visitors > 24 m but ≤ 35 m from Project boundary	82 ≤ x < 85	
1.1.4	WRS staff and visitors > 35 m from Project boundary	< 82	
1.2	Residents at the special use areas, 1.2 km from demolition works	51	Daytime $L_{Aeq,12\ hr}$ – 85
1.3	Residents at the special use areas, 1.8 km from demolition works	48	Daytime $L_{Aeq,12\ hr}$ – 85
1.4	Residential estates, 1.8 – 2 km away	≤ 48	Daytime $L_{Aeq,12\ hr}$ – 75
1.5	Schools, 1.9 – 2 km away	≤ 47	Daytime $L_{Aeq,12\ hr}$ – 60
2	*Piling*		
2.1.1	WRS staff and visitors ≤ 21 m from Project boundary	70 ≤ x < 85	$L_{Aeq,12\ hr}$ - 85
2.1.2	WRS staff and visitors > 21 m from Project boundary	< 80	
2.2	Residents at the special use areas, 390 m from piling works	50 ≤ x < 55	Daytime $L_{Aeq,12\ hr}$ – 75
2.3	Residents at the special use areas, 1 km from piling works	< 45	Daytime $L_{Aeq,12\ hr}$ – 75
2.4	Residential estates, 1.8 – 2 km away	< 45	Daytime $L_{Aeq,12\ hr}$ – 75
2.5	Schools, 1.9 km away	< 45	Daytime $L_{Aeq,12\ hr}$ – 60

Note:
(1) Values in bold indicate an exceedance of the limits/guideline values.

Figure 8.5: Noise Contours for Demolition Works at Receptors in Close Proximity to Worksites

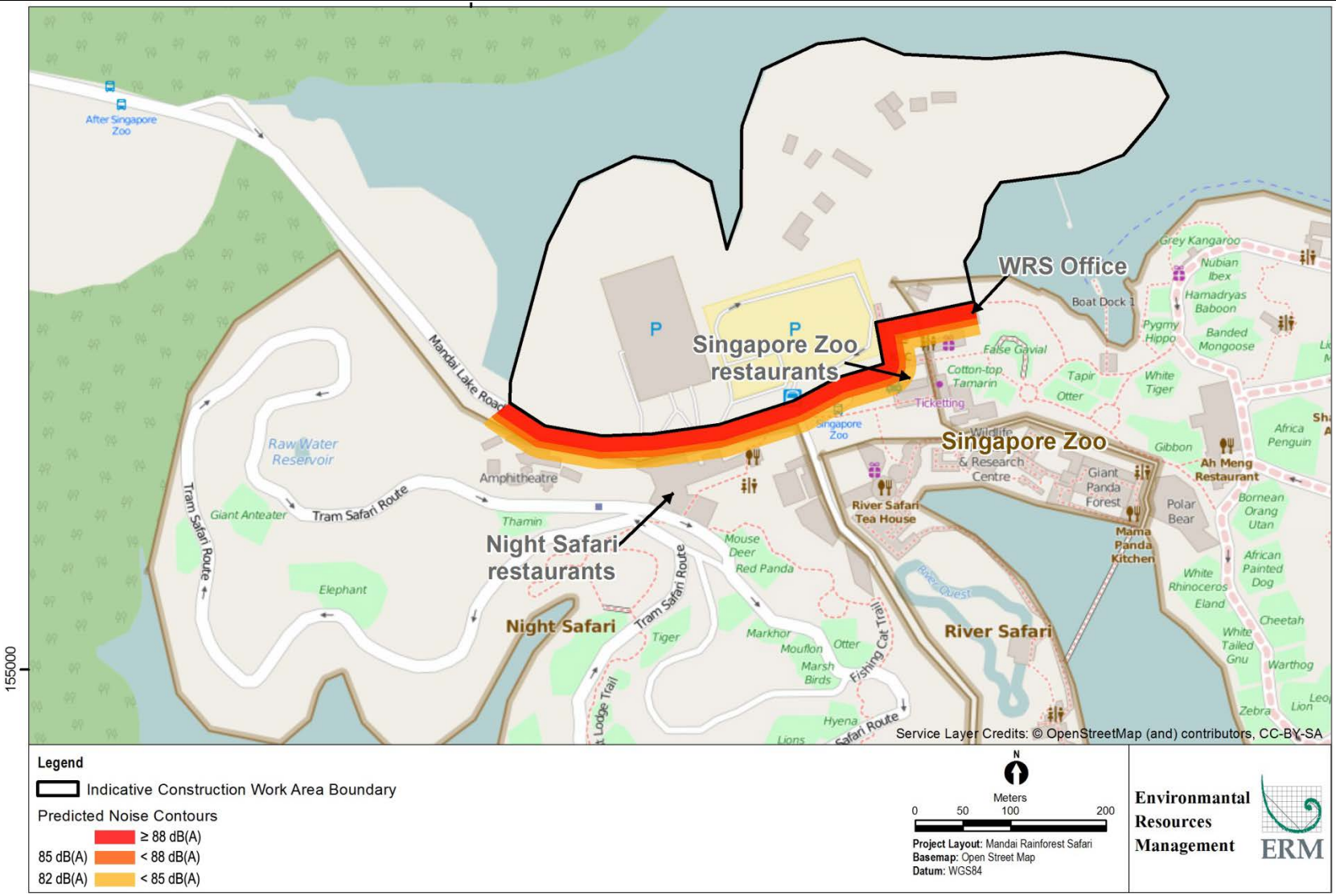


Figure 8.6: Noise Contours for Demolition Works at Receptors within 2 km of Worksites

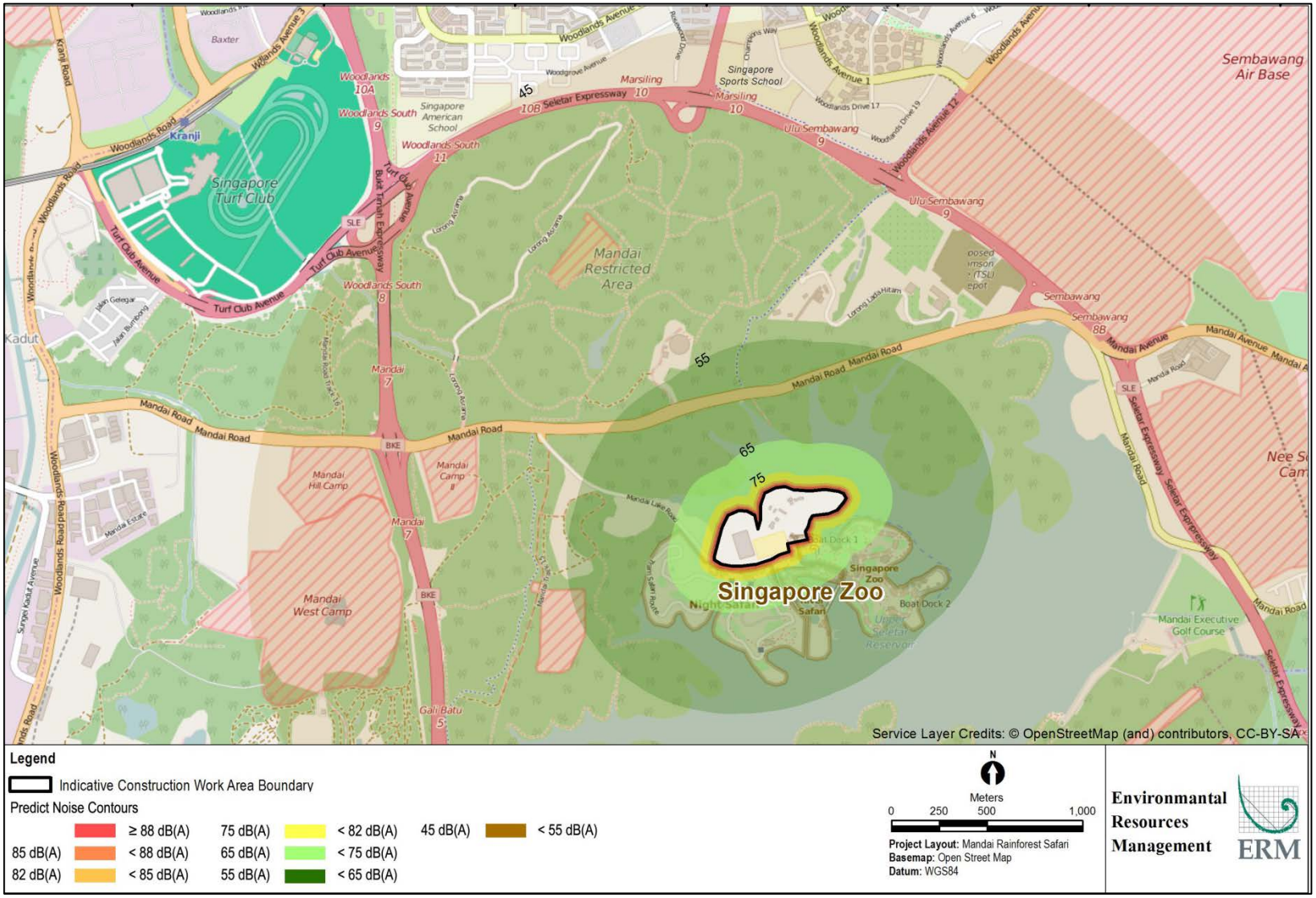
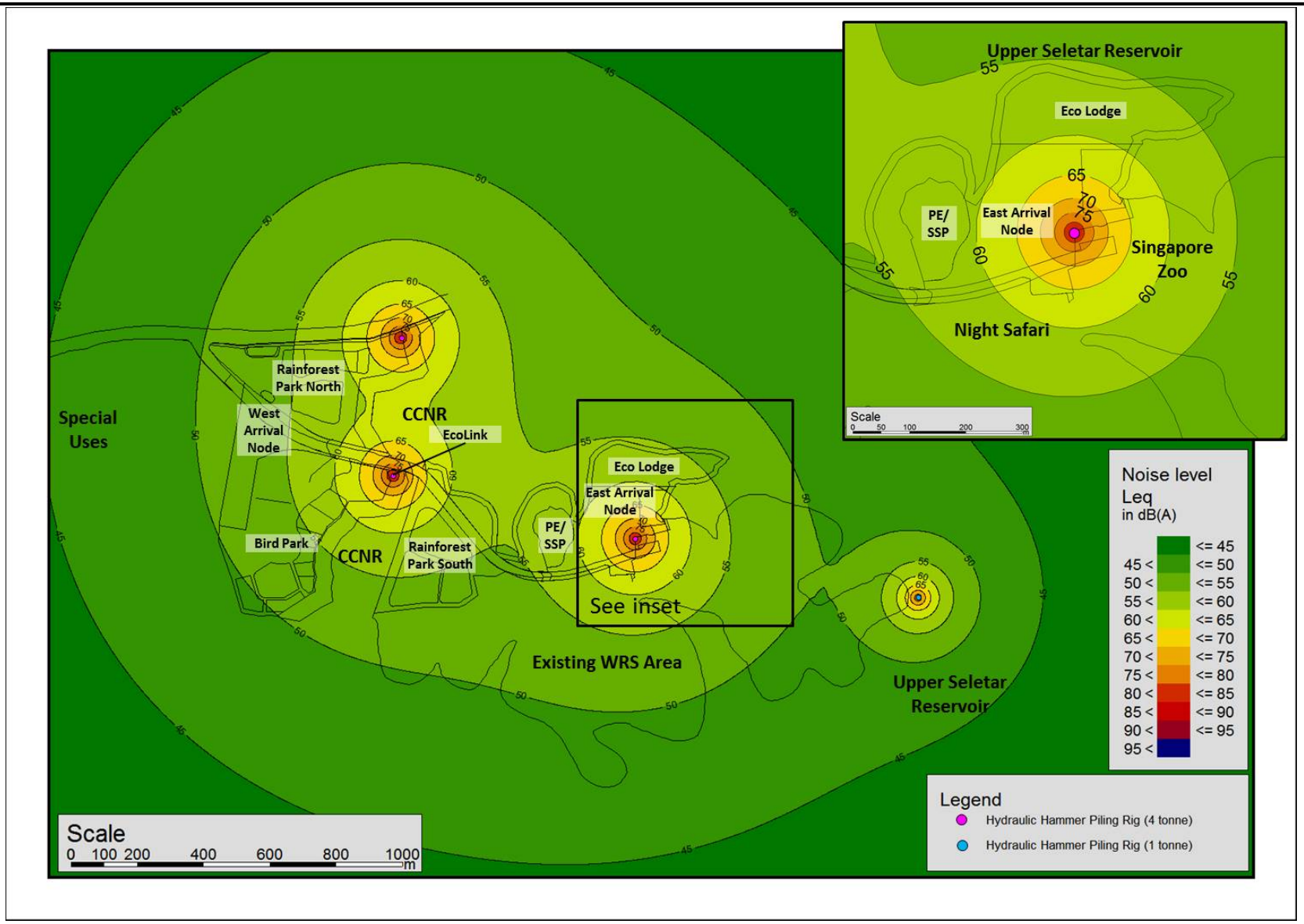


Figure 8.7: Worst Case Noise Contours for Concurrent Piling Works at Bird Park, Rainforest Park North, East Arrival Node and Boardwalk



As shown in *Figure 8.5*, noise levels exceeding the guideline value of 85 dB(A) are predicted to occur only at areas within 24 m of the Project boundary for demolition works. NSRs that would be exposed to high noise levels during demolition works would therefore comprise WRS staff at the corporate office building, or WRS staff and visitors at the restaurants and entrance nodes of the *Singapore Zoo* and *Night Safari*. Baseline noise levels at these areas are expected to be more than 10 dB(A) below the predicted noise levels generated from demolition works i.e. $L_{Aeq,5min}$ 66 – 70 dB(A) during the day based on short-term measurements at the *Singapore Zoo* entrance. Impulsive sounds associated with the operation of equipment such as the concrete breaker, hammer etc. will therefore be heard distinctly by human receptors at these areas.

As shown in *Figure 8.7*, noise levels from piling works are predicted to be between 70 and 85 dB(A) within close proximity of the Project boundary, i.e. the corporate office near the *Singapore Zoo* entrance, restaurants near the *Singapore Zoo* and *Night Safari* entrance nodes, and walkways between the WRS attractions (*Singapore Zoo, River Safari* and *Night Safari*). Similar to demolition works, metal-on-metal sounds associated with the hammering of piles for the proposed underground carparks will be heard distinctly by NSRs at these areas. However, beyond 21 m from the Project boundary, noise levels are predicted to fall below 80 dB(A), which is a **Negligible** impact magnitude.

The construction programme indicates that the various packages will take between 6 and 33 months each to construct. However, demolition and piling works will likely be completed within a shorter timeframe, i.e. < 6 months. In addition, visitors to the WRS site are not likely to be located within close proximity of the Project boundary for more than a few hours at a time. Both staff and visitors at the WRS site are therefore likely to be exposed to noise generated from demolition and piling works for a short term duration.

As shown in *Table 8.16*, noise levels are predicted to be well within the applicable limits for most receptors located at greater distances from the Project boundary. Impacts due to noise generated from piling works is therefore assessed to be of **Negligible** impact magnitude at these receptors.

The magnitude of impact for receptors within the WRS site, as well as receptors located up to 2 km from the Project boundary, are summarised in *Table 8.17.*

Table 8.17: Impact Magnitude & Significance due to Noise from Demolition & Piling

Receptor	Predicted Noise Levels, dB(A)	Duration of Exposure	Impact Magnitude	Impact Significance
Demolition works				
WRS staff and visitors ≤ 17 m from Project boundary	≥ 88	Short term	**Large**	**Moderate**
WRS staff and visitors > 17 m but ≤ 24 m from Project boundary	85 ≤ x < 88		**Medium**	**Minor**
WRS staff and visitors > 24 m from Project boundary	< 85		**Negligible to Small**	**Negligible**

Receptor	Predicted Noise Levels, dB(A)	Duration of Exposure	Impact Magnitude	Impact Significance
Personnel at the special use areas, 1.2 km from demolition works	51	Short term	**Negligible**	**Negligible**
Personnel at the special use areas, 1.8 km from demolition works	48	Short term	**Negligible**	**Negligible**
Residential estates, 1.8 – 2 km from Project boundary	< 48	Short term	**Negligible**	**Negligible**
Schools, 1.9 – 2 km from Project boundary	< 47	Short term	**Negligible**	**Negligible**
Piling				
WRS staff and visitors ≤ 21 m from Project boundary	70 – 85	Short term	**Negligible to Small**	**Negligible**
WRS staff and visitors > 21 m from Project boundary	< 80		**Negligible**	**Negligible**
Personnel at the special use areas, 390 m from piling works	< 45	Short term	**Negligible**	**Negligible**
Personnel at the special use areas, 1 km from piling works	< 45	Short term	**Negligible**	**Negligible**
Residential estates, 1.8 – 2 km from Project boundary	< 45	Short term	**Negligible**	**Negligible**
Schools, 1.9 km from Project boundary	< 45	Short term	**Negligible**	**Negligible**

8.4.1.4 Mitigation

Measures to avoid, minimise, and limit the magnitude of noise impact to human receptors caused by the Project's construction phase are outlined in *Table 8.18*. Mitigation includes construction management best practices, monitoring, and general housekeeping activities. It is noted that all mitigation measures should be reviewed and further details included following completion of the detailed design and construction plan.

Table 8.18: Mitigation Measures for Noise

Phase / Activity	Specific Actions
General Management & Planning	• Locate construction worksite entrances as far as possible from areas with high human traffic such as the entrance nodes and connecting walkways between entrance nodes for the *Singapore Zoo, River Safari* and *Night Safari* attractions within the WRS site. • Contractor to liaise closely with WRS throughout the construction period to schedule the noisiest construction activities (in particular piling and demolition) so as to minimise disturbance to visitors and staff during peak visitation periods (such as weekends and public holidays) or during events requiring low noise levels. • Restrict public access to locations in close proximity i.e. 10 m to the Project boundary where possible by providing alternative pathways, and relocating amenities.

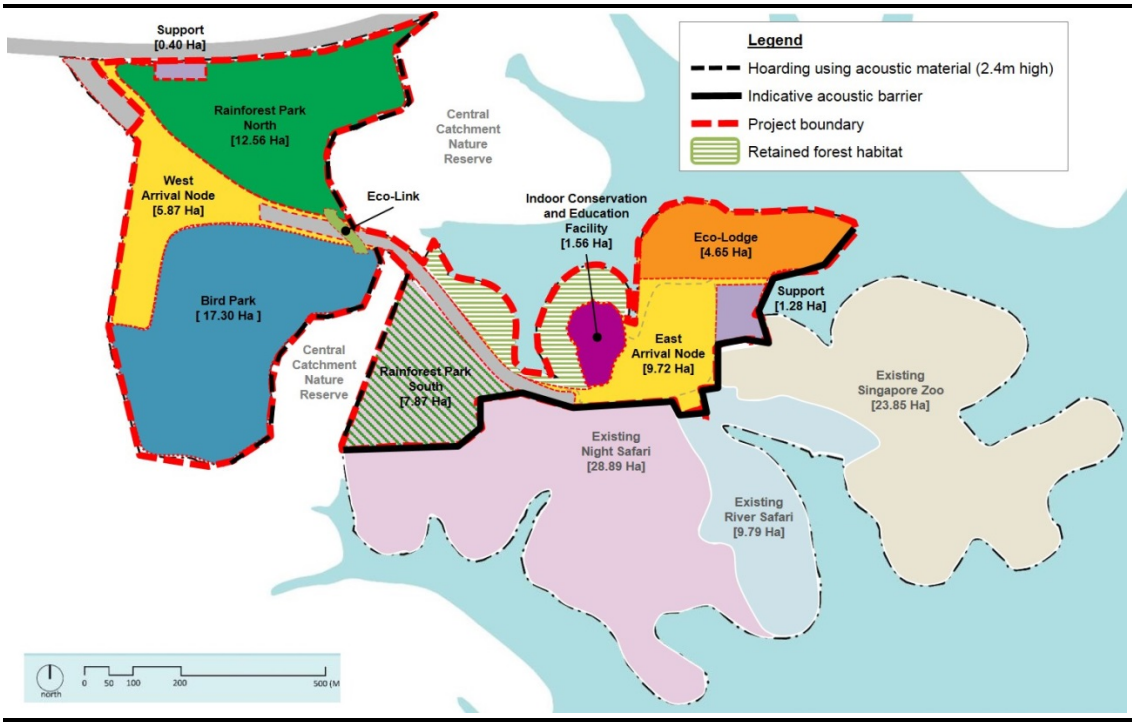
Phase / Activity	Specific Actions
Mitigation at Source	• Contractor to source for quieter models of construction equipment where reasonably practicable i.e. with sound pressure levels at least 5 dB quieter than other models readily available locally, when measured 1 m from the equipment body while the equipment is operating at its rated load. Equipment to be labelled with weatherproof stickers showing clearly its noise specification. • Install rubber lining within demolition chutes. • Equipment and vehicle engines to be turned off when not in use. • Workers to be trained in noise-reduction behaviours such as reducing the drop height of materials. Daily toolbox briefings should include reminders on the need to implement noise-reduction behaviours, in particular during piling and demolition activities. • Where technically feasible, use alternative earth retaining and stabilising structures for the proposed underground structures at the *East and West Arrival Nodes*, such as diaphragm walls, contiguous bored piles or secant bored piles that could eliminate the need for sheet piling. • Where piling is required, consider the use of quieter piling methods for example, using non-impactive piling equipment instead of hammers for installation of perimeter fencing at the *Bird Park*, and for *Boardwalk* piles along Upper Seletar Reservoir, where reasonably practicable. If not feasible, use acoustic shrouds around the hammer head to reduce noise. • Use hydraulic and electric tools in place of pneumatic equipment such as concrete breakers.

Pathway Mitigation	• SI Works:
	  • Use acoustic enclosures on rig engines and install a silencer at the exhaust pipe of the engines throughout the drilling operations.
	  • Erect portable hoarding around drilling rigs.
	  • Erect portable acoustic enclosures around the hammer during Standard Penetration Test (SPT).
	• Instead of hoardings, erect acoustic barriers along the boundary between the Project construction work area and the WRS site (see *Figure 8.8*). Where practicable, acoustic barriers shall be at a sufficient height to block visibility of construction equipment from receptors within the WRS site. The acoustic barriers shall be a minimum height of 3.5 m, shall achieve a Sound Transmission Class of 20 and shall achieve a minimum reduction of 10 dB(A).
	• Undertake the following pathway mitigation measures:
	  • Enclose the facade of the demolition worksite directed towards nearby receptors with acoustic curtains.
	  • Erect screens around smaller worksites where noisy activities will be carried out over a short-term period, e.g. concrete or road breaking.
	  • Enclose static noisy equipment such as generators and water pumps as fully as possible (allowing openings for access and safety considerations), using sound reduction material with a sheet material mass of at least 10 kg/m^2 and/or which achieve a minimum noise reduction of 15 dB(A) as compared to without the acoustic enclosure, as measured at the same distance from the noise source.
	• Locate structures or equipment such as storage silos or temporary site office buildings, between noise generating activities and the nearest NSRs (WRS site and the special use areas) to serve as barriers.

Monitoring	• Carry out daily noise monitoring in accordance with Singapore Standard

Phase / Activity	Specific Actions
	SS 602:2014 *Annex C & D* to ensure compliance against limits in the *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations* and guideline values adopted for this study (see *Annex 1).* Monitoring shall be undertaken using a Class 1 (Type 1) Sound Level Meter at 1 m from the nearest building within the WRS site and at 1 m from the nearest façade at the entrance plaza of *Singapore Zoo,* the entrance plaza of River Safari and the entrance plaza of *Night Safar*i. Where there are site access restrictions, monitoring shall be undertaken at the construction work area boundary. • In the event that measurements exceed limits at the affected receptors, Contractor EHS team to investigate and identify the source(s) of noise. Corrective actions shall be undertaken to ensure that mitigation measures listed above are properly implemented. Where mitigation measures have been properly implemented and noise levels still results in exceedance, EHS team to liaise with MPH to examine feasibility of scaling down construction activities e.g. reduce number of equipment deployed near affected receptor location. • Carry out daily spot checks of construction equipment to ensure that equipment is operating within its noise specification. In the event of an exceedance, EHS team to ascertain if exceedance is due to the improper operation of the construction equipment. In the event of repeated and significant exceedances (i.e. more than 3 dB(A)), EHS team to earmark construction equipment for maintenance.
Management of Implementation	• Contractor EHS team to undertake daily inspection of construction area to ensure that the various packages are in compliance with the management and monitoring measures in the EMMP. • Maintain a complaints procedure to log and track response to complaints received from stakeholders.

Figure 8.8: Indicative Configuration of Acoustic Barriers



8.4.1.5 *Residual Impacts*

Site planning, such as locating noisy equipment and haul roads away from sensitive receptors, will minimise interface between receptors and the Project area. Implementation of pathway mitigation measures such as portable screens, acoustic blankets and barriers can reduce noise levels generated from the Project area by between 10 and 20 dB(A) [(12)]. Mitigation at source through the selection of quieter equipment and construction methods, as well as training of workers to adopt quieter working methods, will further reduce noise levels, e.g. noise generated during demolition and piling works are estimated to be reduced by up to 10 dB(A). In addition, engagement with stakeholders such as WRS will enable the scheduling of noisy construction activities to avoid periods requiring low noise conditions. In view of the level of attenuation achievable from implementation of the abovementioned mitigation measures, it is estimated that residual noise levels will be at or below the applicable noise limits for all receptors except for receptors located within close proximity of the Project boundary. The magnitude of residual impact following implementation of mitigation measures is therefore assessed to be **Small**. A summary of the impact assessment is presented in *Table 8.19*.

Table 8.19: Impact Assessment Summary

Criterion	Rating	Comment
Impacts to Human Receptors from Noise Emissions		
Nature	Negative	High noise levels from operation of construction equipment and vehicles
Type	Direct	High noise levels could lead to nuisance impacts, disturbance to sleep and leisure activities as well as interference with speech communication.

Criterion	Rating	Comment
Impacts to Human Receptors from Noise Emissions		
Duration	Short-term to Long-term	The total duration of construction works is estimated to be at least 6 years; the duration of exposure for WRS staff is therefore assessed to be intermittent over the long-term. However, it is noted that the duration of exposure for WRS visitors will likely be less than a day, i.e. short-term. The duration of particularly noisy activities such as demolition and piling works is expected to be less than 6 months, i.e. short-term.
Extent	Local	Noise generated by construction activities will exceed applicable limits for WRS staff and visitors within 32 m of the Project boundary; and for night-time limits for residents within the special use areas and schools located approximately 1.9 km from the Project boundary. Noise is predicted to be attenuated to below applicable limits for most receptors located at greater distances, i.e. 1 – 2 km from the Project boundary.
Scale	-	In general, noise levels is predicted to exceed 88 dB(A) at distances within 22 m of the Project boundary during Project construction. Noise generated due to movement of construction vehicles along Mandai Lake Road and Mandai Road is estimated to range between 66 – 69 dB(A) for WRS staff and visitors within 10 m of the haul road, and between 58 – 61 dB(A) for receptors at the special use areas. Noise generated from particularly noisy activities such as demolition works, were estimated to exceed 88 dB(A) at distances < 17 m from the Project boundary. Noise generated from demolition works at the existing multi-storey carpark and back-of-house area within the WRS site, were predicted to be well below applicable limits for receptors outside the WRS site e.g. the special use areas, and residential estates and schools located within a 2 km radius from the Project area. Noise generated from piling is estimated to reach 85 dB(A) only for receptors in close proximity to the piling rig.
Frequency	Intermittent and Frequent	Noise will be generated throughout the Project construction phase to some degree; however, there may be prolonged periods where noise levels are relatively low as compared to particularly noisy activities such as demolition and piling works.
Magnitude	Negligible	Noise levels generated during general construction will attenuate to meet or fall well below the applicable limits for receptors located at distances > 32 m from the Project boundary.
	Large	During particularly noisy activities such as demolition works, noise levels are predicted to exceed the regulatory limits and guideline values by more than 3 dB(A) at a small portion of the WRS site i.e. areas ≤ 17 m from the Project boundary.
Receptor Sensitivity	-	Receptor sensitivity is taken into account in the definition of noise impact magnitude.

Criterion	Rating	Comment
Impacts to Human Receptors from Noise Emissions		
Significance	Negligible	For most receptors located at distances > 1km from the Project boundary, noise levels are expected to attenuate to well within the applicable limits, i.e. negligible impacts. For a majority of the WRS site, noise levels are expected to be well within 85 dB(A) i.e. negligible to minor impacts to WRS staff and visitors.
	Major	Major impact is only expected for WRS staff stationed for a long-term period within 22 m of the Project boundary during Project construction.
	Moderate	Moderate impact can be expected for WRS staff stationed between 17 – 24 m of the Project boundary, due to the short term duration of demolition works (< 6 months). Moderate impact is only expected for WRS visitors at close proximity to the Project boundary due to the short-term exposure to noise levels exceeding 88 dB(A), generated during demolition works, and general construction activities.
Residual Impact Magnitude	Negligible	Mitigation such as site planning will ensure that construction worksite entrances and boundaries are located as far as possible from heavily trafficked areas within the WRS site such as the entrance nodes of existing attractions and connecting walkways. Additional mitigation measures such as the use of quieter equipment models will ensure that noise levels from general construction activities will be well below the limits for most receptors > 10 m from the Project boundary.
	Negligible	For particularly noisy activities such as piling and demolition, the additional implementation of source and pathway mitigation measures such as installation of acoustic barriers and use of quieter construction methods, will further attenuate noise levels by 10 to 20 dB(A). Noise levels due to noisy activities such as piling and demolition are therefore expected to be reduced to well below the noise limits for WRS staff and visitors located > 10 m from the Project boundary.
	Small	For particularly noisy activities such as piling and demolition, the additional implementation of source and pathway mitigation measures such as installation of acoustic barriers and use of quieter construction methods, will further attenuate noise levels by 10 to 20 dB(A). Noise levels due to noisy activities such as piling and demolition are therefore expected to be reduced to meet the limits for WRS staff and visitors located at 10 m from the Project boundary.
Residual Impact Significance	Negligible to Minor	Due to the implementation of measures to mitigate overall noise levels generated from the Project area, noise levels will be at or well within the applicable noise limits and interface between receptors and construction noise sources will be reduced.

8.4.2 Impacts to Human Receptors from Cumulative Noise Emissions

8.4.2.1 Sources

In addition to noise generated from the Project construction work area, it is possible that cumulative noise impacts may arise from the following committed developments which are not related to the Project:

- Mandai depot located approximately 1.7 km northeast of the Project, which will serve as a train maintenance depot for the Thomson-East Mass Rapid Transit (MRT) line from 2019;
- Sewer works along Mandai Road approximately 800 m west of the Project, is tentatively scheduled for completion by end 2017.

8.4.2.2 Receptors

Human receptors that will be exposed to cumulative noise impacts from the Project and committed developments include WRS staff and visitors, as well as personnel within the special use areas.

8.4.2.3 Impacts

At the time of writing, construction of the identified committed developments was ongoing. Noise contributions from these construction sites were therefore measured during baseline noise surveys undertaken within and around the Project area in June/July and October 2015. In general, baseline measurements at the Project area were well below the guideline value of 85 dB(A) for human receptors within the WRS site. Baseline measurements were not undertaken at the special use areas due to site access restrictions. However, from site observations, baseline noise levels were primarily dominated by local noise sources such as vehicular traffic along Mandai Road and Mandai Lake Road, operations and human traffic within the WRS site, and exercises associated with the adjacent special use areas. Noise due to construction from committed developments was not distinctly audible within the Project area. Given the distance of these committed developments from the Project, it is assessed that cumulative noise impacts due to concurrent committed developments in proximity to the Project area will be **Negligible**.

Table 8.20: Impact Assessment Summary

Criterion	Rating	Comment
Impacts to Human Receptors from Cumulative Noise Emissions		
Nature	Negative	Cumulative noise levels from Project construction, and concurrent activities at nearby committed developments.
Type	Direct	High noise levels could lead to nuisance impacts, disturbance to sleep and leisure activities as well as interference with speech communication.
Duration	Long-term	The total duration of concurrent works is estimated to be 4 years.
Extent	Local	Cumulative noise generated by activities at the Project area and committed developments will be attenuated within approximately 2 km (without taking into consideration screening effects).

Criterion	Rating	Comment
Impacts to Human Receptors from Cumulative Noise Emissions		
Scale	-	From baseline noise measurements and site observations, contributions from ongoing construction works at committed developments to the ambient noise environment at the Project area will not be audible.
Frequency	Frequent	Concurrent construction works at committed developments will be ongoing from Project construction commencement up to 2020. Following completion, operation of committed developments will occur concurrently with Project construction until 2023.
Magnitude	Negligible	Noise from concurrent construction works at committed developments was not distinctly audible during baseline noise surveys at the Project area. Noise generated during operation of committed developments is not likely to be higher than that generated during construction. Contribution of noise from committed developments is therefore assessed to be negligible.
Receptor Sensitivity	-	Receptor sensitivity is taken into account in the definition of noise impact magnitude.
Significance	Negligible	Negligible impacts can be expected due to exposure to cumulative noise emissions from Project construction and committed developments in the area.

8.4.3 *Impact to Human Receptors due to Vibration*

8.4.3.1 *Sources*

Groundborne vibration will likely be generated during the installation of driven piles during construction, for example prior to the excavation and construction of underground carparks at the *West and East Arrival Nodes* and for other larger above ground structures.

8.4.3.2 *Receptors*

In general, vibration propagated through the ground during earthworks is attenuated within a short distance from the source. Formulae from empirical studies generally consider a distance of approximately 110 m from the vibration source [(14)]. Human receptors that may be exposed to vibration impacts from the Project therefore include those who would be within 110 m of the Project construction work area boundary, and comprise WRS staff and visitors, as well as personnel temporarily residing within the special use areas.

8.4.3.3 *Impacts*

Vibration can lead to annoyance due to sleep disturbance. Low levels of perceptible vibration may also cause disturbance and can cause concern about structural damage to nearby buildings. It is noted however that the potential for actual cosmetic damage is limited to buildings that are very close to high energy sources such as driven piling. Guidance on the effect of vibration levels to human receptors was published by the British Standard Institute, and is presented in *Table 8.21* [(13)]. Reference was made to this guidance in developing the assessment criteria for vibration impacts to human receptors (see *Annex 2*).

[14] British Standard Institute (2014) **Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration.** BS 5228-2:2014.

Table 8.21: Guidance on Effects of Vibration Levels

Vibration Level (mm s^{-1})	Effect
0.14	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3	Vibration might be just perceptible in residential environments.
1.0	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

For the purpose of this assessment, vibrations due to both percussive and vibratory piling methods were predicted using empirically derived formulae reproduced in *British Standard BS 5228-2:2014 Annex B* [13], summarised as follows:

- Vibration levels generated from percussive piling such as hydraulic or diesel hammers, were calculated using *Equation (3)* –

$$v_{res} = k_p \left[\frac{\sqrt{W}}{r^{1.3}}\right]$$

  v_{res} is the resultant peak particle velocity (mm s^{-1});
  k_p is a scaling factor dependent on soil type;
  W is the nominal hammer energy (kJ); and
  r is the distance between the pile toe and receptor location.

- Vibration levels generated from vibratory piling were calculated using *Equation (4)* –

$$v_{res} = \frac{k_v}{x^{\partial}}$$

  k_v is a scaling factor;
  x is the horizontal distance between the pile and receptor location; and
  ∂ is a scaling factor dependent on the mode of operation of the vibratory hammer.

As details on the piling methods that would be adopted during construction were not available at the concept stage, contours for predicted vibration levels from both percussive and vibratory piling are presented in *Figure 8.9* and *Figure 8.10* respectively. The predicted vibration levels are also summarised in *Table 8.22*.

Figure 8.9: Predicted Vibration Contours from Percussive Piling (k_p = 5)

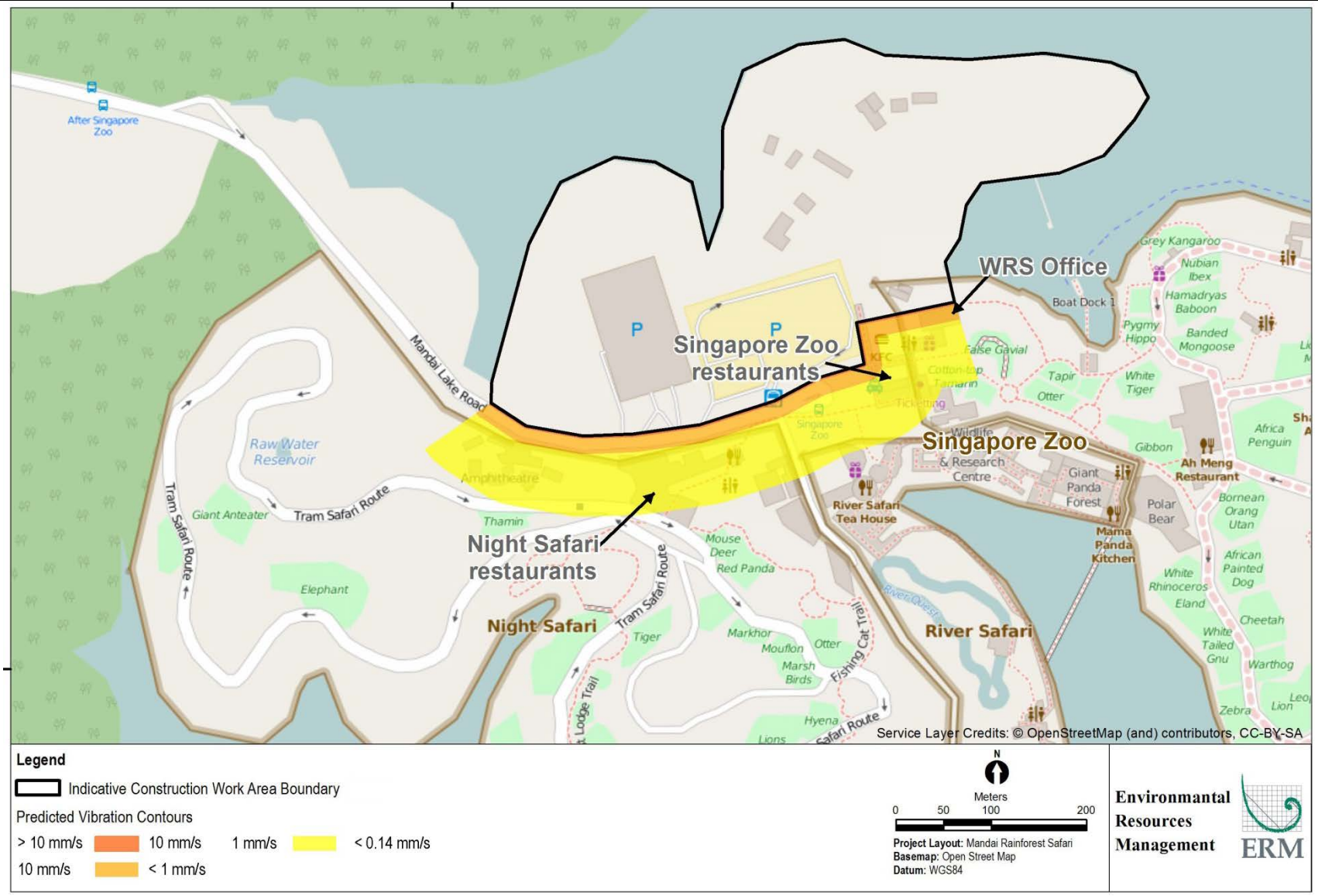


Figure 8.10: Predicted Vibration Contours from Vibratory Piling

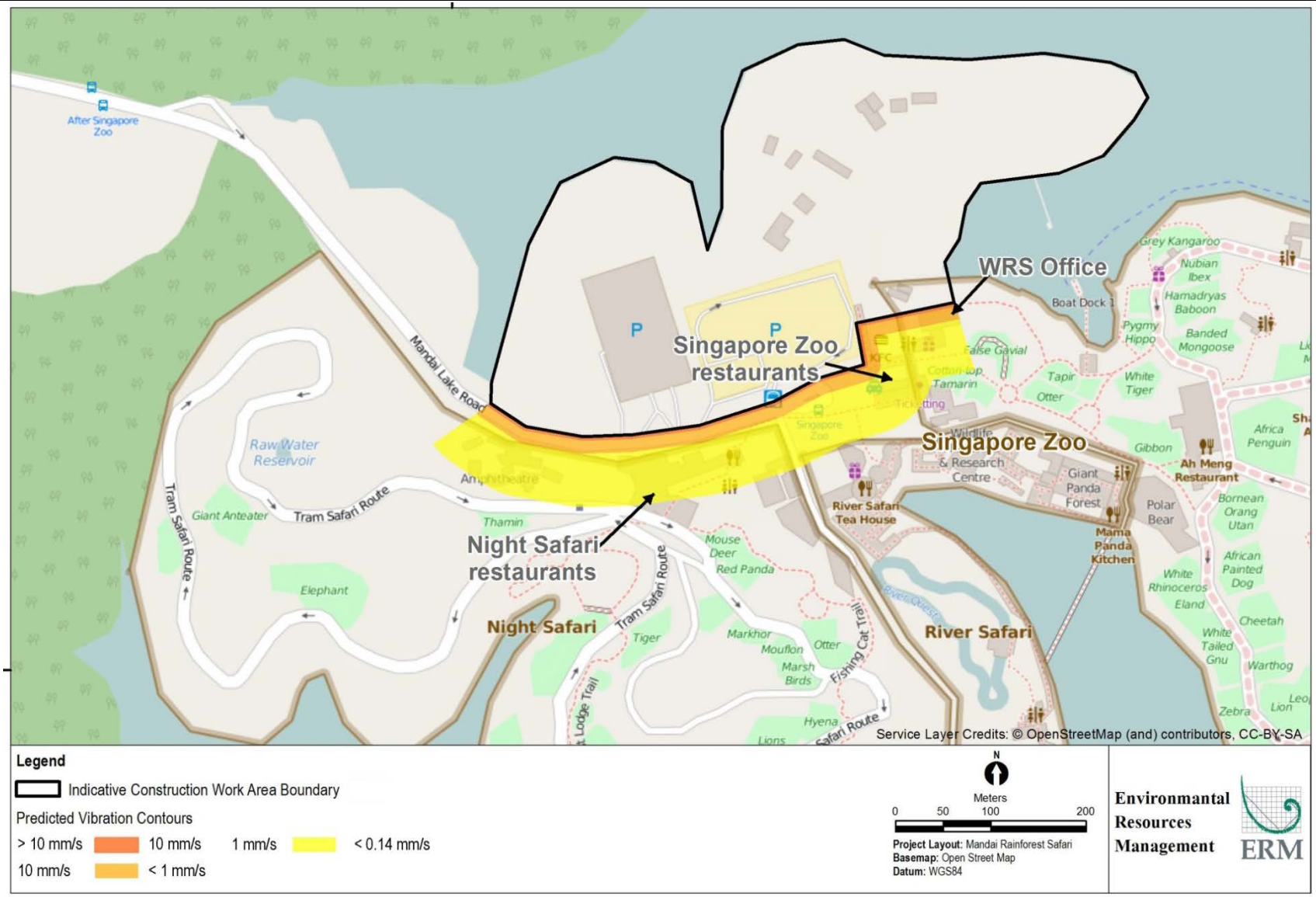


Table 8.22: Predicted Vibration Levels from Piling

Calculation Parameters	Type of Piling		
	Percussive Piling		Vibratory Piling
k_p [1]	3	5	
k_v			60[2]
∂ [3]			1.4
W [kJ] [4]	85	85	
Distance at which PPV = 0.14 mm/s [m]	57	85	74
Distance at which PPV = 1 mm/s [m]	12	19	18
Distance at which PPV = 10 mm/s [m]	2.2	3.2	3.5

Notes:

(1) k_p = 3 for piles being driven through very stiff soils; and k_p = 5 for piles at refusal.

(2) Probability of predicted value being exceeded is 50%. While higher k_v values are presented in *BS 5228-1:2014*, these are deemed to yield predicted levels that are overly conservative and which are therefore unlikely to occur during actual construction for the Project.

(3) ∂ = 1.4 for steady state operation.

(4) 85 kJ is the upper range defined for W in *Equation (3)*.

Source: British Standard Institute, 2014 [13]

Vibration levels are predicted to exceed 10 mm/s at distances less than 3.2 m from a percussive piling rig, and less than 3.5 m from a vibratory hammer. Areas within the WRS site that fall within 3.5 m of the Project boundary are restricted to Mandai Lake Road. It is therefore unlikely that WRS staff or visitors will be directly exposed to vibration levels above 10 mm/s.

Vibration levels are predicted to be between 1 mm/s and 10 mm/s at distances up to 19 m from a percussive piling rig, and up to 18 m from a vibratory hammer. Restaurants at the entrance nodes of *Singapore Zoo* and the *Night Safari*, the *Night Safari* amphitheatre, and a sheltered, open-air area between the *Singapore Zoo* and *Night Safari* entrance nodes rented out for corporate events, fall within 19 m of the Project boundary. It is anticipated that WRS visitors at these locations may be exposed to vibration levels over a short-term duration, i.e. up to a few hours, whereas staff and workers stationed at these locations may be exposed for a longer duration, e.g. up to 8 hours a day. The magnitude of vibration impact to WRS staff and visitors located within these areas is therefore assessed to be **Medium**, i.e. **Moderate** significance.

Vibration levels will attenuate to less than 1 mm/s at distances greater than 19 m from a percussive piling rig, and at distances greater than 18 m from a vibratory piling rig. This includes most of the WRS site. Visitors within the WRS site will be engaged in outdoor recreational activities, whereas WRS staff will comprise those stationed at outdoor areas and those undertaking administrative work in an office environment. Based on guidance values, vibration levels less than 1 mm/s may be perceptible but are unlikely to cause complaint. The magnitude of vibration impact to WRS staff and visitors located more than 19 m from the Project boundary is therefore assessed to be **Small**, i.e. **Minor** significance.

Personnel residing at the special use areas (approximately 100 m from the Project boundary at the *West Arrival Node*) may experience vibration levels of 0.12 mm/s during percussive piling, and 0.10 mm/s from vibratory piling. Based on guidance values, vibration at these levels is

unlikely to be perceptible. The magnitude of vibration impact to residents at the special use area is therefore assessed to be **Negligible**, i.e. **Negligible** significance.

8.4.3.4 Mitigation

Measures to mitigate the noise impacts to human receptors due to construction activities are outlined in *Table 8.23*.

Table 8.23: Mitigation Measures for Vibration

Phase / Activity	Specific Actions
General Management & Planning	• Contractor to liaise with WRS to schedule construction activities so as to minimise disturbance to visitors and staff during peak visitation periods (such as weekends or public holidays). • Coordinate with WRS to provide alternative walkways for WRS staff and visitors to transit between the entrance nodes of *Singapore Zoo, River Safari* and *Night Safari*, to minimise interface between receptors and piling works near the Project boundary.
Mitigation at Source	• Where technically feasible, use earth retaining and stabilising structures for the proposed underground carparks, such as use of diaphragm walls, contiguous bored piles or secant bored piles that could eliminate the need for percussive piling, e.g. sheet-piling. • Use quieter piling methods, for example, using bored piling or pressed-in piling with low soil displacement piles instead of hammers.
Management of Implementation	• Maintain a complaints procedure to log and track response to complaints received from stakeholders.

8.4.3.5 Residual Impacts

The implementation of mitigation measures such as scheduling of piling works to avoid sensitive periods will minimise the effects on sensitive receptors. In addition, the use of alternative earth retaining and stabilising structures would reduce the generation of vibration levels from the Project area. Where it is not technically feasible to eliminate the need for piling, the use of alternative piling methods would reduce vibration levels to below perceptible levels. Due to the close proximity of the underground structures at the *East and West Arrival Node*, and the existing WRS site, residual vibration impacts is conservatively assessed to be of **Small** magnitude. The impact assessment summary is provided in *Table 8.24*.

Table 8.24: Impact Assessment Summary

Criterion	Rating	Comment
Impacts to Human Receptors due to Vibration		
Nature	Negative	Vibration levels due to piling works at *East and West Arrival Nodes*.
Type	Direct	Vibration levels could lead to disturbance to sleep and annoyance.
Duration	Short-term	Piling works is likely to span < 6 months.
Extent	Local	Vibration generated during piling works will be attenuated to a level below the detection of human receptors within 100 m from the piling rig.

Criterion	Rating	Comment
Impacts to Human Receptors due to Vibration		
Scale	-	Vibration levels are predicted ≥10 mm/s at distances less than 3.2 m from a percussive piling rig, and less than 3.5 m from a vibratory hammer. Vibration levels are predicted between 1 mm/s and 10 mm/s at distances between 3.2 - 19 m from a percussive piling rig, and between 3.5 - 18 m from a vibratory hammer. Vibration levels are predicted ≤ 1 mm/s at distances more than 19 m from a percussive piling rig, and more than 18 m from a vibratory hammer.
Frequency	Intermittent	Vibration will be generated intermittently during percussive piling works, and continuously during vibratory piling works for short periods of time.
Magnitude	Negligible	Negligible impact to residents at the special use areas due to vibration levels < 0.14 mm/s during piling works at the *West Arrival Node*.
	Medium	Small impact to WRS staff and visitors due to vibration levels < 1 mm/s at distances greater than 18 – 19 m from the Project boundary. Medium impact to WRS staff and visitors due to vibration levels between 1 mm/s and 10 mm/s, within 18 – 19 m from the Project boundary.
Receptor Sensitivity	-	Receptor sensitivity is taken into account in the definition of vibration impact magnitude.
Significance	Negligible to Moderate	Moderate impacts can be expected due to exposure to vibration levels between 1 and 10 mm/s during piling works, within 18 m - 19 m of the Project boundary. Minor impacts can be expected for receptors located at distances greater than 18 – 19 m from the Project boundary; whereas Negligible impacts can be expected for receptors located more than 85 m from the Project boundary, e.g. residents at the special use areas.
Residual Impact Magnitude	Negligible	Implementation of mitigation measures would reduce vibration levels generated during piling works or eliminate the source of vibration. Through scheduling and site planning, the interface between piling works and receptors e.g. WRS staff and visitors would be reduced.
	Small	Residual impact magnitude would be Small for small portions of the WRS site within close proximity to the Project boundary. Residual impacts for receptors within the majority of the WRS site is expected to be negligible.
Residual Impact Significance	Negligible to Minor	**Minor** residual impacts to WRS staff and visitors may occur despite implementation of mitigation measures, due to close proximity of the piling works to WRS site. Residual impacts to staff and visitors within a major portion of the WRS site is expected to be **Negligible**.

8.5 BIODIVERSITY

8.5.1 Impact to Terrestrial and Aquatic Biodiversity during Construction

Construction activities may have temporary or permanent and positive or negative impacts on biodiversity values. These impacts may be directly caused by activities from construction (such as the use of machinery such as piling rigs, geotechnical equipment etc.) or indirect impacts caused by secondary effects (such as mortality of fauna from poaching as a result of worker influx).

8.5.1.1 Sources

The sources of impact to biodiversity values are derived from the pre-construction and construction activities that will occur onsite as outlined in *Chapter 2, Project Description*. The construction schedule and hence timing of the construction activities also has a bearing on the scale and intensity of impacts on biodiversity values. The impact source descriptions, project components and construction schedule considered are:

Source Descriptions

The Project Description (*Chapter 2*) describes the construction activities within the Project area. The construction activities likely to impact biodiversity include:

- Clearing of vegetation (all types);
- Use of temporary hoarding/barriers;
- Use of construction machinery and equipment;
- Discharge of hazardous substances or pollution;
- Construction of buildings and utilities;
- Construction of enclosures;
- Construction of pavements, steps and retaining walls;
- Excavation;
- Replanting of existing vegetation;
- Landscaping;
- Movement of construction materials, machinery and equipment;
- Storage of construction materials on-site;
- Human interaction with wildlife (workers); and
- Hours of construction.

Project Components

The key project components identified in relation to sources of construction phase biodiversity impacts are as follows:

- *East and West Arrival Nodes*;
- Mandai Lake Road modifications;
- *Eco-Link*;
- *Bird Park* and *Rainforest Park North*;
- *Rainforest Park South*;
- *Boardwalk*;
- *Eco-Lodge*; and
- *Planet Explorer* and *Sri Seletar Point*.

The relationship between impacts sources and Project components are outlined in *Table 8.25*.

Table 8.25: Interaction between Project Components and Impact Sources during Construction

Sources / Project Component	East and West Arrival Nodes	Mandai Lake Road modifications	Eco-Link	Bird Park and Rainforest Park North	Rainforest Park South	Boardwalk	Eco-Lodge	Planet Explorer and Sri Seletar Point
Clearing of vegetation	X	X	X	X	X	X	X	X
Use of temporary barriers	X	X	X	X	X		X	X
Use of construction machinery and equipment	X	X	X	X	X	X	X	X
Discharge of hazardous substances or pollution	X	X	X	X	X	X	X	X
Construction of buildings and utilities	X	X		X	X		X	X
Construction of enclosures				X	X			
Construction of pavements, steps and retaining walls	X	X	X	X	X	X	X	X
Excavation	X	X		X	X		X	X
Replanting of vegetation	X	X	X	X	X		X	X
Movement of construction materials, machinery and equipment	X	X	X	X	X	X	X	X
Storage of construction materials on-site	X	X	X	X	X	X	X	X
Human interaction with wildlife (workers)	X	X	X	X	X	X	X	X
Impacts from noise during construction	X	X	X	X	X	X	X	X

Construction Schedule

The construction schedule in *Table 8.26* has been used as the basis to assess impacts on habitats and species. The construction schedule includes timing for the erection of hoarding, species relocation and construction activities. It should be noted that the key breeding season for species detected on site is between mid-March and July annually. Migratory species detected on-site are generally present from August/September and March annually. While it would have been good for the Eco-Link to be constructed first to allow animals safe passage, it is not possible to do so as there is a need to carry out services diversion works along Mandai Lake Road before the Eco-Link can be implemented.

Table 8.26: Proposed Project Component Construction Schedule

Project Component	Construction Package	Proposed Hoarding and Construction Period	Number of Months	Coincides with Migratory Season	Coincides with Breeding Season
1. East Arrival Node	D	Q3 2018 - Q3 2021	39	Yes - 4 seasons	Yes - 4 seasons
2. West Arrival Node	A and B	Q3 2016 – Q2 2020	48	Yes - 4 seasons	Yes - 4 seasons
3. Mandai Lake Road Modifications	B	Q2 2017 – Q3 2020	42	Yes - 4 seasons	Yes - 4 seasons
	D	Q3 2018 - Q3 2021	39	Yes - 4 seasons	Yes - 4 seasons
4. Eco-Link & Bird Park	B	Q4 2016 - Q2 2020	45	Yes - 4 seasons	Yes - 4 seasons
5. Rainforest Park North	C (North)	Q4 2017 - Q2 2020	33	Yes - 3 seasons	Yes - 3 seasons
6. Rainforest Park South	C (South)	Q3 2020 – Q2 2023	36	Yes - 3 seasons	Yes - 3 seasons
7. Boardwalk	G	Q1 2018 – Q3 2020	33	Yes - 3 seasons	Yes - 3 seasons
8. Eco-Lodge	F	Q4 2019 – Q2 2023	45	Yes - 4 seasons	Yes - 4 seasons
9. Planet Explorer & Sri Seletar Point	E	Q3 2019 – Q2 2022	36	Yes - 3 seasons	Yes - 3 seasons

The impacts from the construction schedule are discussed further in the habitat and species impact assessment *Table 8.35* and *Table 8.36*.

Noise Generating Activities

Noise generating activities may cause disturbance and displacement of fauna during construction. Sources of noise will be primarily from the use of machinery and tools from construction activities within Project component areas. Impacts from noise will commence during construction and last for a period of up to 7 years. The construction programme indicates that the *Eco-Lodge* and the *East* and *West Arrival Nodes* will each take approximately 4 years to construct, and both require demolition and piling works which will likely be completed within a shorter timeframe, i.e. within 6 months. As outlined in *Section 8.4, Noise and Vibration*, noise levels exceeding the guideline value of 85 dB(A) are predicted to occur at areas within 24 m of the Project boundary for demolition works and within 43 m of the Project boundary as a result of piling, which are predicted to be the noisiest activities. Sensitive habitats are located adjacent to noise generating activities and species are likely to vacate these areas during construction. The assessment of noise impacts to fauna is in *Section 8.5.13*.

Wastewater discharge to Surface Water Courses

As outlined in *Section 8.2* and in accordance with the project design philosophy and NParks requirements detailed in *Chapters 1* and *2*, construction works and the drainage design will be

such that there will be no discharge to surface water courses within the Project Area. Assessment of effects to aquatic habitats in Upper Seletar Reservoir and the unnamed stream are considered to be adequately managed by the mitigation measures outlined in *Table 8.7, Mitigation Measures for Surface Water Construction Phase.*

8.5.1.2 Receptors

The Project area and adjacent areas contain significant biodiversity values. Baseline studies identified a diversity of flora and fauna species and ecosystems, including species listed on the SRDB and IUCN Red List of threatened species, endemic species and migratory species. These are described in detail in *Chapter 6*. Further analysis of the baseline data, specific to the *Project Description (Chapter 2)* is outlined in the following subsections. This analysis has been used in the impact assessment for habitats and species.

Habitat Values

Information on the vegetation classifications identified within the Project area is contained in *Chapter 6, Baseline Environment*. For the purposes of this impact assessment, impacts on habitat values has been undertaken to highlight the habitat values retained and impacted within the Project area. During the baseline assessment, species/habitat associations were determined in order to define likely spatial species impacts from the Project components. The species/habitat associations are detailed in *Table 8.33*.

To determine impacts on habitats within the Project components, ERM has overlain the components onto the habitat distribution map and the vegetation classification map to illustrate the spatial impacts on habitats as a result of Project construction activities. *Figure 8.11* depicts the Project components in relation to the vegetation type distribution within the Project area. *Figure 8.12* depicts the project components in relation to the habitat type distribution within the Project area.

As outlined in *Chapter 2, Project Description*, each Project component has been designed to avoid and minimise impacts on important habitats within the Project area during the Masterplanning phase. Habitats retained have been classified based on the categories outlined in *Table 8.27*.

Table 8.27: Habitat Retention Classifications

Habitat Retention Type	Description
Habitat retained	Habitat retained refers to existing vegetated areas within the Project Area which are expected to be retained as they i) reside within areas which the development will avoid (e.g., forest buffers, building setbacks), or ii) are in open areas which are not expected to be modified or cleared for pavements, landscaping etc. This excludes areas retained within enclosures.
Habitat enclosed	Habitat enclosed refers to existing vegetated areas within the Project Area which are expected to be enclosed within covered enclosures.
Habitat cleared	Habitat cleared refers to existing vegetated areas within the Project Area which are expected to be i) cleared to accommodate built structures and paved areas, or ii) modified due to landscaping (including grassland areas which will be revegetated).

The area of each type of vegetation and habitat retained/enclosed/cleared as a result of the Project components are shown in *Table 8.28* and *Table 8.29* respectively. The areas calculated in relation to impacts on habitats are based on a conservative scenario (i.e. worst case) and may change based on the final design. This information has been used to describe impacts to habitats from the Project components in the impact descriptions for habitats.

The Project footprint in relation to vegetation and habitat types in the study area is presented in *Figure 8.11* and *Figure 8.12* respectively.

Table 8.28: Area of Vegetation Retained, Enclosed or Cleared during Construction Phase

	Mature Secondary/ Disturbed Primary vegetation (m^2)			Mature Secondary vegetation (m^2)			Young Secondary (Native dominated) vegetation (m^2)			Young Secondary (Non-native dominated) vegetation (m^2)			Scrubland vegetation (m^2)			Grassland vegetation (m^2)			
Project Component	Area retained[+]	Area enclosed[++]	Area cleared[~]	Area retained	Area enclosed	Area cleared	Area retained	Area enclosed	Area cleared	Area retained	Area enclosed	Area cleared	Area retained	Area enclosed	Area cleared	Area retained	Area enclosed	Area cleared	Total
1. East and West Arrival Nodes*	-	-	-	19,351	-	-	-	-	21,950	16,121	-	-	892	-	16,844	-	-	24,841	**99,999**
2. Mandai Lake Road modifications	-	-	-	-	-	2,402	-	-	-	-	-	41	-	-	3,186	-	-	-	**5,629**
3. Eco-Link	-	-	-	-	-	418	-	-	-	-	-	-	-	-	1,446	-	-	-	**1,864**
4. Bird Park and Rainforest Park North*	-	-	-	32,784	11,237	4,195	3,380	17,720	83	42,899	54,870	9,841	25,037	-	3,198	609	-	40,146	**245,999**
5. Rainforest Park South*	-	-	-	8,772	10,348	-	14,773	19,589	3,997	-	-	-	-	-	-	-	-	-	**57,479**
6. Boardwalk^	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
7. Eco-Lodge~~	-	-	-	-	-	19,549	-	-	18,742	-	-	-	-	-	-	-	-	-	**38,291**
8. Planet Explorer and Sri Seletar Point	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**

Project Component	Mature Secondary/ Disturbed Primary vegetation (m^2)			Mature Secondary vegetation (m^2)			Young Secondary (Native dominated) vegetation (m^2)			Young Secondary (Non-native dominated) vegetation (m^2)			Scrubland vegetation (m^2)			Grassland vegetation (m^2)			
	Area retained[+]	Area enclosed[++]	Area cleared[~]	Area retained	Area enclosed	Area cleared	Area retained	Area enclosed	Area cleared	Area retained	Area enclosed	Area cleared	Area retained	Area enclosed	Area cleared	Area retained	Area enclosed	Area cleared	Total
9. Buffers/ Setbacks and Retained Habitat	18,768	-	-	40,548	-	-	-	-	-	-	-	-	-	-	-	8,313	-	-	**67,629**
Total Area	**18,768**	**-**	**-**	**101,455**	**21,585**	**26,564**	**18,153**	**37,309**	**44,772**	**59,020**	**54,870**	**9,882**	**25,929**	**-**	**24,674**	**8,922**	**-**	**64,987**	**516,890**

Notes:

[+] Area retained refers to existing vegetated areas within the Project Area which are expected to be retained as they i) reside within areas which the development will avoid (e.g., forest buffers, building setbacks), or ii) are in open areas which are not expected to be modified or cleared for pavements, landscaping etc. This area excludes areas retained within enclosures.

[++] Area enclosed refers to existing vegetated areas within the Project Area which are expected to be enclosed within covered enclosures.

~ Area cleared refers to existing vegetated areas within the Project Area which are expected to be i) cleared to accommodate built structures and paved areas, or ii) modified due to landscaping (including grassland areas which will be revegetated).

* Landscaped areas will be created within project components and will contain a mix of habitat values included planted trees, understorey vegetation and some grassland areas.

^ The construction footprint for the *Boardwalk* will be above drainage infrastructure. Some minor removal of vegetation covering the drain along the route may occur.

~~ The construction footprint for the *Eco-Lodge* has not yet been determined. A worst case scenario has been assumed for this area. All significant trees will be avoided if possible.

Table 8.29: Area of Habitat Retained, Enclosed or Cleared during Construction Phase

	Disturbed Primary forest habitat (m^2)			Secondary forest habitat (m^2)			Grassland habitat (m^2)			Forested freshwater habitat (m^2)			
Project Component	Habitat retained[+]	Habitat enclosed[++]	Habitat cleared	Habitat retained	Habitat enclosed	Habitat cleared	Habitat retained	Habitat enclosed	Habitat cleared	Habitat retained	Habitat enclosed	Habitat cleared	Total
1. East and West Arrival Nodes*	-	-	-	36,364	-	34,407	-	-	24,841	-	-	4,387	**99,999**
2. Mandai Lake Road modifications	-	-	-	-	-	5,452	-	-	-	-	-	177	**5,629**
3. Eco-Link	-	-	-	-	-	1,864	-	-	-	-	-	-	**1,864**
4. Bird Park and Rainforest Park North*	-	-	-	101,964	83,827	17,220	609	-	40,146	2,136	-	97	**245,999**
5. Rainforest Park South*	-	-	-	23,545	29,937	3,997	-	-	-	-	-	-	**57,479**
6. Boardwalk^	-	-	-	-	-	-	-	-	-	-	-	-	**0**
7. Eco-Lodge~~	-	-	-	-	-	38,291	-	-	-	-	-	-	**38,291**
8. Planet Explorer and Sri Seletar Point	-	-	-	-	-	-	-	-	-	-	-	-	**0**
9. Buffers/Setbacks and Retained Habitat	18,768	-	-	40,548	-	-	8,313	-	-	-	-	-	**67,629**
Total Area of Habitat	**18,768**		**-**	**202,421**	**113,764**	**101,231**	**8,922**	**-**	**64,987**	**2,136**	**-**	**4,661**	**516,890**

Notes:

[+] Habitat retained refers to existing vegetated areas within the Project Area which are expected to be retained as they i) reside within areas which the development will avoid (e.g., forest buffers, building setbacks), or ii) are in open areas which are not expected to be modified or cleared for pavements, landscaping etc. This area excludes habitat retained within enclosures.

[++] Habitat enclosed refers to existing vegetated areas within the Project Area which are expected to be enclosed within covered enclosures.

~ Habitat cleared refers to existing vegetated areas within the Project Area which are expected to be i) cleared to accommodate built structures and paved areas, or ii) modified due to landscaping (including grassland areas which will be revegetated).

* Landscaped areas will be created within project components and will contain a mix of habitat values included planted trees, understorey vegetation and some grassland areas.

^ The construction footprint for the *Boardwalk* will be above drainage infrastructure. Some minor removal of vegetation covering the drain along the route may occur.

~~ The construction footprint for the *Eco-Lodge* has not yet been determined. A worst case scenario has been assumed for this area. All significant trees will be avoided if possible.

Figure 8.11: Project Footprint in Relation to Vegetation Classification

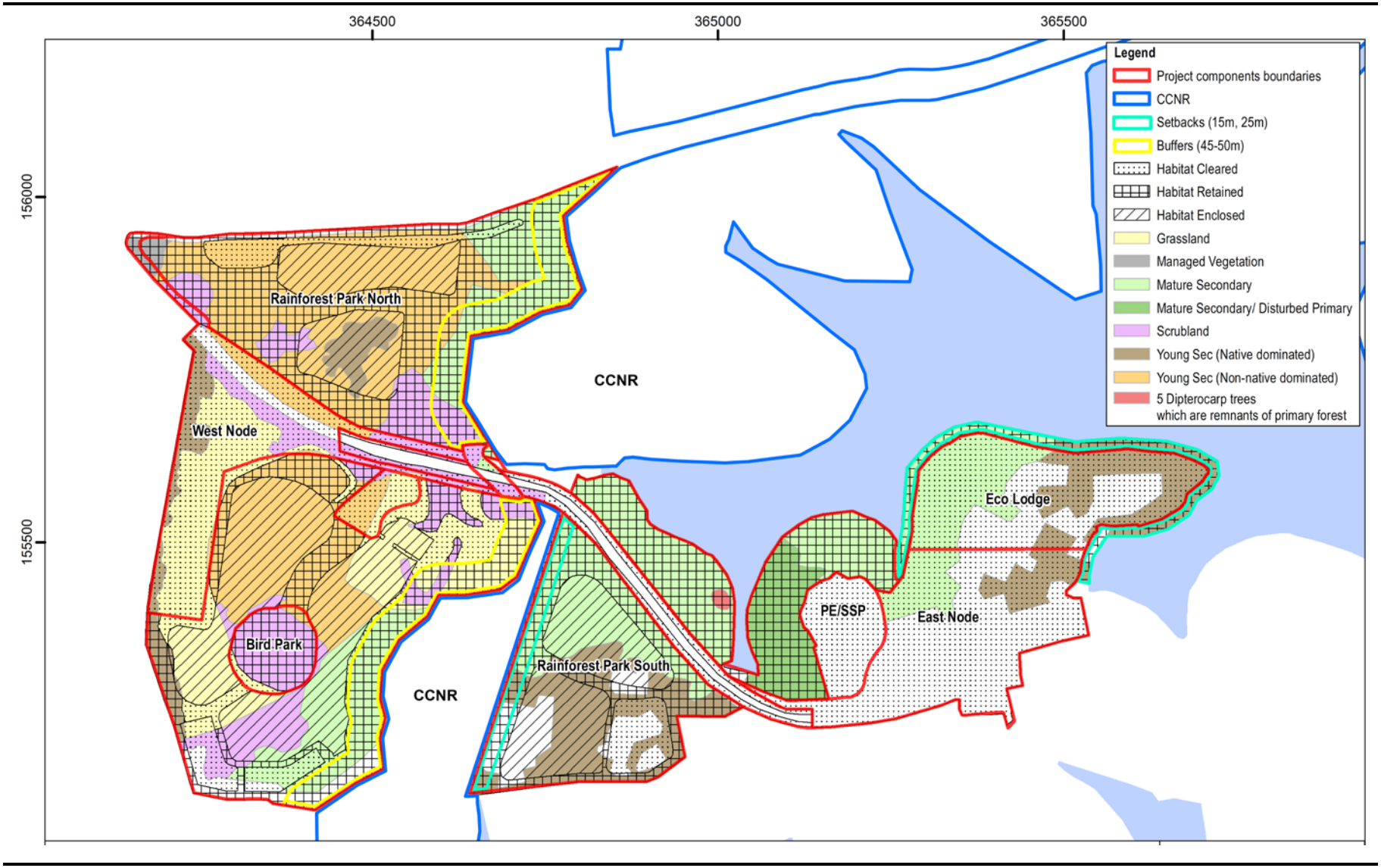
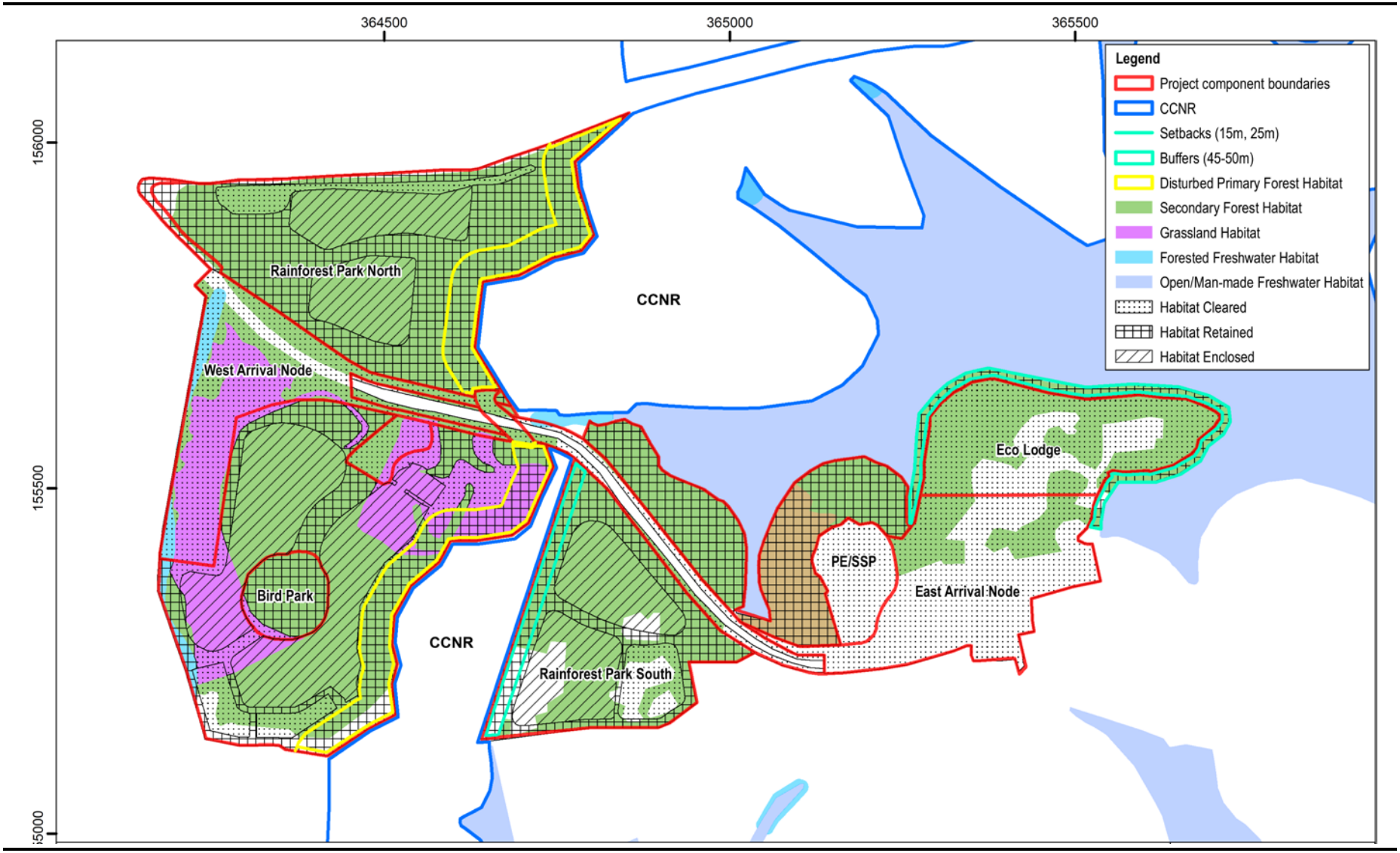


Figure 8.12: Project Footprint in Relation to Habitat Classification



Wildlife Corridors

Impacts to existing wildlife corridors can disrupt forest connectivity within a fragmented landscape where forest persists within a mosaic of other land uses. The construction of the Project has the potential to restrict movement of wildlife between forest patches; impact the exchange of genetic material between otherwise isolated populations; and disrupt key processes such as seed dispersal that may contribute to the regeneration of disturbed forests.

The *Eco-Link* will be an integral part of the approach to restore connectivity within and outside of the Project area. Prior to the construction of the *Eco-Link*, it is proposed to retain an area adjacent to the buffer on the north and south sides of Mandai Lake Road to enable fauna movement. It is proposed that the *Eco-Link* will be prioritised in the construction schedule and will be the first Project component to complete construction in Quarter 1, 2019. When the *Eco-Link* is operational, it will serve as the primary wildlife corridor, providing a safe passage for fauna movement across Mandai Lake Road.

Edge Effects on Habitats

Edge effects are negative impacts that occur when a habitat is exposed to a different adjacent habitat type or structure. These impacts can include increased risk of parasitism or disease, increased risk of predation, adverse microclimate conditions (including drying out and subsequent fire risk), and competition from invasive species [(15)].

The Project area has also been subject to high intensity microburst storm events that have disturbed forested habitats and caused significant destruction of trees in the past. These natural events may be exacerbated by the Project from the creation of wind corridors from buildings and enclosures.

As described in *Chapter 2, Project Description*, a 45-50 m buffer will be maintained within the *Rainforest Park North* and *Bird Park* adjacent to the western edge of the CCNR. The forested area within the *Rainforest Park South* adjacent to the eastern edge of the CCNR is currently disturbed forest and is utilised by WRS for the *Night Safari*. As part of the repurposing of the *Night Safari* to accommodate the *Rainforest Park South,* all buildings and structures in the *Rainforest Park South* will be set back 25 m from the boundary of the CCNR.

It should be noted that specific management measures for edge effects have been built into the design. These measures will continue to be refined as the design progresses and are outlined in *Chapter 2, Project Description*. These measures include such features as using heat absorbing colour palettes, roof gardens and forest restoration strategies.

The length of potential edge effects beside project components was measured using the project component boundaries. These edge effect lengths enable the impact assessment to consider the intensity of edge effects on adjacent habitats and to assist in identifying potential mitigations during construction. The lengths of edges are outlined in *Table 8.30*.

[15] USDA (2012) Conservation Buffer, Guidelines V2.0. United States Department of Agriculture, National Agroforestry Center.

Table 8.30: Potential Project Area Edge Effect Area Lengths

Description of Edge Area	Disturbed Primary/ Secondary Forest habitat (m)	Grassland habitat (m)	Forested Freshwater habitat (m)
East Arrival Node adjacent to remnant forested areas	240	-	-
West Arrival Node adjacent to remnant forested areas	180	-	-
Length of Mandai Lake Road to be modified	1,100		
Mandai Lake Road beside the CCNR	120 (North) 90 (South)	-	-
CCNR adjacent to *Bird Park* and *Rainforest Park North* boundaries	1,140	290	-
CCNR adjacent to the *Rainforest Park South* boundary	495	-	-
CCNR adjacent to the *Eco-Link* landing area north and south	50 (North) 45 (South)		
Bird Park boundary adjacent to forested freshwater habitat near the unnamed stream	-	-	420
Eco-Lodge boundary adjacent to the Upper Seletar Reservoir	830	-	-
Planet Explorer and *Sri Seletar Point* boundary adjacent to the Upper Seletar Reservoir	420	-	
Boundary of the *Planet Explorer* and *Sri Seletar Point* adjacent to remnant forest	120		
Boardwalk along the Upper Seletar Reservoir	7,480	-	-

Threatened Species Values

For the purposes of the impact assessment, priority species were selected based on the following criteria:

- Listed on the IUCN Red List or the SRDB as CR, EN or VU;
- Migratory or restricted range species; or
- Species of interest identified within the Project area.

The following sections describe the threatened species values as they relate to the impact assessment for the project components. Data has been derived from *Chapter 6 Baseline Environment* to enable interpretation and to assess the magnitude of the various impacts assessed for habitats (in *Table 8.35*) and for species (*Table 8.36*).

Threatened Fauna

Comparative Impact Area

Impacts to threatened fauna species have been determined based on the spatial impacts to habitats (as shown in *Table 8.35*) and subsequent changes in resource availability within the Project area. Adjacent refuge areas and the immediately adjacent CCNR have been used for comparative analysis in the impact assessment and this area is referred to as the Project Vicinity. The proposed refuge areas are shown in *Figure 8.13*.

Fauna mobility and utilisation of the *Eco-Link*

Based on data contained in *Chapter 6, Baseline Environment*, and the threatened species profiles contained in *Annex 11*, ERM has derived a list of priority fauna species that may be obstructed within the Project area during construction and operation (*Table 8.31*). Highly mobile and mobile species listed in the table are also candidates to use the *Eco-Link* and hence have influenced the design. Further information on the flora selected for *Eco-Link* planting to provide habitat cover for these species can be found in *Annex 15.1, Forest Restoration Plan,* and *Annex 15.2, Planting and Species Associations*. The Plan includes specific information on the flora species chosen to attract fauna as well as minimum tree spacing requirements to enable arboreal fauna movement.

The mobility data from *Chapter 6, Baseline Environment,* and information on species lifecycles contained in *Annex 11, Priority Species Profiles,* shows that the majority of priority fauna species reside on both sides of Mandai Lake Road, in particular key species of conservation concern such as the Sunda Pangolin (*Manis javanica*) and Lesser Mousedeer (*Tragulus kanchil*). Roadkill records [16] of the Sunda Pangolin along Mandai Lake Road indicate that individuals are moving between these areas and suffering mortality as a result. Species are also marked in the table where it is considered, based on their lifecycle patterns, that they are likely to utilise the *Eco-Link* in the short and longer term (subject to suitable habitat establishment and refugia). Highly mobile and mobile arboreal species and aerial species (birds and bats) are also likely to use the *Eco-Link* once sufficient resources have been established. Ground dwelling fauna will require the establishment of sufficient ground level habitat and refugia. Less mobile species are likely to utilise the *Eco-Link* once sufficient vegetative cover has been established.

Table 8.31: Mobility of Fauna Species Detected Within the Project Area

Fauna Category	Mobility Categories	Number of Species	Species
Ground-dwelling fauna	Highly Mobile	5	• Sambar Deer* • Sunda Pangolin* • Lesser Mouse Deer* • Red Junglefowl* • Wild Boar*
	Mobile	6	• King Cobra* • Striped Sun Skink* • Blue Malayan Coral Snake* • Red Legged Crake~ • Malayan Racer • Banded Malayan Coral Snake

[16] WRS Roadkill Data

Fauna Category	Mobility Categories	Number of Species	Species
	Limited Mobility	4	• Lim's Black-spotted Sticky Frog~ • Golden-eared Rough-sided Frog~ • Malesian Frog • Malayan Giant Frog
Arboreal fauna	Highly Mobile	1	• Long-tailed Macaque*
	Mobile	14	• Malayan Colugo~+ • Banded Leaf Monkey~+ • Horsfield's Flying Squirrel*+ • Sunda Slow Loris~ • Twin-barred Tree Snake* • Singapore Bent Toed Gecko~+ • Peninsular Rock Gecko~+ • Lowland Dwarf Gecko~+ • Black Bearded Flying Dragon~+ • Red Tailed Racer~+ • Yellow-striped Tree Skink~+ • Wagler's Pit Viper~+ • Yellow-ringed Cat Snake~+ • Twin-barred Tree Snake~+
	Limited Mobility	1	• Spotted Tree Frog
Aerial fauna	Highly Mobile	6	• Violet Cuckoo~+ • Straw-headed Bulbul*+ • Blue-crowned Hanging Parrot* • Oriental Magpie Robin* • Lesser Bamboo Bat* • Greater Bamboo Bat*
	Mobile	10	• Chestnut-bellied Malkoha* • Black-headed Bulbul* • Chestnut Bellied Malkoha* • Red-crowned Barbet~ • Drongo Cuckoo~ • Blue-Rumped Parrot~ • Yellow-eared Spiderhunter~ • Thick-billed Green Pigeon~ • Spotted Wood Owl~ • Red-Eyed Bulbul
	Limited Mobility	4	• Mangrove Pitta* • Buffy Fish Owl~+ • Blue-eared Kingfisher~+ • Black-headed Bulbul~+
Total Number of Species		51	

* Indicates species likely to utilise the *Eco-Link* in the short term
~ Indicates possible use of the *Eco-Link* if suitable habitat available in the longer term
+ indicates mobile forest specialist

Figure 8.13: Location of Candidate Relocation Refuge Areas

Species Home Ranges and Territoriality

Consideration of home ranges and territorial behaviours are important when considering displacement of species and available refuge areas within the vicinity of the Project during construction. Little is known about the home range distribution of some of the threatened species within the Project Area. Some species have relatively small home ranges and are territorial (such as the Lesser Mouse Deer and Malayan Colugo) and other species (such as some birds and migratory species) have a much larger range/distribution.
Specific home ranges for these sensitive species are discussed in the species impact assessments outlined in *Table 8.36* and *Table 9.12*. Known home ranges for highly mobile, mobile and territorial species are shown in *Table 8.32*.

Table 8.32: Known Home Ranges and Territorial Species Within the Project Area

Species	Species Home Range	Territorial
Sunda Pangolin	6.97 ha [(1)]	Yes
Sambar Deer	Males 1,500 ha; females 300 ha [(2)]	Yes
Lesser Mousedeer	Males 5.9 ha; females 4.3 ha [(3)]	Yes
Wild Boar	110-390 ha [(4)]	Yes
Oriental Magpie Robin	-	Yes
Red Junglefowl	0.5 - 17.3 ha [(5)]	-
Mangrove Pitta	-	Yes
Long-tailed Macaque	125 ha [(6)]	Yes
Straw-headed Bulbul	-	Yes
Blue-crowned Hanging Parrot	-	Yes
King Cobra	630 ha [(7)]	-
White-rumped Shama	0.09 ha [(8)]	Yes
Red-legged Crake	-	Yes
Brown-chested Jungle Flycatcher	-	Yes
Banded Leaf Monkey	-	Yes
Malayan Colugo	2 ha [(9)]	Yes
Sunda Slow Loris	0.6-2.0 ha [(10)]	Yes
Tokay Gecko	-	Yes
Black Bearded Flying Dragon	-	Yes
Red-crowned Barbet	-	Yes
Drongo Cuckoo	-	Yes
Yellow-eared Spiderhunter	-	Yes

Notes:

(1) Lim NTL, Ng PKL (2008) Home Range, activity acycle and natal den usage of a female Sunda pangolin *Manis javanica* (Mammalia: Pholidota) in Singapore. Endangered Species Research. Vol 4:233-240. Retrieved from http://www.int-res.com/articles/esr2008/4/n004p233.pdf

(2) Leslie DM Jr (2011) Mammalian Species: *Rusa unicolor* (Artiodactyla: Cervidae). American Society of Mammalogists. Retrieved from http://www.mammalogy.org/uploads/Leslie%202011%20-%20MS%2043(871),%201-30_0.pdf

(3) Matsubayashi H, Bosi E and Kohshima S (2003) Activity And Habitat Use Of Lesser Mouse-Deer (*Tragulus javanicus*). Journal of Mammalogy, 84 (1):234-242

(4) Wickline K (2014). "Sus scrofa" (On-line) Animal Diversity Web. Retrieved from http://animaldiversity.org/accounts/Sus_scrofa/

(5) Irshad Arshad M, Zakaria M (2011) Variation in home range size exhibited by Red Junglefowl

Species	Species Home Range	Territorial

(*Gallus gallus spadiceus*) in oil palm plantation habitat, Malaysia. Pakistan Journal of Zoology. Vol 43(5): 833-840. Retrieved from http://www.djurensratt.se/sites/default/files/lund/science.pdf

(6) Bonadio C (2000) "Macaca fascicularis" (On-line) Animal Diversity Web. Retrieved from http://animaldiversity.org/accounts/Macaca_fascicularis/

(7) Bhaisare D, Ramanuj V, Shankar PG, Vittala M, Goode M, Whitaker R (2010) Observations on a wild King Cobra (*Ophiophagus hannah*), with emphasis on foraging and diet. IRFC Reptiles and Amphibians. Vol 17(2) Retrieved from https://pogirigowrishankar.files.wordpress.com/2013/03/king-cobra-feeding-ecology-paper.pdf

(8) Aguon CF, Conant S (1994) Breeding biology of the White-rumped Shama on Oahu, Hawaii. Wilson Journal of Ornithology. Vol 106(2): 311-328. Retrieved from https://sora.unm.edu/sites/default/files/journals/wilson/v106n02/p0311-p0328.pdf

(9) Beatson K (2011) "Galeopterus variegatus" (On-line) Animal Diversity Web. Retrieved from http://animaldiversity.org/accounts/Galeopterus_variegates/

(10) Wiens F (2002) Behaviour and ecology of wild slow lorises. Doctorate Dissertation. Retrieved from https://www.deutsche-digitale-bibliothek.de/binary/EU5G6AU6YUFG3ET4HH6JYSV74Y5RO3HK/full/1.pdf

Habitat and Species Associations

For the purposes of the impact assessment, habitats and species associations have been used (as outlined in *Table 6.24*, *Chapter 6, Baseline Environment*) to provide context to the species likely to be impacted by the various project components (given the impact on their associated habitat). For the purposes of the impact assessment, this table has been reproduced as *Table 8.33*. Reference to species associated with the habitats impacted is discussed in the impact assessments for species and habitats in *Table 8.35* and *Table 8.36*.

Table 8.33: Species-Habitat Associations within the Project Area

Habitat Type	Potential Project Component Impact	Terrestrial Vertebrates and Bats	Birds	Herpetofauna
Disturbed Primary Forest/ Secondary Forest	• East and West Arrival Nodes • Eco-Link • Bird Park and Rainforest Park North • Rainforest Park South • Boardwalk • Eco-Lodge • Planet Explorer and Sri Seletar Point	• Lesser Mousedeer • Sambar Deer • Sunda Pangolin • Lesser Bamboo Bat • Horsfield's Flying Squirrel • Banded Leaf Monkey	• Yellow-eared Spiderhunter • Violet Cuckoo • White-rumped Shama • Blue-crowned hanging Parrot • Red-crowned barbet • Blue-rumped parrot • Red-eyed bulbul • Crested Serpent Eagle • Chestnut-winged babbler • Drongo Cuckoo	• Singapore Bent-toed Gecko • Red-necked Bronzeback • Black Bearded Flying Dragon • Striped Sun Skink • Red-tailed Racer • Lowland Dwarf Gecko • King Cobra • Wagler's Pit Viper • Spotted Tree Frog • Blue-necked Keelback ^ • Blue Malayan Coral Snake ^

Habitat Type	Potential Project Component Impact	Terrestrial Vertebrates and Bats	Birds	Herpetofauna
			• Thick-billed Green Pigeon • Spotted Wood Owl ^ • Changeable Hawk Eagle ^ • Straw-Headed Bulbul ^ • Chestnut Bellied Malkoha (Recorded in 2008, 2014)	• Lim's Black-Spotted Sticky Frog # • Tokay Gecko +
Grassland	• East and West Arrival Nodes • Eco-Link • Bird Park and Rainforest Park North • Rainforest Park South	• Sambar Deer • Sunda Pangolin • Greater Bamboo Bat	• Lesser Coucal # • Scaly-breasted Munia # • Chestnut Munia # • Baya Weaver #	• King Cobra • Striped Bronzeback # • Painted Bronzeback #
Forested Freshwater Habitat	• East and West Arrival Nodes • Bird Park and Rainforest Park North • Rainforest Park South • Boardwalk • Eco-Lodge • Planet Explorer and Sri Seletar Point		• Masked Finfoot ~ • Grey-headed Fish Eagle ~ • Blue-eared Kingfisher ~ • Purple Heron ~ • Buffy Fish Owl ~ • Black Crowned Night Heron~ • Red-legged Crake (Recorded in 2014)~	• Malayan Flatshell Terrapin~ • Bornean Giant River Terrapin~ • Yellow-ringed Cat Snake~ • Golden-eared Rough-sided Frog~ • Masked Rough-sided Frog #~ • Black-eyed Litter Frog #~ • Copper-cheeked Frog #~ • Malesian Frog #~
Open/ Man-made Freshwater Habitat	• Boardwalk • Eco-Lodge		• Purple Heron~ • Grey Heron~ • Black Crowned Night Heron~ • Grey-Headed Fish Eagle~	

Notes:

^ These species have been identified as woodland specialists, and may have adapted to a certain level of disturbance.

[#] Identified by the specialist but is not listed on the SRDB.

[+] The specialist has advised that this species may not be of native genetic stock and management techniques may be required.

* Exotic species

~ These species are likely to inhabit water edges along the shores of the Upper Seletar Reservoir

Threatened Flora

As outlined in *Chapter 6, Baseline Environment,* significant flora values exist within the development area, including species listed as CR, EN and VU on both the SRDB and IUCN Red List. Individual native trees >1 m in girth not listed on the SRDB were also recorded within the Project area. All CR, EN, VU SRDB listed trees, large native tree species (>1m in girth) and the existing Alstonia trees along Mandai Lake Road (which provide connections for arboreal fauna) will be avoided as a first priority. Should it be necessary to clear any tree of these species, this will be subject to prior approval from NParks.

Threatened flora of conservation significance identified within the Project area is shown in *Table 8.34*. The highest number of trees of conservation significance is within the *Rainforest Park South* area, followed by the *Eco-Lodge* and *Planet Explorer/Sri Seletar Point* project component areas. The *Arrival Nodes*, *Bird Park* and *Eco-Link* have the lowest number of trees of conservation significance.

Table 8.34: Flora Species of Conservation Significance in Relation to Project Components

	Development Component	Number of Significant Flora[1]			
		CR	EN	VU	Native Trees >1m girth
1	East Arrival Node	26	62	86	55
	West Arrival Node	5	2	9	125
2	Mandai Lake Road modifications	17	63	95	238
3	Eco-Link	0	0	3	4
4	Bird Park	12	27	42	192
	Rainforest Park North	37	46	131	252
5	Rainforest Park South	507	1,166	1,895	6,834
6	Boardwalk[2]	N.A	N.A	N.A	N.A
7	Eco-Lodge	48	133	230	304
8	Planet Explorer and Sri Seletar Point	204	344	410	270

Notes:

(1) Only data obtained from the arboriculture survey commissioned by MPH in 2015 is included in this table.

(2) No current data is available for trees within the *Boardwalk* area as the design remains in the very early stages and the intent is to align the *Boardwalk* on top of drainage infrastructure.

For the purposes of the impact assessment, the location of threatened flora species in relation to the project components has been overlain onto the distribution of these flora species from information provided as part of the arborist survey. *Figure 8.14* shows the location of significant flora species in relation to the project components.

Flora and Fauna Requiring Management

Chapter 6, Baseline Environment, has identified a number of flora and fauna species that may require management within the Project area. These species include:

- Wild boar (*Sus scrofa*);
- Sambar Deer (*Rusa unicolor*);
- Long tailed Macaque (*Macaca fascicularis*);
- Rodents (non-native mice and rats);

- *Spathodea campanulata* (Invasive Flora);
- *Cecropia pachystachya* (Invasive Flora); and
- *Falcataria moluccana* (Invasive Flora).

For the purposes of the impact assessment, these fauna and invasive flora species requiring management have been considered. The fauna listed have been identified to frequent the entire Project area. Invasive flora species were identified and are relevant to the *Bird Park*, *Rainforest Park North* and *Rainforest Park South* project component areas. *Figure 8.15* shows the location of the records of invasive flora species identified within the Project area in relation to the Project components.

Figure 8.14: Significant Flora in Relation to the Project Components

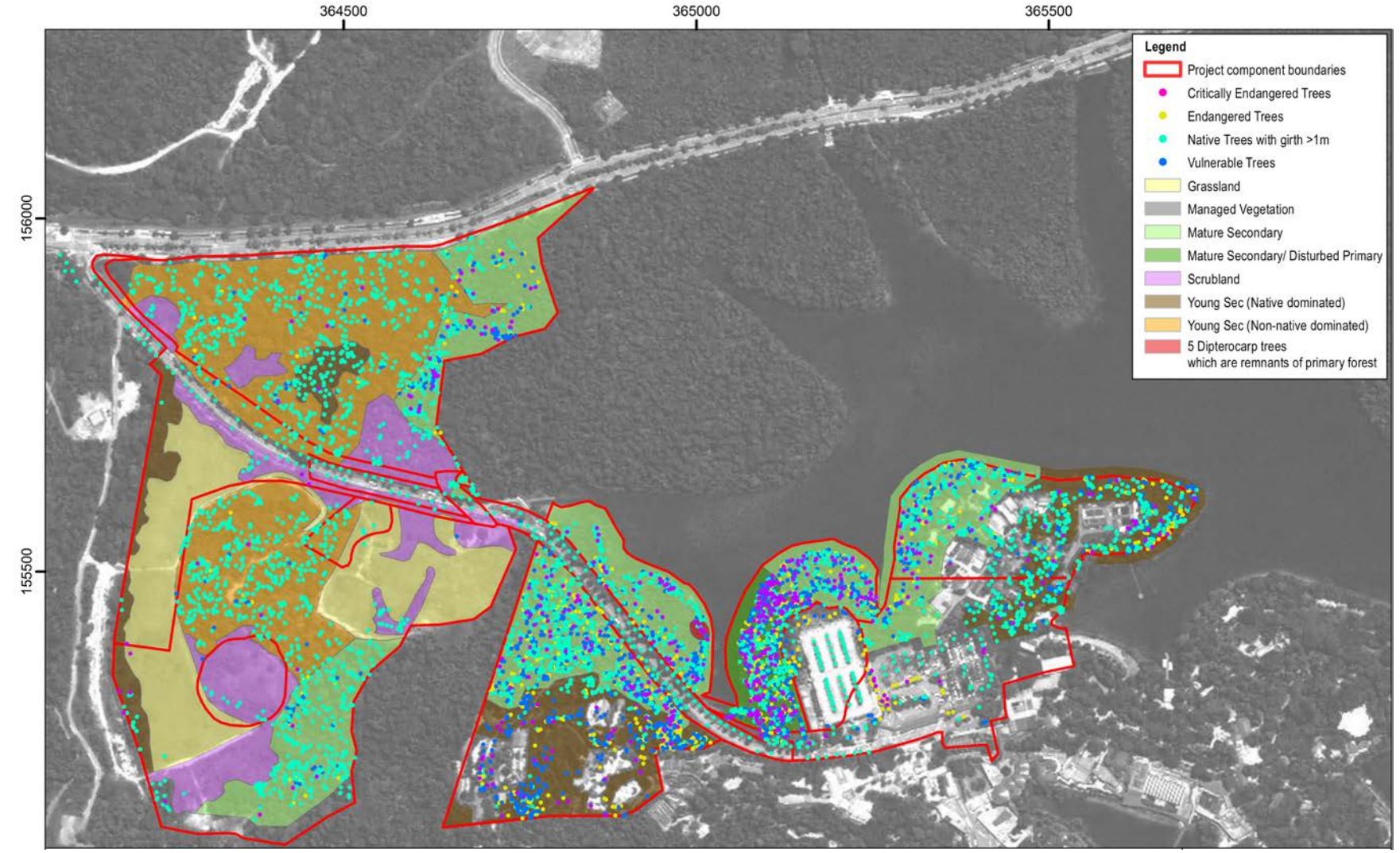
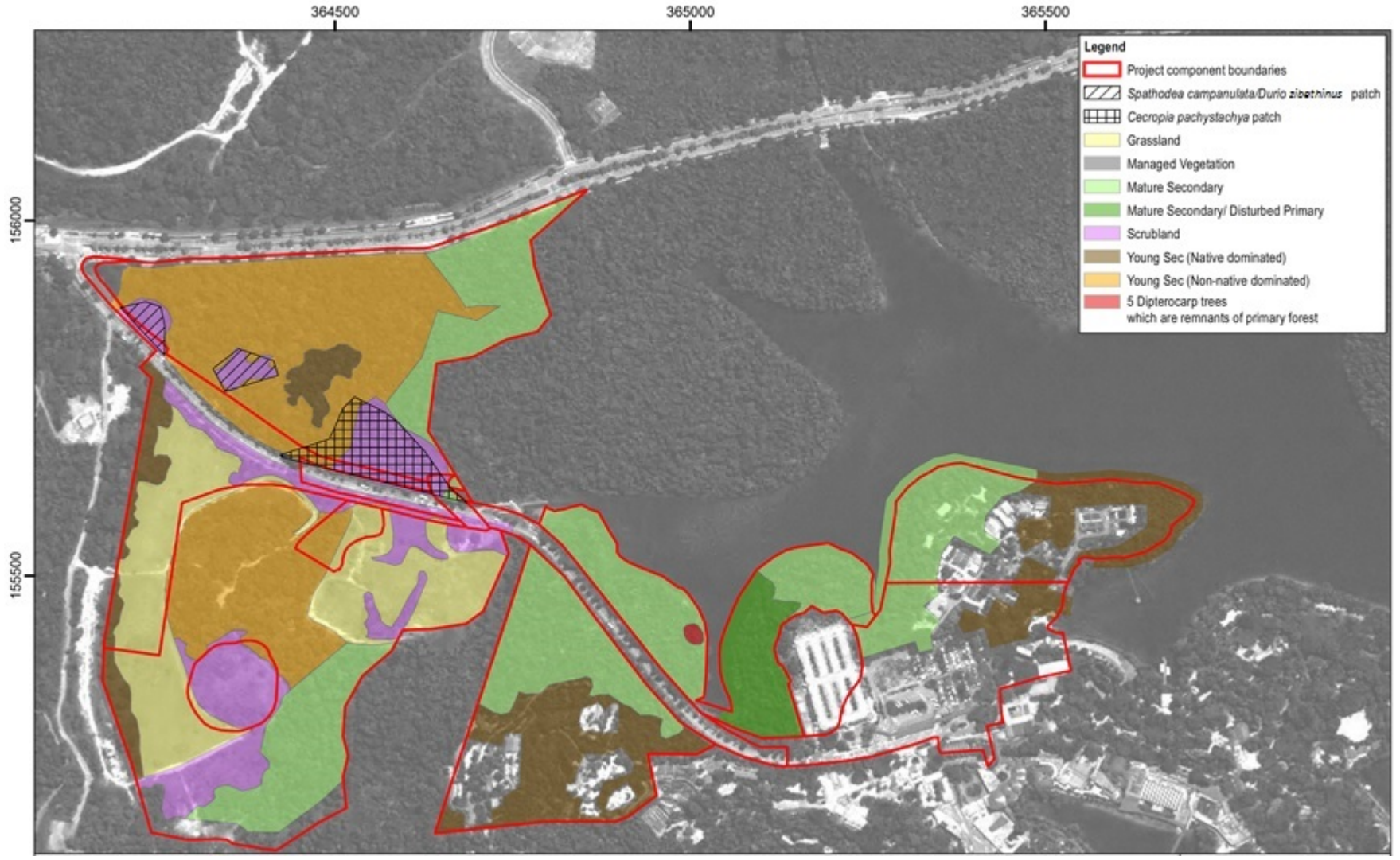


Figure 8.15: Invasive Flora in Relation to the Project Components



8.5.2 *Impacts on Habitats During Construction*

The impact assessment for biodiversity focuses on project components given their likely similar impacts or location within the Project Area. The project components are as follows:

- *East and West Arrival Nodes*
- Mandai Lake Road modifications
- *Eco-Link*
- *Bird Park* and *Rainforest Park North*
- *Rainforest Park South*
- *Boardwalk*
- *Eco-Lodge*
- *Planet Explorer* and *Sri Seletar Point*

The data derived from *Chapter 6, Baseline Environment*, as outlined above has been used to define the magnitude of impacts for each project component. Where the magnitude of impact has not been able to be measured and defined (such as through the definition of an area impact), a qualitative description of the impact has been included.

A description of likely impacts for habitats is shown in (*Table 8.35*) and for species in (*Table 8.36*). These descriptions outline the impacts likely to occur during *construction*. These impacts are highlighted in **bold** in these tables and require mitigation to reduce the severity of impacts. Mitigations for these impacts are outlined in *Section 8.5.4* to *Section 8.5.13* as well as an assessment of likely impact reduction following mitigation.

Impact assessment summaries for the impact types identified are summarised in tables within *Section 8.5.4* to *Section 8.5.13*. These summaries provide an analysis of the significance of these impacts to biodiversity from the project components against the impact assessment criteria as outlined in *Chapter 4.*

Table 8.35: Impact Descriptions for Habitats during Construction

Project Component	Impact Description
Generic Impacts (applies to all Project components)	**Direct Impacts** • **Disturbance and displacement during construction** of resident species will occur due to ancillary construction facilities, human presence, noise, light, dust and/or vibration. These impacts will be focused around the main construction sites of project components. Species displaced will likely move towards refuge sites within the CCNR, as well as land to the south and west of the project area. The duration of these impacts will occur during the entire construction schedule (7 years) however the approximately 2 year period from 2018 to 2020 will see the peak construction period when up to 5 work packages will be constructed concurrently. Once displaced from the Project area during construction, ground dwelling fauna will be prevented from returning to the site through the erection of hoarding/fencing. Construction sequencing will focus on activities in the western portion of the Project Area from Quarter 3, 2016 to Quarter 2, 2020. Construction of the eastern portion will occur from Quarter 3, 2018. • The impacts to fauna will include **changes to behaviours**, increased competition for resources and nocturnal/diurnal changes. Possible dust deposition on flora may also occur as well as disturbances to underground root systems from compaction. Both mobile and less mobile species/territorial species listed in *Table 8.31* will be susceptible to disturbance and displacement due to construction activities. An assessment of likely species impacts has been undertaken in the Species Impact Assessment at *Table 8.36*. • **Restrictions to wildlife movement** will occur from barriers, buildings, and retaining walls adjacent to the construction sites. These restrictions will change and restrict access to foraging, nesting and breeding habitats and restriction of movement for less mobile species. Existing wildlife corridors will be restricted during construction, particularly across Mandai Lake Road running north to south, but also potential east-west movement from the current WRS land to special use land west of the Project area. Wildlife movement will be dependent on the sequencing of the construction of the work packages, and hence it is proposed to prioritise construction of the *Eco-Link* to restore north-south connectivity. Further information on the impact from the construction works schedule is discussed in each of the following project component impact assessments.

Project Component	Impact Description
	• **Mortality from vehicle/machinery strike** may occur during construction activities, especially along Mandai Lake Road and Mandai Road to the north of the Project area. Existing wildlife corridors will be restricted during construction potentially increasing the risk of fauna strike by vehicles during the construction period for each project component. Hoarding (as outlined in *Annex 18*) and fencing will be constructed along portions of Mandai Road and Mandai Lake Road to limit potential wildlife interaction with vehicles during construction. Species most likely to be impacted are mobile and territorial species as shown in *Table 8.31.* **Indirect Impacts** • **Increases in runoff from construction sites**, including paved surfaces and temporary surface water controls from construction sites will occur. Impacts to aquatic habitats include potential scouring of bed and banks of natural waterways, including the unnamed stream, the small stream located north of Mandai Lake Road and other small waterways adjacent to the Upper Seletar Reservoir during the construction period. This may change the characteristics of the habitat type within the waterway. Water sources available to wildlife may also be polluted if not appropriately managed. • **Potential degradation of habitat by invasive species** as a result of introduction, proliferation and/or competition with native species in areas cleared for the construction. Cleared and bare soil surfaces may assist in the germination of invasive species. Invasive species identified to occur within the project site include: *Spathodea campanulata*; *Cecropia pachystachya*; and *Falcataria moluccana*. Introduction of additional invasive species may occur during construction from vehicles and other transmission pathways (waterways, humans and fauna). The areas where these species were identified within the baseline assessment are shown in *Figure 8.15* in relation to the project components. • **Potential degradation of habitat from accidental release of hazardous substances or pollution** from construction equipment. Impacts include damage to aquatic habitats from chemical changes in water causing injury/mortality to extant species. As outlined in *Table 8.26*, the construction schedule indicates that the risk of potential releases of hazardous substances and pollution will occur for a 7 year period during construction, with the peak intensity of construction occurring for a 2 year period between 2018 and 2020. The location of the project components in relation to waterways and forested freshwater habitat is shown in *Figure 8.12.* The *Bird Park*, *Rainforest Park North*, *Rainforest*

Project Component	Impact Description
	Park South and *Boardwalk* have the highest risk of accidental release of pollutants into adjacent waterways given their proximity to the unnamed stream, Upper Seletar Reservoir and other minor streams within the Project area. Further discussion on the risk of pollution on aquatic habitats is contained in the impact assessment for each project component below. • **Water quality impacts from runoff**, including increases in turbidity and possible oil/grease and other pollutant loads. Impacts may include smothering of vegetation, aquatic plant and aquatic fauna mortality from sedimentation, and eutrophication of water bodies. Further discussion on the risk of pollution on habitats is contained in the impact assessment for each project component below. The risk of water quality impacts from construction will occur for a 7 year period. • **Competition for resources/conflict between wildlife** from changes in habitat resource availability/exclusion from habitats. Impacts to fauna are likely as they move away from threats from construction in existing habitats to new areas such as the CCNR and land to the west and south of the Project area. Hoarding will be erected to limit re-entry of ground-dwelling fauna into construction sites and will be replaced by permanent fencing during operations. Nearby refuge areas are likely to contain existing populations of fauna, increasing competition for resources. Existing wildlife corridors will be restricted during construction, potentially increasing the risk of resource conflict in refuge areas within the CCNR and areas in the vicinity of the Project area. • **Potential mortality of fauna from hunting and poaching** as a result of worker influx and community access. This may include mortality of individuals and a reduction in populations. Of particular concern is hunting for the Sunda Pangolin (*Manis javanica*). The construction work schedule indicates that the risk of hunting and poaching by workers will extend over the 7 year period from Quarter 3, 2016 until Quarter 2, 2023. • **Habitat creation for species requiring management** such as invasive plant species and mammals accessing domestic waste generated on site. The species identified as requiring management include rodents (non-native rats and mice), Long-tailed Macaque (*Macaca fascicularis*) and Wild Boar (*Sus scrofa*) as well as invasive plants and weeds. The areas where these species were identified within the baseline assessment are shown in *Figure 8.15* in relation to the Project components. Discussion on the likely human conflict with fauna species requiring management is outlined in *Table 8.36*.

Project Component	Impact Description
	Related Species Impacts (*See separate Species Impact Assessment in Section 8.5.3*) The following species will be impacted during the construction of the Project components according to the construction schedule shown in *Table 8.26*: • Highly mobile and territorial species listed in *Table 8.31*, including the Sunda Pangolin (*Manis javanica*) and Lesser Mouse Deer (*Tragulus kanchil*) may be impacted from clearing of habitats utilised for movement, breeding and foraging. These species may relocate to surrounding habitats within the CCNR and to the area west of the Project area; however territorial species may conflict with existing populations in these areas. • Bird species, including the White-rumped Shama (*Copsychus malabaricus*), Blue crowned hanging Parrot (*Loriculus galgulus*) and the Red-crowned barbet (*Megalaima rafflesii*), from the clearing of trees that are utilised for roosting, nesting and feeding. These species are likely to disburse to other suitable habitats within the project vicinity. • Arboreal mammal species including the Malayan Colugo (*Cynocephalus variegatus*) and Horsfield's Flying Squirrel (*Iomys horsfieldii*) from disturbance and displacement during construction and a reduction in habitat and resource availability. These species are likely to relocate to suitable habitat within the surrounding landscape, however species such as the Malayan Colugo are territorial and may conflict with existing populations. • Forest dwelling herpetofauna, including the Singapore Bent-toed Gecko (*Cyrtodactylus majulah*), Red-necked Bronzeback (*Dendrelaphis kopsteini*), Black Bearded Flying Dragon (*Draco melanopogon*) and Striped Sun Skink (*Eutropis multifasciata*) from disturbance and displacement during construction and a reduction in habitat and resource availability. These species are generally less mobile and may suffer mortality if not relocated from project component areas prior to construction and construction activities are not sensitively carried out. • Freshwater dependent birds and herpetofauna including the Purple Heron (*Ardea purpurea*), Grey Heron (*Ardea cinerea*), Black Crowned Night Heron (*Nycticorax nycticorax*) and Grey-Headed Fish Eagle (*Ichthyophaga ichthyaetus*) and Yellow-ringed Cat Snake (*Boiga dendrophila*) and Golden-eared Rough-sided Frog (*Hylarana baramica*) from disturbance and displacement during construction and a reduction in habitat and resource availability.

Project Component	Impact Description
	• Insects reliant on forests and grasslands for breeding and foraging, including the Spotted Judy (*Abisara geza niya*), Yellow Chequered Lancer (*Plastingia pellonia*) and Handsome Grenadier (*Agrionoptera sexlineata*) from disturbance and displacement during construction and a reduction in habitat and resource availability. These species generally have a short lifecycle and may be extirpated from cleared habitats during construction. Invertebrates are likely to recolonise landscaped and forested areas where there is suitable habitat available from populations in adjacent habitats, including the CCNR, buffer areas and setbacks. • Aquatic macroinvertebrates and fish from water runoff and pollution from work sites entering the unnamed stream, the small stream located north of Mandai Lake Road and small waterways entering the Upper Seletar Reservoir. The location of forested freshwater habitat in relation to the Project components is shown in *Figure 8.12*. • Migratory species from disturbance and displacement during construction and a reduction in habitat and resource availability. Disturbance to migratory species is expected to occur across 7 years, leading to migratory species being displaced and seeking other locations. The period of highest impact will be the approximately 2 year period from 2018 to 2020 i.e. peak construction period when up to 5 work packages will be constructed concurrently, albeit at different stages of completion.
Specific Impacts from Construction of the East and West Arrival Nodes	**Project Description Summary** • The construction of the *West and East Arrival Nodes* is proposed to occur from Quarter 3, 2016 until Quarter 2, 2020 and Quarter 3, 2018 until Quarter 3, 2021, respectively. The total construction period will be approximately 48 months for the *West Arrival Node* and 39 months for the *East Arrival Node*. The construction will involve the demolition of the existing car park structures at the *East Arrival Node* and piling and construction activities for both Nodes. Construction will result in the clearing of vegetation and the excavation of ground level areas to accommodate underground structures and carparks. Construction activities will include the use of noise generating machinery during daylight hours.

Project Component	Impact Description
	Direct Impacts • The construction of the *East and West Arrival Nodes* will exclude wildlife access to existing habitat within the Project area and clear habitat prior to construction activities. The area of habitat impacted is outlined as follows:

	Disturbed Primary Forest Habitat (m^2)	Secondary forest habitat (m^2)	Grassland habitat (m^2)	Forested freshwater habitat (m^2)	Total (m^2)
Habitat retained	-	36,364	-	-	**36,364**
Habitat cleared	-	34,407	24,841	4,387	**63,635**
Habitat enclosed	-	-	-	-	**-**

• The area of existing habitat that will be cleared as a result of construction of the *East and West Arrival Nodes* will be 63,635 m^2, impacting species that currently utilise these areas. Retained forested habitat may be prone to impact from microburst storm activity during construction.

• **Disturbance and displacement** due to construction activities of the *East* and *West Arrival Nodes* is likely to disturb fauna in adjacent areas, including forested areas to the west of the Project site and Secondary forest habitats adjacent to the *East Arrival Node*. Noise sources will include construction noise, piling and machinery/vehicles (further assessment in relation to noise impacts has occurred at *Section 8.5.13*). Species sensitive to noise will be disturbed during the construction period and are likely to seek refuge within CCNR south and north of the Project area, the WRS site and forested areas to the west of the Project area. Dust will be generated from demolition and construction activities, potentially depositing on leaves and affecting the photosynthetic capacity of flora (rainfall is likely to wash dust off, but may impact flora, especially during the inter-monsoon periods). This will cause impacts to sensitive species within the CCNR during the construction period. Fauna will be relocated prior to construction and are likely to avoid the area until the work package is completed. Flora within the CCNR and adjacent areas may be impacted by dust deposition.

• **Edge effects on habitats** will occur in forested areas adjacent to the *East* and *West Arrival Node* construction activities. The *East Arrival Node* will be constructed within an existing disturbed area and hence edge effects are likely to be minimal. Forested areas adjacent to the *West Arrival Node* (including forested habitats both north and south of Mandai

Project Component	Impact Description
	Lake Road, and the forested freshwater habitat adjacent to the unnamed stream may be impacted from hoardings and construction activities. Impacts on habitats from adjacent hoardings and building construction activities may also lead to edge impacts. Impacts may include heat and light reflection into forested areas causing drying out of forest edges. Dust may also be emitted from construction sites, depositing on surrounding vegetation. This is likely to be an issue only during extended periods of low rainfall. • **Restrictions to wildlife movement** will occur from hoardings erected around the construction areas for the *East* and *West Arrival Nodes*. Restrictions for fauna will occur around the edge of the Project component and adjacent forested areas. Fauna will be relocated prior to construction and, once displaced, ground dwelling fauna species will be prevented from re-entering the Project site. **Indirect Impacts** • **Increases in runoff** from paved surfaces and temporary surface water controls from construction activities. Paved areas will be created for the construction of the *Arrival Nodes*, increasing runoff. **Related Species Impacts** • Species related impacts are likely from the construction of this Project component and these have been assessed separately in the Species Impact Assessment *in Section 8.5.3*. These species impacts relate to the exclusion of fauna from the Project component area and potential strike of mobile fauna by construction vehicles and equipment during the construction of this Project component. The relocation of fauna prior to construction will also impact species that are territorial in nature or are less mobile (see *Table 8.31* and *Table 8.32* above for a list of these species).
Specific Impacts from modifications to Mandai Lake Road	**Project Description Summary** • The modifications to Mandai Lake Road are proposed to occur as part of Packages B and D, including the construction of a People Mover System, widening of Mandai Lake Road and associated construction for the *Arrival Nodes* and *Eco-Link*. The construction period will occur from Quarter 2, 2017 until Quarter 3, 2020 (42 months) for Package B; and from

Project Component	Impact Description
	Quarter 3, 2018 until Quarter 3, 2021 for Package D (39 months). The existing Mandai Lake Road may be widened but kept within the existing 30 m road reserve and will not encroach upon the CCNR. • Impacts will occur from the minor clearing of habitats along the road reserve. Some excavation will occur within the existing road reserve. Construction activities will include the use of noise generating machinery during daylight hours. Retained habitat may be prone to impact from microburst storm activity during construction. **Direct Impacts** • The modification of Mandai Lake Road will exclude wildlife access to existing habitat within the Project area and clear habitat prior to construction activities. It is not anticipated that substantial clearing of existing habitat will occur during construction as all work will occur within the existing road reserve. The development will avoid the existing Alstonia trees along Mandai Lake Road (which provide connections for arboreal fauna) as a first priority. If individual conservation significant trees are required to be cleared, a separate approval will be obtained from NParks. • **Disturbance and displacement**: the modification of Mandai Lake Road is likely to disturb fauna in adjacent areas, including the CCNR adjacent to the existing road reserve. Species sensitive to noise will be disturbed during the construction period and are likely to seek refuge within the CCNR south and north of the Project area, the WRS site and forested areas to the west of the Project area. Noise sources will include construction noise, piling and machinery/vehicles (further assessment in relation to noise impacts has occurred at *Section 8.5.13*). This will cause impacts to sensitive species within the CCNR during the construction period. Dust will be generated from demolition and construction activities, potentially depositing on leaves and affecting the photosynthetic capacity of flora (rainfall is likely to wash dust off, but may impact flora, especially during the inter-monsoon periods). Fauna will be relocated within the project component area prior to construction. Once displaced from the Project area during construction, ground dwelling fauna will be prevented from returning to the site through the erection of hoarding/fencing. Flora may be impacted temporarily by dust deposition. • **Edge effects on habitats** will occur in areas adjacent to the Mandai Lake Road activities that will also be subject to construction activities (Package A, B and D). It is not envisioned that significant additional edge effects will occur during

Project Component	Impact Description
	modification of Mandai Lake Road. Edge effect impacts from the road modification adjacent to the CCNR may occur from the erection of hoardings during construction. Impacts may include heat and light reflection into forested areas causing drying out of forest edges. Dust may also be emitted from construction sites, depositing on surrounding vegetation. This is likely to be an issue only during extended periods of low rainfall. • **Restrictions to wildlife movement** will occur from hoardings erected adjacent to the length of Mandai Lake Road. During the modifications, restrictions for fauna will occur on both the northern and southern sides, including the approximately 120 metres that is immediately adjacent to the CCNR. Impacts may occur for highly mobile and mobile fauna listed in *Table 8.31* that move north to south across Mandai Lake Road and within the CCNR. Once displaced from the Project area during construction, ground dwelling fauna will no longer be able to access the Project site. **Indirect Impacts** • **Increases in runoff** from paved surfaces and temporary surface water controls from construction activities. Paved areas will be created for the construction of the Mandai Lake Road modifications, increasing runoff. Further assessment of impacts on water quality from construction is described in *Section 8.3 Soil and Groundwater*. **Related Species Impacts** • Species related impacts are likely and have been assessed separately in the Species Impact Assessment in *Section 8.5.3*. These species impacts relate to potential strike by construction vehicles and equipment during the construction of this Project component. Restriction of movement for species who reside in areas north and south of Mandai Lake Road are likely. The relocation of fauna prior to construction will also impact species that are territorial in nature as well as mobile species (see *Table 8.31* and *Table 8.33* for a list of species potentially impacted).
Specific Impacts from Construction of the *Eco-Link*	**Project Description Summary** • The construction of the *Eco-Link* is proposed to occur from Quarter 2, 2017 until Quarter 1, 2019 (total 24 months). The *Eco-Link* crosses over Mandai Lake Road, flaring out immediately on both sides to a broad landing. The *Eco-Link* will be

Project Component	Impact Description
	constructed wholly within the buffer areas of the *Rainforest Park North* and *Bird Park*, on the northern and southern sides of Mandai Lake Road. Use of a retaining wall will be less intensive on the north side due to the elevated terrain profile, thus mitigating impacts on north side landing. Earth cutting on the south side will be necessary for the construction of the retaining wall next to the CCNR. Earth cutting works will not encroach on the CCNR at any time. The construction will involve piling within the existing road reserve, construction of the retaining wall and *Eco-Link* deck. Construction activities will include the use of noise generating machinery during daylight hours. **Direct Impacts** • **Clearing** for the construction of the *Eco-Link* will exclude wildlife access to existing habitat within the Project area. Minimal clearing will occur as part of the construction of the *Eco-Link* within the buffer areas. • **Edge effects on habitats** will occur in areas adjacent to the *Eco-Link* construction activities and within the buffer areas. Adjacent hoardings and building construction activities may also lead to edge impacts on habitats. Impacts may include heat and light reflection into forested areas causing drying out of forest edges. Dust may also be emitted from construction sites, depositing on surrounding vegetation. This is likely to be an issue only during extended periods of low rainfall. • **Restrictions to wildlife movement** will occur from the erection of hoardings and the construction of retaining walls adjacent to Mandai Lake Road and the *Eco-Link*. During the construction period, temporary restrictions for fauna will occur within the footprint of the *Eco-Link* in the buffer areas. Impacts will be likely for highly mobile and mobile fauna listed in *Table 8.31* that move north and south across Mandai Lake Road in the vicinity of the CCNR. • **Disturbance and displacement** during piling and construction activities of the *Eco-Link* is likely to disturb fauna. The construction will involve piling within the existing road reserve, construction of the retaining wall and *Eco-Link* deck. Noise sources will include construction noise, piling and machinery/vehicles (further assessment in relation to noise impacts has occurred at *Section 8.5.13*). Species sensitive to noise will be disturbed during the construction period and are likely to seek refuge within the CCNR south and north of the Project area, the WRS site and forested areas to the west of the Project area. This will cause impacts to sensitive species within the CCNR during the construction period. Fauna

Project Component	Impact Description
	will be relocated within the project component area prior to construction and are likely to avoid the area until the work package is completed. Dust will be generated from demolition and construction activities, potentially depositing on leaves and affecting the photosynthetic capacity of flora (rainfall is likely to wash dust off, but may impact flora, especially during the inter-monsoon periods). **Related Species Impacts** • Species related impacts are likely and have been assessed separately in the Species Impact Assessment in Section *8.5.3*. These species impacts relate to the exclusion of fauna from the Project component area and potential strike by construction vehicles and equipment during the construction of this Project component. Specific species impacts are likely for forest dependent mobile bird and mammal species (including nocturnal species) that currently cross Mandai Lake Road to move within and adjacent to the CCNR.
Specific Impacts from Construction of the *Bird Park* & *Rainforest Park North*	**Project Description Summary** • The construction of the *Bird Park* and *Rainforest Park North* is proposed to occur from Quarter 4, 2016 until Quarter 2, 2020. The new *Bird Park* comprises walk-in aviaries, a netted amphitheatre, an indoor exhibit area, smaller individual aviaries and Back-of-House facilities to support the operations of the park. Built structures in the *Rainforest Park North* will generally be limited to impacted areas and running along the edge of the park adjacent to Mandai Road. A main circulation spine will link the two large netted enclosures. • A 45-50 m buffer will be kept along the western edge of the CCNR adjacent to the *Bird Park* (southern side of Mandai Lake Road) and *Rainforest Park North* (northern side of Mandai Lake Road). Aside from the construction of the *Eco-Link*, vegetation in the buffer will be retained and there will be no other construction activities of any type within the buffer. Fencing and management of the *Bird Park* and *Rainforest Park North* will be employed to reduce the risk of escapees. Stone markers will be used to demarcate the boundary between the buffer and CCNR. At the edge of the buffer zone, security fencing will be erected which also functions as a drift fence to guide ground-dwelling animals onto the *Eco-Link*. The total construction period is estimated to be 45 months. The construction will involve the construction of enclosures, buildings and roads/trails. Construction activities will include the use of noise generating machinery and

cranes to erect enclosures during daylight hours.

Direct Impacts

- **Clearance of vegetation** from the construction of the *Bird Park* and *Rainforest Park North* will clear habitat and reduce wildlife access to existing habitat within the Project area. A significant area of existing habitat will be enclosed and hence unavailable for the majority of species currently using it. A total area of 57,463 m^2 of habitat will be cleared to make way for landscaped areas, enclosures, buildings, pathways and other infrastructure. A total of 83,827 m^2 of habitat will be enclosed within attractions. A total of 104,709 m^2 of habitat will be retained outside of enclosures. The areas are outlined as follows:

	Disturbed Primary Forest Habitat (m^2)	Secondary forest habitat (m^2)	Grassland habitat (m^2)	Forested freshwater habitat (m^2)	Total (m^2)
Habitat retained	-	101,964	609	2,136	**104,709**
Habitat cleared	-	17,220	40,146[#]	97	**57,463**
Habitat enclosed	-	83,827	-	-	**83,827**

Note:
[#] Grassland habitats will be converted to landscaped areas that will contain a mix of forested areas and managed grasslands.

- **Restrictions to wildlife movement** will occur from hoardings erected for the construction of the *Bird Park* and *Rainforest Park North* attractions and Back-of-House area. Prior to the construction of the *Bird Park* and *Rainforest Park North*, hoarding will be erected and fauna relocated. Once displaced from the Project area during construction, ground dwelling fauna will no longer be able to access the Project site. As a result, restrictions on fauna movement along the boundary of Mandai Road to the north, Mandai Lake Road (north and south sides) and the western side of the CCNR will essentially be permanent from the time of construction.

- **Disturbance and displacement** due to construction activities of the *Bird Park* and *Rainforest Park North* are likely to disturb fauna in adjacent areas, including the CCNR. Noise sources will include construction noise, piling and machinery/vehicles (further assessment in relation to noise impacts has occurred at *Section 8.5.13n*). Species

Project Component	Impact Description

	sensitive to noise will be disturbed during the construction period and are likely to seek refuge within the CCNR south and north of the Project area, the WRS site and forested areas to the west of the Project area. Fauna will be relocated from within the Project area prior to construction and are likely to avoid the area until the work package is completed. Once displaced from the Project area during construction, ground dwelling fauna will no longer be able to access the Project site. Dust will be generated from demolition and construction activities, potentially depositing on leaves and affecting the photosynthetic capacity of flora (rainfall is likely to wash dust off, but may impact flora, especially during the inter-monsoon periods).
	
	• **Edge effects on habitats** will occur in areas adjacent to the *Rainforest Park North* and *Bird Park* construction activities. A 45- 50 m buffer will be created adjacent to the western edge of the CCNR to reduce edge effects. Potential edge effects may occur from enclosures and attractions located near to the CCNR. Potential escape of attraction fauna may enter the CCNR if not appropriately managed. Transmission of disease from captive fauna to native fauna within the Project area and CCNR may also occur if not appropriately managed. Impacts on habitats from adjacent hoardings and building construction activities may also lead to edge effects. Impacts may include heat and light reflection into forested areas causing drying out of forest edges. Dust may also be emitted from construction sites, depositing on surrounding vegetation. Dust deposition is likely to be an issue only during extended periods of low rainfall during inter-monsoon periods.
	
	• The approximate length of edge effects adjacent to forested areas include:
	  • Disturbed primary/secondary forest from construction of the *Rainforest Park North* is 480 m on the eastern side adjacent to the buffer;
	  • Forested freshwater habitat from construction of the *Bird Park* is 420 m on the western side towards the unnamed stream; and
	  • Disturbed primary/secondary forest from the *Bird Park* construction is 660 m on the eastern side adjacent to the buffer.

Project Component	Impact Description
	Indirect Impacts • **Increased runoff** from paved surfaces and temporary surface water controls from construction activities. Paving will be used during construction for the *Bird Park* and *Rainforest Park North*, increasing runoff that will flow west towards the unnamed stream. The impacts of increased flows include potential scouring of the beds and banks of waterways, changing the morphology of channels and affecting habitats. **Related Species Impacts** • Species related impacts are likely and have been assessed separately in *Section 8.5.1.4*. These species impacts relate to potential strike by construction vehicles and equipment during the construction of this Project component. • Grassland dependent birds and bats that utilise grassland habitats for foraging in the proposed *Bird Park* such as the Scaly-breasted Munia (*Lonchura punctulata*), Chestnut Munia (*Lonchura atricapilla*), Baya Weaver (*Ploceus philippinus*) and the Lesser Bamboo Bat (*Tylonycteris pachypus*) will have a reduction in available habitat resources and will be displaced during construction. • Arboreal mammals including the Banded Leaf Monkey (*Presbytis femoralis*) may be affected by the loss of trees for foraging and movement by the construction of the *Bird Park* and *Rainforest Park North*. The species may also be impacted by noise and vibration during construction, and is likely to vacate habitat within this area. • Ground dwelling mammals such as the Sunda Pangolin (*Manis javanica*) and Lesser Mouse Deer (*Tragulus kanchil*), will be displaced during construction. It is likely that this area contains suitable breeding habitat (Sunda Pangolin dens) and foraging habitat for both species. Once displaced from the Project area during construction, ground dwelling fauna will no longer be able to access the Project site. Displaced individuals are likely to seek refuge in suitable nearby habitats. There is a chance that these refuge areas may already contain populations, leading to conflict over resources.

<table>
<tr><th>Project Component</th><th>Impact Description</th></tr>
<tr><td>Specific Impacts from Construction of the Rainforest Park South</td><td>
Project Description Summary

• Development of the Rainforest Park South entails the repurposing of the western portion of the existing Night Safari land. The area will contain 2 large habitats within netted enclosures. It is proposed to retain patches of existing dense forest and trees of conservation significance. All buildings and structures will be setback 25 m from the boundary of the CCNR so as to be protected from the possibility of treefall from the nature reserve.

• The construction of the Rainforest Park South will occur as part of Package C (South) and is proposed to occur from Quarter 3, 2020 to Quarter 2, 2023 (total 36 months). The works will involve the construction of buildings and the erection of enclosures. Construction activities will include the use of noise generating machinery during daylight hours.

Direct Impacts
• The construction of the Rainforest Park South will exclude wildlife access to existing habitat within the Project area, as follows:
<table>
<tr><th></th><th>Disturbed Primary Forest Habitat (m^2)</th><th>Secondary forest habitat (m^2)</th><th>Grassland habitat (m^2)</th><th>Forested freshwater habitat (m^2)</th><th>Total (m^2)</th></tr>
<tr><td>Habitat retained</td><td>-</td><td>23,545</td><td>-</td><td>-</td><td>23,545</td></tr>
<tr><td>Habitat cleared</td><td>-</td><td>3,997</td><td>-</td><td>-</td><td>3,997</td></tr>
<tr><td>Habitat enclosed</td><td>-</td><td>29,937</td><td>-</td><td>-</td><td>29,937</td></tr>
</table>
• During construction, there will be 3,997 m^2 cleared and 29,937 m^2 of habitat enclosed to accommodate the Rainforest Park South. Approximately 23,545 m^2 of habitat will be retained. Retained habitat may be prone to impact from microburst storm activity during construction. All trees of conservation significance will be retained as a first priority. If individual trees of conservation significance require removal, a separate approval will be obtained from NParks.

• Restrictions to wildlife movement will occur from hoardings erected adjacent to the Rainforest Park South. Fauna will be relocated prior to construction. Restriction of fauna movement will occur along the boundary of the CCNR to the west of the Rainforest Park South during construction.
</td></tr>
</table>

Project Component	Impact Description
	• **Disturbance and displacement** due to construction activities of the *Rainforest Park South* which are likely to disturb fauna in the CCNR. Noise sources will include construction noise, piling and machinery/vehicles (further assessment in relation to noise impacts has occurred at *Section 8.5.13*). Species sensitive to noise will be disturbed during the construction period and are likely to seek refuge within the CCNR south and north of the Project area, the WRS site and forested areas to the west of the Project area. This will cause impacts to sensitive species within the CCNR during the construction period. Fauna will be relocated within the project component area prior to construction and are likely to avoid the area until the work package is completed. Dust will be generated from demolition and construction activities, potentially depositing on leaves and affecting the photosynthetic capacity of flora (rainfall is likely to wash dust off, but may impact flora, especially during the inter-monsoon periods). • **Edge effects on habitats** in areas adjacent to the *Rainforest Park South* for primary/secondary forest is 495 m on the western side. Potential edge effects may occur from enclosures and attractions located near to the CCNR during construction. This area is currently utilised by the *Night Safari* immediately adjacent to the CCNR and currently has extant edge effects from these operations. Impacts on habitats from adjacent hoardings and building construction activities may also lead to edge impacts. Impacts may include heat and light reflection into forested areas causing drying out of forest edges. Dust may also be emitted from construction sites, depositing on surrounding vegetation. This is likely to be an issue only during extended periods of low rainfall. • **Restrictions to wildlife movement** will occur from temporary barriers adjacent to the CCNR during construction. Prior to the construction of *Rainforest Park South*, hoarding will be erected and fauna relocated. Restrictions of fauna movement during construction will occur along the eastern side of the CCNR. Once displaced from the Project area during construction, ground dwelling fauna will no longer be able to access the Project site. **Indirect Impacts** • **Increased runoff** from paved surfaces and temporary surface water controls from construction activities. Paving will be used during construction for the *Rainforest Park South*, increasing runoff that will flow to lower points towards the Upper Seletar Reservoir. It should be noted that a commitment has been made to not discharge any water from the Project area into the Upper Seletar Reservoir.

Project Component	Impact Description
	Related Species Impacts • Species related impacts are likely and have been assessed separately in the Species Impact Assessment in *Section 8.5.1.4*. These species impacts relate to potential strike by construction vehicles and equipment during the construction of this Project component. Fauna will be relocated prior to construction and hoarding erected to prevent re-entry into construction sites. Woodland dependent bird species, arboreal mammals and other forest dwelling species will be displaced during construction activities. Sensitive fauna species in adjoining areas within the CCNR may also be impacted by noise and vibration during construction, and are likely to temporarily vacate habitat within this area. • Bird species, including the White-rumped Shama (*Copsychus malabaricus*), Blue-crowned hanging Parrot (*Loriculus galgulus*) and the Red-crowned barbet (*Megalaima rafflesii*), were detected in this area and may be disturbed during construction. • Arboreal mammal species including the Malayan Colugo (*Cynocephalus variegatus*), Greater Bamboo Bat (*Tylonycteris pachypus*) and Horsfield's Flying Squirrel (*Iomys horsfieldii*) were detected in this area and may be impacted by disturbance and displacement during construction and a reduction in habitat and resource availability. These species are likely to relocate to suitable habitat within the surrounding landscape; however species such as the Malayan Colugo are territorial and may conflict with existing populations.
Specific Impacts from Construction of the *Boardwalk*	**Project Description Summary** • The proposed *Boardwalk* is planned within the land boundary of the *Singapore Zoo*, *River Safari* and *Night Safari* and will skirt the edge of the Upper Seletar Reservoir with a total length of approximately 5 km. The majority of the *Boardwalk* will span over existing and upgraded drains that are currently in place around the edge of the Upper Seletar Reservoir. The width proposed for the *Boardwalk* is 2 m to 3 m. Construction of the *Boardwalk* will minimise the clearing of vegetation and avoid flora of conservation significance. The *Boardwalk* will be elevated above the drain and constructed so as not to significantly increase beyond the footprint of the drain. The design will facilitate animal movement across the open drain by placing covers across the drain underneath the *Boardwalk* at regular intervals. In case of the need for realignment due to localised site constraints, approvals from relevant agencies will be sought. The

Project Component	Impact Description
	construction period for the *Boardwalk* is estimated to be from Quarter 1, 2018 to Quarter 3, 2020 (total of 33 months). **Direct Impacts** • **Clearing of vegetation/habitat** during construction is likely to be minimal. Some minor clearing of ground and mid-storey vegetation around the existing drain may be required to provide access for construction equipment. All existing trees of conservation significance are planned to be retained. If the final design indicates that trees will be removed, this will be subject to approval from NParks. • **Restrictions to wildlife movement** will occur from *Boardwalk* construction areas. The *Boardwalk* will be constructed using prefabricated components transported onto the site. The areas to be restricted will be immediately surrounding the installation area. This will result in fauna being unable to access forested areas within the WRS site from water edge environments of the Upper Seletar Reservoir. This will occur for a total of 33 months from the start of construction. • **Disturbance and displacement** due to construction activities of the *Boardwalk* is likely to disturb fauna within the WRS area. Species sensitive to noise will be disturbed during the construction period and are likely to seek refuge within the WRS site. Noise sources will include construction noise from machinery (further assessment in relation to noise impacts has occurred at *Section 8.5.13*). Water edge dependent species will likely disburse to the northern and southern edge of the Upper Seletar Reservoir. This will cause impacts to sensitive species over the construction period. Dust will be generated from construction activities, potentially depositing on leaves and affecting the photosynthetic capacity of flora (rainfall is likely to wash dust off, but may impact flora, especially during the inter-monsoon periods).
	Indirect Impacts • **Potential Impacts on water quality** and increases in runoff into the Upper Seletar Reservoir from construction of the *Boardwalk* impacting on aquatic species. The impacts of increased flows include overland flow into the Upper Seletar Reservoir. It should be noted that a commitment has been made to not discharge any water from the Project area into the Upper Seletar Reservoir.

<table>
<tr><th>Project Component</th><th>Impact Description</th></tr>
<tr><td></td><td>Related Species Impacts

• Freshwater dependent birds and herpetofauna including the Purple Heron (Ardea purpurea), Grey Heron (Ardea cinerea), Black Crowned Night Heron (Nycticorax nycticorax) and Grey-Headed Fish Eagle (Ichthyophaga ichthyaetus) and herpetafauna including the Yellow-ringed Cat Snake (Boiga dendrophila) and Golden-eared Rough-sided Frog (Hylarana baramica) may be disturbed from water-edge habitats during construction. These species are likely to be temporarily disturbed, however they are likely to seek alternative suitable habitat in the vicinity during construction.</td></tr>
<tr><td>Specific Impacts from Construction of the Eco-Lodge</td><td>Project Description Summary

• The Eco-Lodge site will consist of full-service hotel amenities and will be operational 24 hours a day all year around to accommodate guests. As such, lighting will need to be in place 24 hours a day for safety and security purposes. The overall building form and height will respect existing tree lines and will be integrated with the surrounding landscape. Up to 400 rooms and family accommodation units will be located at the site. As many as possible of the existing mature trees at this site will be retained as a first priority.

• The construction of the Eco-Lodge as part of Package F is proposed to occur from Quarter 4, 2019 to Quarter 2, 2023 (construction period will be 45 months). The construction will involve the demolition of existing small buildings within this area. Construction will result in the clearing of vegetation and the excavation of ground level areas for piling construction. Construction activities will include the use of noise generating equipment used for demolition and construction machinery during daylight hours.

Direct Impacts
• The construction of the Eco-Lodge will exclude wildlife access to existing habitat within the Project area, as follows:
<table>
<tr><th></th><th>Disturbed Primary Forest Habitat (m^2)</th><th>Secondary Forest Habitat (m^2)</th><th>Grassland Habitat (m^2)</th><th>Forested Freshwater Habitat (m^2)</th><th>Total (m^2)</th></tr>
<tr><td>Habitat retained</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Habitat cleared</td><td>-</td><td>38,291</td><td>-</td><td>-</td><td>38,291</td></tr>
<tr><td>Habitat enclosed</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
</table></td></tr>
</table>

Project Component	Impact Description
	• **Clearing of vegetation/habitat** will occur to accommodate the building footprint for the *Eco-Lodge*. The intention is to retain all trees of conservation significance within the footprint area. If individual trees are required to be removed, this will be subject to separate approval by NParks. Retained habitat may be prone to impact from microburst storm activity during construction. • **Edge effects on habitats** will occur in areas adjacent to the *Eco-Lodge* construction area from the erection of hoardings adjacent to forested areas. The length of edge effect disturbance adjacent to the *Eco-Lodge* boundary is estimated to be 830 m. These impacts will occur from adjacent hoardings and building construction activities. Impacts may include heat and light reflection into forested areas causing drying out of forest edges. Dust may also be emitted from construction sites, depositing on surrounding vegetation. This is likely to be an issue only during extended periods of low rainfall. • **Restrictions to wildlife movement** will occur from hoardings adjacent to the *Eco-Lodge* construction areas. • **Disturbance and displacement** due to construction activities of the *Eco-Lodge* is likely to disturb fauna within the adjacent forested habitats of the WRS site, and also possibly along the edges of the Upper Seletar Reservoir. Noise sources will include construction noise, piling and machinery/vehicles (further assessment in relation to noise impacts has occurred at *Section 8.5.13*). Species sensitive to noise will be disturbed and are likely to seek refuge within the WRS site and the CCNR during the construction period. Fauna will be relocated within the project component area prior to construction and are likely to avoid the area until the work package is completed. Dust will be generated from demolition and construction activities, potentially depositing on leaves and affecting the photosynthetic capacity of flora (rainfall is likely to wash dust off, but may impact flora, especially during the inter-monsoon periods).
	Indirect Impacts • **Increased runoff** from paved surfaces and temporary surface water controls from construction activities. The impacts of increased flows include potential increasing surface flows towards the Upper Seletar Reservoir. It should be noted that a commitment has been made to not discharge any water from the Project area into the Upper Seletar Reservoir.

Project Component	Impact Description
	Related Species Impacts • Species related impacts are likely and have been assessed separately in the Species Impact Assessment in *Section 8.5.1.4*. These species impacts relate to disturbance during construction. Fauna will be relocated prior to construction and hoarding erected to prevent re-entry into construction sites. Water edge dependent species, woodland dependent bird species, arboreal mammals and other forest dwelling species will be displaced during construction activities. • Waterside dwelling birds such as the Purple Heron (*Ardea purpurea*), Grey Heron (*Ardea cinerea*), may be impacted from reductions in access to shorelines during construction. The species in adjoining areas within the WRS area and adjacent forested habitat of the Upper Seletar Reservoir may also be impacted by noise and vibration during construction, and are likely to temporarily vacate habitat this area. • Arboreal mammal species detected in this area including the Malayan Colugo (*Cynocephalus variegatus*) and Horsfield's Flying Squirrel (*Iomys horsfieldii*) from disturbance and displacement during construction and a reduction in habitat and resource availability. These species are likely to relocate to suitable habitat within the surrounding landscape; however species such as the Malayan Colugo are territorial and may conflict with existing populations.
Specific Impacts from the *Planet Explorer / Sri Seletar Point Construction*	**Project Description Summary** • The *Planet Explorer and Sri Seletar Point* project component will consist of a 3 storey high museum and exhibition building housing an indoor nature-themed entertainment facility. Function rooms, training rooms and ancillary facilities will be included within the buildings. Mature Secondary/ Disturbed Primary and Secondary forest habitats in the vicinity of the *Planet Explorer and Sri Seletar Point* (refer to *Figure 2.12*) have been identified for retention and there will be no development works carried out in these areas of retained forest. • The construction of the *Planet Explorer / Sri Seletar Point* is proposed to occur as part of Package E from Quarter 3, 2019 until Quarter 2, 2022 (total of 36 months). The construction will involve the erection of buildings, construction of paths and other facilities. Clearing of habitats and some excavation will occur for site preparation. Construction activities

Project Component	Impact Description
	will include the use of noise generating machinery during daylight hours. **Direct Impacts** • The construction of the *Planet Explorer / Sri Seletar Point* will avoid forested areas of high biodiversity values. The adjacent Disturbed Primary/Mature Secondary forest and forest adjacent to the Upper Seletar Reservoir to the north of the Project component will be retained. • All trees of conservation significance are planned to be retained as a first priority. Where an individual tree of conservation significance is planned to be removed, it will be subject to approval by NParks. Retained habitat may be prone to impact from microburst storm activity during construction. • **Restrictions to wildlife movement** will occur from temporary hoardings constructed for the Planet Explorer and Sri Seletar Point. Prior to the construction, the hoarding will be erected and fauna relocated. Restrictions during construction for fauna movement will occur in remnant habitats along the northern side of Mandai Lake Road (including the disturbed primary forest habitat) and habitat within the WRS site. Once displaced from the Project area during construction, ground dwelling fauna will no longer be able to access the Project component site. • **Disturbance and displacement** due to construction activities will disturb fauna in the adjacent disturbed primary forest habitat and WRS area. Noise sources will include construction noise, piling and machinery/vehicles (further assessment in relation to noise impacts has occurred at *Section 8.5.13*). Species sensitive to noise will be disturbed during the construction period and are likely to seek refuge within the CCNR and WRS site. This will cause impacts to sensitive species within the CCNR during the construction period. Fauna will be relocated within the project component area prior to construction and are likely to avoid the area until the work package is completed. Once displaced from the Project area during construction, ground dwelling fauna will no longer be able to access the Project site. Dust will be generated from demolition and construction activities, potentially depositing on leaves and affecting the photosynthetic capacity of flora (rainfall is likely to wash dust off, but may impact flora, especially during the inter-monsoon periods).

Project Component	Impact Description
	• **Edge effects on habitats** will occur in areas adjacent to the disturbed primary forest habitat (west of the construction area). These impacts will occur from adjacent hoardings and building construction activities. Impacts may include heat and light reflection into forested areas causing drying out of forest edges. Dust may also be emitted from construction sites, depositing on surrounding vegetation. This is likely to be an issue only during extended periods of low rainfall. **Indirect Impacts** • **Increased runoff** from paved surfaces and temporary surface water controls from construction activities. Paving will be used during construction of *Sri Seletar Point* and *Planet Explorer*, increasing runoff that will flow towards the Upper Seletar Reservoir. It should be noted that a commitment has been made to not discharge any water from the Project area into the Upper Seletar Reservoir.

8.5.3 *Impacts on Species During Construction*

Table 8.36 outlines the predicted impact on threatened species in the Project area due to the Project activities during construction.

Table 8.36: Assessment of Impacts to Species during the Construction Phase

Species Grouping	Impact Description
Ground Dwelling Mammals	The Sunda Pangolin (*Manis javanica*) (IUCN CR; SRDB CR) was identified in survey Zones A, D and E (corresponding to the CCNR and *Bird Park*). The species is resident and has a large foraging range within forests and grasslands. It is dependent on basal tree hollows for dens. The species is mobile and requires refuge during the day. Vegetation clearance is likely to impact on habitat and resource availability for the Sunda Pangolin across the site. The species may also be impacted by machinery and vehicle strike. Loss of available habitat during construction within the Project area for this species will be 284,643 m^2 (all cleared/enclosed Secondary forest habitat, Grassland habitat and Forested freshwater habitat). Once displaced from the Project area during construction, ground dwelling fauna including pangolins will be prevented from accessing the Project site through the construction of a permanent fence. The Lesser Mouse Deer (*Tragulas kanchil*) (IUCN LC; SRDB CR) was identified in survey Zones A, B and E. These areas coincide with the *Rainforest Park North* and CCNR. The species is resident and has a small home range (4.3 ha for females and for males 5.9 ha [17]). The species is territorial and individuals can be aggressive to individuals of the same sex. This species will be displaced from the Project site during construction at each work site. Once displaced from the Project area during construction, ground dwelling fauna including the Lesser Mouse Deer will be prevented from accessing the Project site through the construction of a permanent fence. Movement of the species in neighbouring refuge areas may cause conflict with other resident Lesser Mouse Deer in refuge areas. The species may also be impacted by machinery and vehicle strike.
Arboreal Mammals	The Banded Leaf Monkey (*Presbytis femoralis*) (IUCN NT; SRDB CR) was identified in survey Zone A (the CCNR). The species is known to visit the Project area. Baseline studies identified a single individual in Zone A, suggesting that the species may not permanently inhabit the Project area. The species is highly mobile and forages on leaves within tree canopies. Vegetation clearance may impact on the habitat and resource availability of the Banded Leaf Monkey during construction. It is anticipated that 214,995 m^2 of secondary forest habitat that may be suitable for this species will be removed or enclosed due to construction. There will be approximately 202,421 m^2 of secondary forest habitat that will be retained. Given that the species is believed to be non-resident; the impact is likely to be small to moderate and it is possible that the species would return during operations if sufficient habitat resources are re-established.

[17] Matsubayashi et al. (2003) Activity And Habitat Use Of Lesser Mouse-Deer (*Tragulus Javanicus*) Journal of Mammalogy, 84(1):234–242, 2003

Species Grouping	Impact Description
	The Malayan Colugo (*Cynocephalus variegatus*) (IUCN LC; SRDB NC) was identified in survey Zone B, the area of the future *Bird Park*. The species is strictly arboreal, gliding between trees for foraging. The species has a relatively small home range (estimated at 2 ha [18]), consisting of mature forest trees with suitable foraging resources. The Malayan Colugo can be territorial of foraging and sleeping areas [19]. Clearing activities are likely to impact on the habitat and resource availability of the Malayan Colugo during construction. The species is resident within the Project area. Injury or mortality may occur during clearing activities. The impacts will last throughout construction, however may be permanent if habitat resources are not replaced within the Project area and the species does not return during operation. Horsfield's Flying Squirrel (*Iomys horsfieldii*) (IUCN LC; SRDB EN) was identified in survey Zone A and H. These areas coincide with the CCNR and forested area north of Mandai Road. The species is mobile and clearing activities are likely to impact on the habitat and resource availability of the Horsfield's Flying Squirrel during construction. Injury or mortality may occur during clearing activities. The impacts will last throughout construction of individual work packages however may be permanent if sufficient foraging and nesting resources are not replaced during operation.

[18] Linzey, D. 2008. Dermoptera. Pp. 390-391 in McGraw-Hill Encyclopedia of Science and Technology, Vol. 5, 10 Edition. New York: McGraw-Hill.

[19] Shapiro, L. 2010. "Cynocephalus variegatus (Audebert, 1799)" (On-line). Encyclopedia of Life. Accessed January 18, 2011 at http://www.eol.org/pages/1040858.

Species Grouping	Impact Description
Grassland Dependent Birds and Bats	Lesser Bamboo Bat (*Tylonycteris pachypus*) (IUCN LC; SRDB CR) was identified in survey Zone D and F. These areas coincide with the *Bird Park* and WRS site. The species is adaptable, mobile and has a large home range. Other bat species that utilise grassland areas for foraging will also be impacted through the loss of habitat during construction. Clearing activities are likely to impact on the habitat and resource availability of the Lesser Bamboo Bat (and other grassland dependent bat species) during construction. Injury or mortality may occur during clearing activities if clearing of roosting habitat occurs during the daytime. Potential impacts may occur as a result of construction through direct impacts from collision. Grassland dependant bird species (such as the Scaly-breasted Munia (*Lonchura punctulata*), (IUCN LC; SRDB NC) Chestnut Munia (*Lonchura atricapilla*) (IUCN LC; SRDB NC); and Baya Weaver (*Ploceus philippinus*) (IUCN LC; SRDB NC)) were identified in survey Zone D. This area coincides with the *Bird Park*. These species are adaptable and have large home ranges. Other grassland bird species are also likely to be impacted through loss of foraging habitat. The species are mobile. Clearing activities are likely to impact on the habitat and resource availability of the species during construction. Potential impacts could occur with the construction of enclosures and netting. It is anticipated that 64,987 m^2 of grassland habitat suitable for these species will be removed during construction.
Forest Dwelling Herpetofauna	Forest dwelling herpetofauna (such as the Singapore Bent-toed Gecko (*Cyrtodactylus majulah*) (IUCN LC; SRDB NC); Red-necked Bronzeback (*Rhabdophis subminiatus*) (IUCN LC; SRDB NC); and Black Bearded Flying Dragon (*Draco melanopogon*) (IUCN LC; SRDB NC); and Striped Sun Skink (*Eutropis multifasciata*) (IUCN LC; SRDB NC)) were identified in Zone D, the site of the future *Bird Park*. These species are adaptable and mobile but may be impacted if sufficient refugia are not available. Clearing activities are likely to impact on the habitat and resource availability of these species during construction. It is anticipated that 214,995 m^2 of secondary forest habitat will be removed prior to construction.
Forest Dependent Bird Species	Forest dependant bird species such as the Violet Cuckoo (*Chrysococcyx xanthorhynchus*) (IUCN LC; SRDB CR); White-rumped Shama (*Copsychus malabaricus*) (IUCN LC; SRDB CR); Blue-crowned hanging Parrot (*Loriculus galgulus*) (IUCN LC; SRDB EN); and Red-crowned barbet (*Megalaima rafflesii*) (IUCN LC; SRDB NC) were identified in survey Zone A, B, D, E and F (This area coincides with the CCNR, *Rainforest Park* North, Bird *Park* and WRS site). These species are adaptable, mobile and have home

Species Grouping	Impact Description
	ranges that are dependent on forest distribution. They utilise trees for nesting and roosting. The species generally are restricted to habitats in forests. Clearing activities are likely to impact on habitat and resource availability for the species during construction. It is anticipated that 214,995 m^2 of secondary forest habitat will be removed during construction.
Aquatic Dependent Birds & Herpetofauna	Aquatic dependent birds such as the Grey-headed Fish Eagle (*Ichthyophaga ichthyaetus*) (IUCN NT; SRDB CR); Blue-eared Kingfisher (*Alcedo meninting*) (IUCN LC; SRDB CR); Purple Heron (*Ardea purpurea*) (IUCN LC; SRDB EN); and Buffy Fish Owl (*Ketupa ketupu*) (IUCN LC; SRDB CR) were identified in survey Zone A, B, D, E, F. These zones coincide with the CCNR, *Rainforest Park North*, *Bird Park* and WRS site. Other water dependent birds may also be impacted during construction. These species utilise open water or riparian forests for parts of their lifecycle. Some species will also roost in habitat surrounding the Upper Seletar Reservoir. These species will be impacted mostly by the clearing of riparian vegetation adjacent to the Upper Seletar Reservoir and construction of the *Boardwalk* through disturbance and displacement. Aquatic dependent herpetofauna such as the Malayan Box Terrapin (*Cuora amboinensis*) (IUCN VU; SRDB NC) were identified in survey Zone A, B, F. These zones coincide with the CCNR, *Rainforest Park North* and WRS site. Other water dependent species may also be impacted during construction. These species will be impacted mostly through impacts to riparian forests along the unnamed stream and along the edges of the Upper Seletar Reservoir. The primary impacts will be from habitat loss and disturbance and displacement during construction. Possible water quality impacts may also impact foraging areas.
Freshwater Fish and Macroinvertebrates	Fish and macroinvertebrate species located in waterways within the vicinity of the Project (refer to *Figure 6.7*) will likely be impacted from construction activities such as clearing habitats; changes to moisture differentials within riparian forests; increased light infiltration and changes in water quality and quantity within the surface waters during construction. The impacts of these changes are likely to alter the habitat resources available; cause potential nutrient and temperature changes, and impact the physiochemical properties of habitats. These impacts may alter the species mix and cause possible mortality to aquatic species.

Species Grouping	Impact Description
Invertebrates	Invertebrate species located within forests will likely be impacted through changes in available resources from construction activities. Direct impacts will include loss of suitable breeding and foraging habitats; direct loss of individuals, both at the pupal and adult stages; and loss of feed sources. Indirect impacts include increased competition for resources; and increased predation from species.
CR, EN and VU SRDB listed plants	All flora of conservation significance will be retained within the project area as a first priority. Where individual flora species of conservation significance need to be cleared to accommodate the project, this will be subject to approval from NParks. Dust will be generated from demolition and construction activities, potentially depositing on leaves and affecting the photosynthetic capacity of flora (rainfall is likely to wash dust off, but may impact flora, especially during the inter-monsoon periods).

8.5.4 Clearing Vegetation / Habitats Prior to Construction

8.5.4.1 Mitigation

Measures to mitigate the impacts due to the clearing of vegetation/habitats prior to construction activities are outlined in *Table 8.37*.

Table 8.37: Mitigation Measures for Clearing of Vegetation and Habitats

<table>
<tr><th>Phase / Activity</th><th>Specific Actions</th></tr>
<tr><td>General Management & Planning</td><td>

The boundaries of the CCNR are to be flagged or otherwise marked in the field prior to construction. The boundaries are to be checked weekly during clearing and construction works.
The measures outlined in the Project Description to set-aside areas where development will be avoided (including the patch of disturbed primary/secondary forest; forested area east of the CCNR on the northern side of Mandai Lake Road) and buffer areas will conserve habitats within the Project area. The following additional mitigation measures will be required to manage flora prior to and during construction to reduce impacts to flora species of conservation significance prior to clearing activities:

All CR, EN and VU listed species, significant native individuals (over 100 cm girth), plants for function such as animal food, nesting material etc., and the existing Alstonia trees along Mandai Lake Road which provide connections for arboreal fauna will be marked in the field;
All trees/plants to be retained in the field will be physically marked and recorded using a GPS. Saplings of plants identified for collection will also be marked on site and translocated prior to commencing clearance activities;
Prior to any site clearing (demolition works), piling works, grading, trenching or other soil disturbance, a tree protection zone (TPZ) must be installed around each tree identified for retention. The TPZ must be implemented according to the distances in the following table. It is noted that the table below is a general guideline (NParks, 2011) and a larger protection zone may be required as determined on a case by case basis:
<table>
<tr><th>Girth (m)</th><th>Minimum Protection Zone</th></tr>
<tr><td>≤1.0m</td><td>2.0m</td></tr>
<tr><td>≥1.0m but ≤1.5m</td><td>3.0m</td></tr>
<tr><td>≥1.5m but ≤2.0m</td><td>4.0m</td></tr>
<tr><td>≥2.0m</td><td>5.0m</td></tr>
<tr><td colspan="2">Source: NParks, Conservation of Trees / Plants, 2011</td></tr>
</table>

Where trees and vegetation are moved or translocated within the Project area, a suitably qualified arborist should advise on the methods and approach necessary to ensure the trees' health during translocation. Translocated trees must be managed through adequate watering and monitoring of their health to ensure their long term survival. Advice should be sought from an arborist if the tree exhibit signs of stress;
During site clearance, care will be taken when removing trees in riparian zones to reduce impacts to the bed and banks of waterways;
Where practicable, retention of saplings, seeds and seed banks within the soil profiles for use in forest restoration; and
Any proposal to remove flora species of conservation significance must be subject to approval by NParks.

</td></tr>
</table>

Phase / Activity	Specific Actions

	• The following measures will be required to train personnel on site:
	  • All personnel to undertake basic biodiversity awareness training prior to commencement of construction to raise their awareness of the (i) ecological sensitivity of the site, (ii) protocols to adopt when wildlife is encountered, (iii) the need to be cautious when operating machinery to avoid injury/mortality to fauna. Refresher training will be provided at least every 6 months during the construction phase.
	
	• The following measures will be included in the Earth Control Measures Plan (ECMP) to manage potential water pollution and impacts on aquatic habitats following clearing activities:
	  • Wastewater management measures due to construction activities such as piling;
	  • Erosion and sediment control measures as developed by a Qualified Erosion Control Professional (QECP) in accordance with PUB requirements;
	  • The Contractor shall submit the ECM proposal duly endorsed by his QECP to PUB and carbon copied to the owner / developer as follows:
	  1. Before work commences, submit the ECM proposal indicating that: exposed ground surfaces have been minimised according to the construction activities in each phase; effective sediment control facilities (including storage and treatment facilities) will be implemented; a system of ECM as indicated will be in place before work commences; Clearance Certificate to commence earthworks is obtained;
	  2. Revise and resubmit the ECM proposals according to each phase of the construction activities indicating that: exposed ground surfaces have been minimised according to the construction activities in each phase; Effective sediment control facilities (including storage and treatment facilities) will be implemented; a system of ECM will be revised and put in place to control silty discharge for each phase; and
	  3. Upon completion of work, confirm that all the site activities have been completed and the ECM can be removed.
	
	• The following measures will be implemented to manage water quality impacts from disturbed soil surfaces during clearing activities:
	  • Ensure implementation of mitigation measures to manage water quality impact from runoff during construction as outlined in *Table 8.7*;
	  • Water used in wheel washes to be sourced from mains supply and contained, pumped and periodically removed from site by a licensed wastewater collector or discharged to a surface water drain not connected to the unnamed stream along the Project's western boundary and Upper Seletar Reservoir, in accordance with relevant regulations. Discharge to the unnamed stream along the Project western boundary and Upper Seletar Reservoir is strictly prohibited; and
	  • Ensure sediment and turbidity control methods (e.g. silt fences, coagulation plants) are used during all earthmoving and excavation activities within 250 m of Upper Seletar Reservoir, the unnamed stream along the Project's western boundary or other surface water features in the Project area, to prevent sediment from entering streams and other surface waterbodies. Control methods will also be put in place during construction of the *Boardwalk*, in particular if required in close proximity to the reservoir edge.

Phase / Activity	Specific Actions
	• Clearance activities on site must not occur during rainfall or when storm events are forecast to occur within the vicinity to protect forest edge from wind throw. Where forest edges are exposed to wind, temporary measures must be put in place to protect the forest edge during storm events. This may include additional hoarding.
Demolition, Earthworks and Construction	• The following mitigation measures are to be implemented to reduce the impacts on fauna from noise and vibration during clearing activities (additional measures than those outlined in *Table 8.18* above): • Locate all worksite entrances and haul routes away from the CCNR and buffer areas. • Locate structures or equipment such as storage silos or temporary site office buildings between noise generating activity and the CCNR to serve as barrier.
Monitoring	• All retained and planted vegetation must be monitored for health and disease during construction and operation. A suitably qualified horticulturalist must assess the project area on a regular basis (every 1 month or if disease is identified) during establishment and operation. Where disease outbreaks are identified, the horticulturalist must advise on measures to manage any outbreaks.
Management of Implementation	• The following measures will be applied to manage the implementation of the mitigation measures listed above: • Contractors shall designate an EHS manager/coordinator with responsibility for implementation of the EMMP. • Contractors are to keep a register of all staff who have undertaken environmental awareness training. • Contractor environmental manager/coordinator to undertake daily inspection of construction area that includes: checks on protected flora and maintenance of TPZ; earth control measures; adequacy of hoardings and barriers. • MPH to maintain the services of a suitably qualified arborist. • MPH to maintain a complaints procedure to log and track response to complaints received from stakeholders. • MPH to implement an adaptive management framework and change procedure to manage changes to mitigation measures.

8.5.4.2 Residual Impacts

The impacts related to the clearance of vegetation and habitats will result in a permanent and ongoing impact to the extent of habitat available within the Project Vicinity. It is considered appropriate that impacts on the clearance of vegetation and habitats are assessed in the context of the broader habitat distribution in the Project Vicinity. This is due to the ecological connectedness of the Project area with its surrounds and the distribution of habitats for resident fauna within the Project Vicinity.

The Project Area setbacks, buffer and retained areas (the patch of disturbed primary/secondary forest; forested area east of the CCNR on the northern side of Mandai Lake Road; and buffers/building setbacks along the western and eastern edges of the CCNR and the edges of the Upper Seletar Reservoir) will conserve sensitive habitats and reduce the overall

magnitude of impact. Avoidance of clearing of flora species of conservation significance within the Project area and implementation of a TPZ around species will reduce impacts to protected flora.

The impact will be **Medium** for the Project Vicinity as a significant proportion of the habitat will be impacted. Project construction will result in the clearing of: 101,231 m^2 of Secondary Forests; 64,987 m^2 of Grasslands and 4,661 m^2 of Forested Freshwater Habitats from the Project area. In addition, 113,764 m^2 of Secondary Forests will be enclosed within attraction enclosures. Landscaping and forest restoration activities will occur within the Project area over the longer term (during operation); however this will provide only a partial amount of compensation for the habitat values lost. With the application of avoidance measures, landscaping and forest restoration, the magnitude of impact is expected to be reduced. The residual impact on habitats will therefore be reduced to **Small** within the Project Vicinity.

Further discussion on the impacts to fauna from the clearing of vegetation and habitats is discussed in the residual impact assessment in relation to the disturbance and displacement of fauna in *Table 8.41* and *Table 8.42*.

Table 8.38: Impact Assessment Summary – Clearing of Vegetation/Habitats prior to Construction

Criterion	Rating	Comment
Clearing of Vegetation/Habitats		
Nature	Negative	The clearing of vegetation prior to construction will reduce the area of available habitat within the Project area.
Type	Direct	Impact on the availability of habitats. Subsequent impacts to species within the Project Vicinity.
Duration	Long-term	Loss of habitat is essentially permanent and will result in overall reduction in habitat availability in the Project Vicinity.
Extent	Local	The following areas of habitat will be cleared during construction: • 101,231 m^2 of Secondary Forests • 64,987 m^2 of Grasslands • 4,661 m^2 of Forested Freshwater Habitats In addition, a total of 113,764 m^2 of Secondary Forests will be enclosed.
Scale	Medium	The impact scale from the Project Vicinity (identified refuge areas and the CCNR) is Medium. A significant proportion of the habitat within the Project area will be impacted. Both forest and grassland habitats within the Project area will be permanently lost, impacting species reliant on these habitat types.
Magnitude	Medium	The magnitude of impact to habitats within the Project Vicinity (including identified refuge areas and the CCNR) is considered Medium. The impact will result in the loss of a proportion of grassland and forest habitat such that part of the habitat is affected, but it does not threaten the long-term viability / function of the habitat in the Project Vicinity.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and contains species that are listed as CR on the SRDB and IUCN Red List.

Criterion	Rating	Comment
Clearing of Vegetation/Habitats		
Significance	Major	The significance of impacts to habitats prior to mitigation within the Project Vicinity is considered to be Major (Medium Magnitude; High Receptor Sensitivity).
Residual Impact Magnitude	Small	The residual magnitude of impact to habitats within the Project Vicinity (identified refuge areas and the CCNR) is considered to be Small. A reduction in habitat across the site will reduce habitat availability during construction and will continue during operation. High biodiversity value habitat retained on site in buffers, setbacks and other areas will protect the most significant habitat values of the site. The impacted habitats are generally in a degraded state (although they harbour species of conservation significance). The application of avoidance measures that retain the areas of greatest habitat value, landscaping and forest restoration will therefore reduce the overall magnitude of impacts to the function of habitat.
Residual Impact Significance	Moderate	The significance of residual impacts to habitats within the Project Vicinity is considered to be Moderate (Small Magnitude; High Receptor Sensitivity).

8.5.5 Edge Effects on Habitats during Construction and Operation

8.5.5.1 Mitigation

Measures to mitigate the impacts due to edge effects on habitats during construction and operation activities are outlined in *Table 8.39*.

Table 8.39: Mitigation Measures for Edge Effects on Habitats during Construction and Operation

Phase / Activity	Specific Actions

General Management & Planning	• The following mitigation measures will be applied to all landscaping activities undertaken within Project components to reduce edge effects:
	  • Vegetative barriers will be used at ground level to discourage human incursion into vegetated areas. These vegetative barriers will consist of native indigenous flora planted at a density that is impenetrable to humans.
	  • The TPZ will be clearly sign posted during construction to avoid soil compaction and root damage.
	  • Ground level habitat must be installed that can include: logs and branches, rocks, swales, artificial tunnels and low water logged areas. Ground level habitat should be constructed to be contiguous with vegetation (if appropriate).
	  • Grasses used for planting must be from native indigenous stock or non-native species that are not listed as weed or invasive species or have a low seeding rate. Grasses planted are to consist of a range of heights, included mown and freely sprouting areas.
	  • Any trees transplanted into the Project area components must have local provenance or from within the Johor region for all SRDB and IUCN listed species. Other species may be obtained within the larger Sunda landscape. Suppliers will be pre-screened to ensure that the trees are obtained by legal means and are able to be exported/imported to Singapore. All imported trees must be inspected and/or undergo quarantine if required to reduce the

Phase / Activity	Specific Actions
	chance of transmission of weeds and soil pathogens. • A site nursery is to be established to cultivate native plants for use in forest restoration activities. The nursery is to use native seed stock and saplings. • Mitigation measures outlined in the Forest Restoration Plan must be implemented to ensure adequate establishment and restoration of vegetation within the Project Area. MPH is to contract as necessary specialist advice on forest restoration activities. • To reduce impacts from microburst storm events, the following mitigations must be implemented: • All trees susceptible to wind throw along forest verges, the *Eco-Link*, Mandai Road, Mandai Lake Road and within enclosures must be anchored to prevent wind throw during storm events (including microburst events). Advice on anchoring techniques must be provided by a suitably qualified arborist. • To reduce impacts from edge effects on all built structures, mitigations must include: • A colour palette must be used that has a low Light Reflective Value (LRV) of less than 30%. The LRV may be varied where built structures are enclosed or do not directly face or reflect onto vegetated areas (including facing the Upper Seletar Reservoir). All glazed surfaces must be placed at angles that limit direct light reflection into vegetated areas and the Upper Seletar Reservoir. Screens, louvres or shading may be used to limit direct sunlight penetration and reflection from glazed surfaces. • To reduce edge impacts from Project components, the following buffer distances must be maintained: • Maintain a minimum of 10 m buffer between project components. Forest buffers of up to 45-50 m to be established/retained to maintain connectivity within the Project area with the CCNR. Where forest connectivity cannot be maintained, artificial techniques may be used (such as rope ladders). These ladders may be installed across Mandai Lake Road to link remnant forested patches within the Project area. • To reduce edge effects from artificial lighting, the following mitigation measures must be implemented [20]: • All lighting will be directed away from vegetated areas and habitats. Upward and directional lighting will be avoided to prevent light trespass into unintended areas. Where lighting is required to be installed for safety and security purposes, regulatory requirements must be followed. Reduce the duration of nocturnal lighting sources by using a timer or movement based sensor system to turn off lights. Where permanent lights are to be employed, the lighting configuration (such as spacing between lighting poles) will be designed to ensure that darker areas are present between lit areas to provide darker passages for sensitive fauna to pass. During construction, lights will not be used after construction hours and construction hours are limited to the daytime. During operations, general lighting usage will be consistent with the operating hours of each Project component (operating hours are indicated in *Table 2.5*). Outside of operating hours, low lux level and downcast lighting will be needed along pathways, paved areas etc. in areas where public access cannot be prevented (such as the arrival nodes and carparks) for public safety. Consideration will be given to automatic

[20] Gaston,K et al Reducing the ecological consequences of night-time light pollution: options and developments, Journal of Applied Ecology 2012.

Phase / Activity	Specific Actions

	dimming to reduce lighting intensity. Illumination with a high UV component will be avoided to reduce impacts on insects. Narrow spectrum lights (such as LPS lamps) may be used to minimise impacts on the nocturnal functions of species.
	• To ensure that edge effect impacts are mitigated from enclosure design, all enclosures constructed must be subject to a full engineering design. The engineering design must:
	  • Outline methods to anchor all enclosures into the ground surface to prevent damage from wind and tree throw; Provide sufficient air space above trees to be included within the enclosures, taking into account tree growth rates and future tree replacement; Include failsafe mechanisms to prevent breaches from tree falls from within or outside of enclosures; identify suitable mesh/screen sizes to enable suitable light and water penetration into enclosures while preventing escapees; and enable access points for future maintenance (such as tree replacement)
	  • Mesh size of enclosures must be constructed to exclude resident fauna. A maximum of 25mm stainless steel wire mesh must be used for all enclosures that house fauna. Polyethylene or polypropylene may be used if suitable for the host species. Smaller mesh sizes may be used where the species requires additional protection. Larger mesh sizes may be used for large fauna (such as ground dwelling mammals). All enclosures must contain a band of mesh or steel to prevent rodent and reptile access into the enclosures.
	• The following landscaping requirements will be implemented to reduce edge affects adjacent to buildings, enclosures and other facilities:
	  • The success of planting within landscape features must be monitored. Where a planting strategy is not working, an alternative planting strategy must be developed suitable for the location. Temporary measures should be employed to reduce stress on planted individuals, including watering and fertilising if required. The removal of sources of stress (such as dust) may also occur. If disease outbreaks are present, use methods to control the outbreak or remove the individual.

Demolition, Earthworks and Construction	• The following mitigation measures must be implemented to reduce impacts from demolition, earthworks and construction activities to reduce impacts from air pollution (dust):
	  • Ensure implementation of mitigation measures to minimise impacts from air quality during construction as outlined in *Table 8.1* and *Table 8.4*.
	  • Prior to demolition works, enclose all buildings to be demolished. Deploy demolition chutes and demolition waste receptacles to reduce dust.
	  • Uncovered earth stockpiles will not be located within 100m of the CCNR.
	  • Where excess dust is being deposited onto vegetation and natural rainfall does not remove the dust within a one week period, vegetation will be sprayed with clean water to wash dust off leaves.
	• The following mitigation measures must be implemented to reduce impacts from noise on fauna during demolition, earthworks and construction activities:
	  • Ensure implementation of mitigation measures to reduce noise generation during construction as outlined in *Table 8.18*.
	  • Hoardings along the worksite boundary with the CCNR shall be constructed using the same material as acoustic barriers, but shall be maintained at maximum height of 2.4 m. With reference to the construction packages,

Phase / Activity	Specific Actions
	this is the eastern boundary of Packages B and C North and the western boundary of Package C South.
Transportation	• The following mitigation measures are to be implemented to reduce impacts to fauna and flora from vehicles and transport during construction and operation: • Minimise driving machinery within 10 metres of trees where possible to avoid impacts to root systems through soil compaction. Where machinery is required to be used close to a tree or retained vegetation, it must be a machine that exerts a low pressure on the ground (such as a tracked machine).
Monitoring	• The following monitoring measures must be implemented to monitor the impacts in relation to edge effects during construction and operation: • Where forest edges are newly exposed following clearing, monitor and erect artificial shading and/or implement a sprinkler system to increase moisture levels if forest edges are observed to be drying out. • Monitor the edges of vegetation exposed to machinery and newly constructed buildings, enclosures and other facilities. Where impacts to vegetation are evident, erect temporary shading and/or install a sprinkler system to improve moisture differentials around forest edges. • All retained trees will be monitored weekly for edge effects during construction over the drier inter-monsoon period (March-May and October-November). Where a tree exhibits signs of stress, a suitably qualified arborist should inspect the tree and advise on measures to reduce further impacts and rehabilitation measures. • Where edge effects occur due to natural events (i.e. storm event or strong wind), the affected areas will be inspected as soon as practicable after the event. Temporary measures will be taken to mitigate impacts if required while long term solutions are investigated and implemented with the advice of a suitably qualified specialist. • A qualified horticulturalist will assess the Project area on a monthly basis throughout construction. Where disease outbreaks are identified, the horticulturalist must advise on measures to manage any outbreaks. Measures can include: using selected insecticides/fungicides to control outbreaks; reduction of stressors (dust, water etc.). The plant may be removed or quarantined if it poses a threat to surrounding individuals. • Night-time light monitoring will occur minimally monthly against target light levels of 0.06 lux for vegetated areas in the immediate vicinity of project components and 0.03 lux for vegetated areas further away from project components. These light level targets were established with the aim to be as close as possible to baseline levels during a moonless night. The exact locations for light monitoring will be identified in consultation with the relevant regulatory agencies when detailed lighting design information becomes available.
Management of Implementation	• The following measures will be applied to manage the implementation of the mitigation measures listed above: • Contractor EHS manager/coordinator to undertake daily inspection of construction area to identify compliance/additional measures required to manage impacts. Inspections are to include: all trees retained; exposed forest edges during clearing; anchoring ties; earthworks; and landscaping works.

Phase / Activity	Specific Actions
	• MPH to maintain a complaints procedure to log and track response to complaints received from stakeholders. • MPH to implement an adaptive management framework and change procedure to manage changes to mitigation measures. • MPH to contract a suitably qualified arborist to provide ongoing advice and management of flora within the Project Area.

8.5.5.2 Residual Impacts

Edge effect impacts from construction and operation will result from activities associated with demolition, earthworks and construction. These impacts may lead to negative impacts including increased risk of parasitism or disease, increased risk of predation, adverse microclimate conditions (including drying out and subsequent fire risk), and competition from invasive species. Increased exposure to impacts from microburst storm activity may also occur. It is considered appropriate to assess the impact within the context of the Project Vicinity. This is due to the extent of possible edge effect impacts on the CCNR and surrounding habitats from the Project area.

The magnitude of impact is assessed as **Medium** within the Project Vicinity. The impact will affect the habitats exposed within the Project Vicinity such that the viability/function of part of the habitat or the entire habitat is reduced, but does not threaten the long-term viability of the habitat or species dependent on it.

Mitigation measures have been inbuilt into the design of the Project to reduce edge effect impacts for the different Project components as outlined in the Project Description (*Chapter 2*). Mitigation measures have been designed to reduce the severity of impacts, focusing on measures to use landscaping and forest restoration within the Project area to restore habitat edges and maintaining a forested buffer adjacent to the CCNR. Measures will also be used to reduce impacts from edge effects on all built structures as well as from artificial lighting. The design of enclosures will include measures to reduce impacts on vegetation within and external to enclosures. During construction and operation, noise and air pollution impacts (dust) must also be managed to reduce impacts on surrounding vegetation. Measures to manage trees that have a risk of wind throw during microburst storm events will also reduce ongoing edge effect impacts during operation.

The residual impacts remaining following mitigation during construction and operation are likely to be reduced to **Small** for habitats within the Project Vicinity. The mitigation measures recommended during construction (when the impact will be most significant) will incorporate inspections and monitoring, and further mitigation such as artificial spraying to maintain moisture levels as needed. This monitoring will continue during operation. The impact will affect a small area of habitat, but without the loss of viability/function of the habitat.

Table 8.40: Impact Assessment Summary – Edge Effects on Habitats

Criterion	Rating	Comment
Edge Effects on Habitats		
Nature	Negative	The construction of hoardings, enclosures, buildings and clearing of vegetation will cause edge effects beside the CCNR and remnant forest patches within the Project Vicinity.
Type	Direct	Edge effects may lead to negative impacts including increased risk of parasitism or disease, increased risk of predation, adverse microclimate conditions (including drying out and subsequent fire risk), and competition from invasive species. Increased exposure to impacts from microburst storm activity may also occur.
Duration	Long-term	Impacts on existing vegetation would be long-term if not adequately managed.
Extent	Local	The extent of possible edge effects has been determined to be adjacent to project components and construction sites within the Project Area and adjacent areas of the buffers and other vegetation.
Scale	-	The scale of the impact is expected to be to the habitat within the Project Vicinity and adjacent habitats surrounding the Project during construction and ongoing impacts during operation.
Magnitude	Medium	The magnitude of impact is assessed as Medium during construction as the impact will affect a sufficient proportion of the habitat such that the viability/function of part of the habitat or the entire habitat is reduced, but does not threaten the long-term viability of the habitat or species dependent on it. All borders along the Project boundary will be subject to edge effects during construction and operation.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project Area is within an internationally designated area (Central Forest Important Bird Area) and contains threatened species listed as CR on the SRDB and IUCN Red List.
Significance	Major	The impact significance to habitats and species within the Project Vicinity is considered to be Major (Medium Magnitude; High Receptor Sensitivity).
Residual Impact Magnitude	Small	Mitigation has been built into the design of the Project to limit edge effects within the Project area and surrounding habitats within the Project Vicinity. Such mitigations are expected to reduce the magnitude of impact to Small in that the impact will affect a small area of habitat within the Project Vicinity, but without the loss of viability/function of that habitat.
Residual Impact Significance	Moderate	The significance of impacts to habitats within the Project Vicinity is considered to be Moderate (Small Magnitude; High Receptor Sensitivity).

8.5.7 Disturbance and Displacement of Fauna during Construction

8.5.7.1 Mitigation

Measures to mitigate the impacts due to disturbance and displacement of fauna during construction are outlined in *Table 8.41*.

Table 8.41: Mitigation Measures for Disturbance and Displacement of Fauna during Construction

Phase / Activity	Specific Actions
General Management & Planning	• The measures outlined in the Project Description for setbacks and buffer areas within the Project area and the measures outlined in *Table 8.37: Mitigation Measures for Clearing of Vegetation and Habitats* will assist in reducing the impacts to resident species by providing habitat during construction and operation. The following additional mitigation measures will be required for fauna relocation prior to construction to reduce impacts to fauna species of conservation significance from clearing activities: • Prior to the start of construction, wildlife will be shepherded from the Project area into adjacent refuge areas and hoarding erected in accordance with the *Wildlife Protection Plan* provided in *Annex 18*. • The location of identified wildlife refuge areas during pre-construction and construction activities includes; CCNR south of the Project area; special use area west of the Project area; CCNR north east of the Project area; and habitats along the edge of the Upper Seletar Reservoir. • Experienced wildlife handlers and veterinarians will be on hand during relocation activities; Fauna relocation activities are to be undertaken separately for each work package according to the Construction Schedule. Detailed strategy is outlined within *Annex 18*. • Hoarding (limited to 2.4 m in height) must be erected around the edges of the work package area. The height of 2.4 m has been recommended for the hoardings in order not to block the movement of arboreal fauna yet still prevent human and terrestrial fauna access into the construction site. • All habitat features, such as nests, roosts, basal hollows and ground burrows must be inspected. If fauna is present, methods to encourage the fauna to relocate are to be implemented. • Prior to the fauna relocation activities, a briefing will occur with all involved personnel so they are aware of their roles and responsibilities; measures to deal with injured wildlife; occupational health and safety requirements; and requirements regarding the prohibition of hunting/catching/taking of fauna and flora. This will include incident reporting measures to the NParks and Agri-Food and Veterinary Authority (AVA) of Singapore. • Undertake surveys shortly before the closure of the hoarding to identify any final resident individuals of target species. These individuals will be encouraged to move; and • Hoardings can be closed around each work package once it has been cleared of fauna.

Phase / Activity	Specific Actions

Demolition, Earthworks and Construction	• The following mitigation measures will be required to minimise impacts from air pollution during construction:
	  • Ensure implementation of mitigation measures to minimise impacts from air quality during construction as outlined in *Table 8.1* and *Table 8.4*;
	  • Uncovered stockpiles will not be located within 100m of the CCNR; and
	  • Prior to demolition works, enclose all buildings to be demolished. Deploy demolition chutes and demolition waste receptacles.
	
	• The following mitigation measures will be required to minimise impacts from noise pollution during construction:
	  • Ensure implementation of mitigation measures to reduce noise generation during construction as outlined in *Table 8.18*.
	  • Hoardings along the worksite boundary with the CCNR shall be constructed using the same material as acoustic barriers, but shall be maintained at maximum height of 2.4 m. With reference to the construction packages, this is the eastern boundary of Packages B and C North and the western boundary of Package C South.

Transportation	• The following mitigation measures are to be implemented to reduce impacts on fauna from potential vehicle strike during construction:
	  • Roadside reflectors must be used along Mandai Lake Road and attached to posts 20-50m apart at a height of at least 2m from the ground surface.
	  • Erect hoarding and barriers progressively to prevent fauna from entering road reserves (Mandai Road and Mandai Lake Road). Hoarding should be erected along roads first and to encourage fauna movement towards refuge areas. The hoarding should be carefully removed at the completion of works to prevent damage to vegetation within development areas and to prevent exposure of fauna to risks.

Monitoring	• The following must be monitored in relation to fauna relocation activities:
	  • Camera traps shall be deployed at approximately 50 m intervals parallel to and on both sides of Mandai Lake Road within the temporary ground level corridor provision, and at landing points and along the length of the *Eco-Link*. The camera traps must be inspected fortnightly to collect photographs and ensure they are functioning correctly. The data will be used to inform the effectiveness of the corridor provision and inform the phasing of hoarding and construction.
	  • Surveys will be undertaken in conjunction with shepherding activities outlined in *Annex 18*. Surveys will focus on identifying species requiring relocation within the project component area; and identifying habitat features (such as hollow trees, pangolin dens, nests and roosts) All habitat features are to be recorded using a GPS for future reference. Field data is to be used to refine techniques required for the survey.
	  • MPH must liaise with NParks to determine whether impacts are occurring to the CCNR as a result of Sambar Deer and Wild Boar being displaced into this area. Where damage is determined to be occurring, MPH is to work with NParks to implement a control program (see *impacts associated with Invasive and species requiring management*). In addition, MPH will work with the relevant authorities on the management of these animals in the event that these animals become a public nuisance.

Phase / Activity	Specific Actions

Management of Implementation	• The following responsibilities are required for the management of implementation of the above mitigation measures:
	  • MPH to appoint/employ experienced wildlife handlers and veterinarians to be on hand during relocation activities.
	  • Documents prepared during relocation will include fauna and habitat resources register.
	  • Camera trap records will be used to determine location of wildlife crossing along Mandai Lake Road to monitor potential for road kill and to develop additional mitigation, as necessary.
	  • MPH to implement an adaptive management framework and change procedure to manage changes to mitigation measures.

8.5.7.2 Residual Impacts

Impacts from disturbance and displacement of resident species arise from the reduction in available habitat as well as physical threats to species' lifecycles from the presence of construction activities, vehicles and humans. It is considered appropriate that impacts relating to the disturbance and displacement of species from the Project area be assessed in the context of the broader habitat distribution in the Project Vicinity. This is due to the fact that resident species are distributed and use this broader area of habitat.

The magnitude of impact to species from disturbance and displacement due to site clearance is considered to be **Large** within the Project Vicinity. The impacts will affect resident populations of species within the Project area at sufficient scale to cause a substantial change in abundance and/or change in distribution to species within the Project Vicinity prior to construction without mitigation. Less mobile species/species with a small range such as the Lesser Mouse Deer (*Tragulus kanchil*); Malayan Colugo (*Cynocephalus variegatus*) and Sunda Pangolin (*Manis javanica*)) are of particular concern. Ground dwelling fauna will be permanently excluded from the Project area during operation. Avifauna, invertebrates and some herpetofauna will have access to the Project area during construction and operation. Extant species within the candidate refuge areas will be impacted by fauna displaced from the Project area through resource competition and conflict.

The Project will set aside areas (the patch of disturbed primary/secondary forest; forested area east of the CCNR on the northern side of Mandai Lake Road; and buffers adjacent to the CCNR and 15 m set-backs around the edges of the Upper Seletar Reservoir) to conserve sensitive habitats for species and reduce the overall magnitude of impact. Avoidance of clearing flora species of conservation significance within the Project area and implementation of a TPZ around species will reduce impacts to protected flora.

The application of mitigation will reduce the impacts to species relocated from the Project area prior to construction. Fauna relocation during construction will reduce impacts to displaced fauna by using shepherding techniques described in *Annex 18* and providing refuge areas, preserving existing populations. A staged approach to fauna relocation will also occur to reduce any additional impact on fauna from resource competition and conflict. Monitoring and provision of additional habitat resources within refuge areas will also assist in reducing this potential impact. Habitat resources that may be used include: ground and

arboreal forage (i.e. native food plants) for ground dwelling herbivorous mammals, arboreal mammals and birds; artificial nesting boxes for hollow reliant bird and arboreal mammal species; artificial dens for den dependent nursery species such as the Sunda Pangolin; and ground habitat (fallen logs and undergrowth) for ground dwelling herpetofauna.

Monitoring through the use of wildlife cameras and transect surveys and adaptive management, as required, will further reduce impacts on fauna once displaced. During operation, buffer areas, setbacks and retained vegetation of high biodiversity value will provide habitat for sensitive displaced ground dwelling fauna, including the Sunda Pangolin, Lesser Mouse Deer and Malayan Colugo. The addition of the *Eco-Link* will further reduce risks to these species when moving within currently fragmented areas of the CCNR. The magnitude of impact to species following mitigation is therefore expected to reduce to **Small** within the Project Vicinity.

Table 8.42: Impact Assessment Summary – Disturbance and Displacement of Fauna

Criterion	Rating	Comment
Disturbance and Displacement of Fauna during Construction		
Nature	Negative	Disturbance and displacement of resident species within the Project area prior to construction.
Type	Direct	Clearance of vegetation and shepherding of fauna from the Project site will have a direct impact on resident species within the Project area through displacement and reduction in available habitat resources.
Duration	Long-term	The impacts will commence upon the shepherding of fauna from the Project site and will essentially be permanent for ground dwelling fauna. Over the longer term, habitat retained on the site is expected to encourage the return of avifauna and arboreal species during operations. Resident fauna will relocate to habitat within the Project Vicinity.
Extent	Local	The total amount of habitat cleared during construction will be 170,879 m^2. In addition, a total of 113,764 m^2 of habitat will be enclosed.
Scale	Medium	The impact scale within the Project Vicinity, (identified refuge areas and the CCNR) proposed for fauna relocation is considered to be Medium.
Magnitude	Large	The magnitude of impact to species in the Project Vicinity is considered to be Large. The loss of habitat from the Project area will affect an entire population or species at sufficient scale to cause a substantial decline in abundance and/or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) may not return that population or species, or any population or species dependent upon it, to its former level within several generations, or when there is no possibility of recovery.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and contains threatened species that are listed as CR on the SRDB and IUCN Red List.
Significance	Critical	The significance of impacts to habitats and species within the Project Vicinity is considered to be Critical (Large Magnitude; High Receptor Sensitivity).

Criterion	Rating	Comment
Disturbance and Displacement of Fauna during Construction		
Residual Impact Magnitude	Small	Application of mitigation will reduce impacts on species within the Project Vicinity such that the magnitude of residual impact to species is considered to be Small. The impact is expected to affect a small proportion of the population of most species, but not to substantially affect the populations of the species themselves. Mitigation includes phased relocation of target terrestrial fauna from the Project area in accordance with the Wildlife Protection Plan (refer to *Annex 18*) which will reduce the intensity of disturbance to fauna and the risk of uncontrolled displacement of fauna as compared to relocating wildlife from the entire Project area all at once. Care will be taken to identify target terrestrial fauna and shepherd them towards adjacent refuge habitats outside of the Project construction sites prior to construction in order to preserve existing populations. A long-term wildlife and habitat monitoring programme, that will include refuge habitats within the Project Vicinity, will be initiated from the commencement of site development. In addition, habitat enhancement, which will commence before construction begins, will be carried out in the buffer areas to supplement habitat resources through the planting of native plants for food, nesting and to enhance connectivity. In addition, wildlife shepherding activities will not occur during the prime breeding season for native birds and construction activities will be limited to daylight hours so as to mitigate disturbance to birds and nocturnal fauna, respectively (see *Annex 18* for further information). During operation, buffer areas, setbacks and retained vegetation of high biodiversity value will provide habitat for sensitive displaced ground dwelling fauna, including the Sunda Pangolin, Lesser Mouse Deer and Malayan Colugo. The addition of the *Eco-Link* will further reduce risks to these species when moving within currently fragmented areas of the CCNR.
Residual Impact Significance	Moderate	The significance of impacts to habitats and species taking into account habitat available in the Project Vicinity is considered to be Moderate (Small Magnitude; High Receptor Sensitivity).

8.5.7 Mortality as a Result of Vehicle / Machinery Strike

8.5.7.1 Mitigation

Measures to mitigate the impacts due to mortality as a result of vehicle/machinery strike on species during construction activities are outlined in *Table 8.43*.

Table 8.43: Mitigation Measures for Mortality as a Result of Vehicle / Machinery Strike

Phase / Activity	Specific Actions
General Management & Planning	• The mitigation measures outlined in *Table 8.41, Mitigation Measures for Disturbance and Displacement of Fauna during Construction* will assist in the management of potential vehicle/machinery strike. • All vehicles on site will be restricted to a maximum of 40 km/hr on paved surfaces (i.e. Mandai Lake Road). In addition, a 20km/hr speed limit will be applied at the temporary fauna crossing along a segment of Mandai Lake Road (as depicted in *Figure 3.5h* of *Annex 18*) during construction. • A 'Vehicle-Activated Speed Display' is to be installed on Mandai Lake Road to alert drivers to their speed. • To maintain connectivity and reduce the risk of incursion by fauna into Project component areas and surrounding roads, the following mitigation has been designed: • Perimeter hoarding / fencing of a maximum height of 2.4 m will be installed and shall: exclude all resident fauna from fully closed enclosures (see separate requirement for enclosure design); exclude ground dwelling fauna from all Project components (including Sambar Deer and Wild Boar); exclude all ground dwelling fauna from accessing Mandai Lake Road and Mandai Road (daily inspections in the morning must occur along Mandai Lake Road to determine if fauna have become trapped within the road verge; crush resistant fencing (to withstand tree fall) along the verge of the *Eco-Link* of maximum 2.4 m fence height to prevent fauna from entering the road and to protect from falling trees; low fences may be used to prevent fauna from entering high human traffic areas within vegetative barriers, such as the *Arrival Nodes*.

Monitoring	• The following monitoring will be undertaken during construction to determine impacts on potential road kills and enable adaptive management:
	  • Wildlife camera traps will be installed along the boundary of project component areas during construction activities. The wildlife camera traps are to be placed along wildlife corridors to determine wildlife corridor use during construction. These corridors include: Temporary wildlife crossing point across Mandai Lake Road; Along hoarding facing the CCNR (note time delays should be used so the cameras are active to capture nocturnal fauna); Cameras are to be placed to face forest or grassland areas to determine use of adjacent refuge areas; All wildlife camera traps must be inspected on fortnightly to collect photographs and ensure they are functioning correctly.
	  • A register and investigation process is to be established to determine the cause of any road kills during construction and operation. All deaths are to be investigated and any gaps identified in mitigation measures that may have led to the death/injury should be identified and changes made to the mitigation. This will be captured as part of the adaptive management

Phase / Activity	Specific Actions

	throughout the Project construction.
	• The following monitoring measures will be applied during operations to determine species utilisation of habitat and connectivity:
	  • Wildlife camera traps will be installed permanently during operations at locations in and around the Project area, including along the *Eco-Link*. The specific location will be based on the layout of the project and long term monitoring of the refuge areas.
	• The following monitoring activities will be undertaken during operation to determine the adequate functioning of fences around Project components:
	  • All fencing structures must be maintained and regularly inspected for damage or breaches. Following a storm event, all fences must be inspected and repaired, as necessary.

Management of Implementation	• The following measures will be applied to manage the implementation of the mitigation measures listed above:
	  • Contractor EHS manager/coordinator to undertake daily inspections of construction area and along Mandai Lake Road for signs of road kill or injured/trapped fauna. WRS will be contacted to provide support for injured or trapped fauna.
	  • All road kills will be investigated and additional mitigation implemented as necessary. Such investigations will make use of information from camera traps to determine whether there are patterns in animal crossings of Mandai Lake Road.
	  • MPH to maintain a complaints procedure to log and track response to complaints received from stakeholders.
	  • MPH to implement an adaptive management framework and change procedure to manage changes to mitigation measures.

8.5.7.2 Residual Impacts

Impacts to species from vehicle and machinery strike arise due to this equipment being used within the Project area and becoming a physical threat to fauna. It is considered appropriate to assess the impacts in terms of the threats posed from machinery and vehicles (especially during construction) and also where displaced fauna may be threatened by vehicles on surrounding roads within the Project Vicinity.

The magnitude of impact to species from mortality as a result of vehicle/machinery strike is considered to be **Medium** within the Project Vicinity. Fauna displaced from the Project area are likely to move towards Mandai Lake Road and Mandai Road and hence become susceptible to vehicle strike without mitigation. The impacts may affect a sufficient proportion of a species population that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.

Mitigation measures will be taken to restrict animal movements in order to minimise the likelihood of vehicle strikes and to facilitate movement towards safe refuge areas. Hoardings constructed along Mandai Lake Road during construction will reduce the opportunity for vehicle strike. A speed limit of 40 km/hr along Mandai Lake Road during construction will reduce the potential for impact as this increases alert and response time of drivers. In

addition, a 20km/hr speed limit will be applied at the temporary fauna crossing along a segment of Mandai Lake Road during construction (see *Figure 3.5h* of *Annex 18*). Following the application of the mitigation measures, it is expected that the magnitude of impact will be reduced to **Small** for the Project Vicinity. Fauna are likely to disperse into the identified refuge areas that are away from Mandai Road and Mandai Lake Road. Hoardings along Mandai Road will reduce the opportunity of impact. The impact is likely to affect a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species themselves.

Table 8.44: Impact Assessment Summary – Mortality as a Result of Vehicle/ Machinery Strike

Criterion	Rating	Comment
Mortality as a Result of Vehicle/ Machinery Strike		
Nature	Negative	Potential mortality of fauna as the result of vehicle or machinery strike during construction.
Type	Direct	Impact will be the result of the use of vehicles and machinery which are required for construction activities.
Duration	Long-term	The duration of the impact would be throughout the construction period (approximately 7 years) but may continue during operations due to the use of vehicles along Mandai Road, Mandai Lake Road and within the Project area.
Extent	Local	The extent of impacts will be limited to transport corridors within the Project area and immediately adjacent, including Mandai Road to the north. Displaced fauna may also travel west towards the Bukit Timah Expressway.
Likelihood	Likely	Records of road kills on surrounding roads and within the Project area indicate that mortality occurs to resident species on a regular basis. It is not possible to accurately predict increases in mortality as a result of vehicle/machinery strike from the project development. However, since fauna will be displaced during construction; the scale of the impact may be large if not adequately controlled.
Magnitude	Medium	The magnitude of impact to species in the Project Vicinity is considered to be Medium. The loss of habitat from the Project area will mean that species will be displaced, resulting in an increased risk of collision that may affect a sufficient proportion of a species population that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and contains species that are listed as CR on the SRDB and IUCN Red List.
Significance	Major	The significance of impacts to habitats and species within the Project Vicinity is considered to be Major (Medium Magnitude; High Receptor Sensitivity).

Criterion	Rating	Comment
Mortality as a Result of Vehicle/ Machinery Strike		
Residual Impact Magnitude	Small	The magnitude of impact within the Project Vicinity following mitigation is Small as it is likely to affect a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself. Fauna will be relocated from the majority of the Project area during construction to refuge areas, mainly towards the south of Mandai Lake Road. Hoardings and fences will restrict species from accessing roads in the Project area.
Residual Impact Significance	Moderate	The significance of impacts to habitats and species within the Project Vicinity is considered to be Moderate (Small Magnitude; High Receptor Sensitivity).

8.5.8 Restrictions to Wildlife Movement/Reductions in Connectivity

8.5.8.1 Mitigation

Measures to mitigate the impacts due a reduction in connectivity during construction activities are outlined in *Table 8.45*.

Table 8.45: Mitigation Measures for Restriction to Wildlife Movement/Reductions in Connectivity

Phase / Activity	Specific Actions
General Management & Planning	• To mitigate the loss of connectivity during construction, the following measures must be implemented: • Hoarding and barriers will be installed to prevent fauna from entering road reserves (Mandai Road and Mandai Lake Road). Hoarding will be erected along roads first and to encourage fauna movement towards refuge areas. • Implement a temporary fauna crossing across Mandai Lake Road at least 30 metres in width during construction of the *Bird Park* and *Rainforest Park North*. The location of the temporary fauna crossing is to coincide with existing forested areas either side of Mandai Lake Road, within approximately 100m of the western boundary of the CCNR as shown in *Annex 18, Figure 3.5h.* The temporary fauna crossing is to be closed after the construction of the *Eco-Link* and when suitable habitat has been established on the *Eco-Link*. • Speed limits will be implemented on Mandai Lake Road, limiting speed to 40km/h. The speed limit will be posted on signs at regular intervals along Mandai Lake Road. In addition, there will be a special low-speed zone along the stretch of Mandai Lake Road where the temporary fauna crossing is located as depicted in *Figure 3.5h* of *Annex 18*. Speed bumps and signs will be used to enforce a speed limit of 20km/h at the low-speed zone. A 'Vehicle-Activated Speed Display' will be installed along Mandai Lake Road to alert drivers of their speed. • Roadside reflectors must be used along Mandai Lake Road and attached to posts 20-50m apart at a height of at least 2m from the ground surface. • No direct lighting of the temporary fauna crossing is to occur. All lights are to be directed away from the fauna crossing, including along the road verge. • Maintain connectivity along edges of the Upper Seletar Reservoir during construction activities of the *Boardwalk*. All temporary construction

<table>
<tr><th>Phase / Activity</th><th>Specific Actions</th></tr>
<tr><td></td><td>
rigs/tools are to be removed at night to reduce opportunities for fauna obstruction, where practicable.
• To mitigate impacts within the Project components and buffers during operation, the following landscaping measures are to be incorporated to complement the fencing:
  • The measures contained in the Forest Restoration Plan (see EMMP) are to be implemented.
  • Vegetative barriers may be used at ground level to discourage human incursion into vegetated areas. These vegetative barriers should consist of native indigenous flora planted at a density that is impenetrable to humans but allows small ground dwelling fauna to freely move.
  • Connectivity of planted flora within landscaped features must be planted to allow for refuge for fauna. Based on expert judgement, patches of vegetation must be included that are a minimum of 3 m in length and/or 1 m wide (or variations in shape). In addition, maximum distances between refuge vegetation patches must not exceed 25 m. Vegetation planted within refuge areas must enable access to ground dwelling fauna at ground level.
  • Ground level habitat must be installed in conjunction with vegetative patches. Ground level habitat may include: logs and branches, rocks, swales, artificial tunnels and low water logged areas. Ground level habitat should be constructed to be contiguous with vegetation (if appropriate).
  • Grasses used for planting must be from native indigenous stock or non-native species that are not listed as weed or invasive species or have a low seeding rate. Grasses planted are to consist of a range of heights, included mown and freely sprouting areas.
  • Supplement habitat resources outlined in the following table for birds and arboreal species:
<table>
<tr><th>Habitat Resource</th><th>Target Species</th></tr>
<tr><td>Arboreal forage (native food plants)</td><td>Arboreal browsing species. e.g.
Banded Leaf Monkey
Horsfield’s Flying Squirrel</td></tr>
<tr><td>Artificial nests and roosts</td><td>Hollow reliant nesting/roosting bird and arboreal species. e.g.
White-rumped Shama
Blue-crowned Hanging Parrot</td></tr>
<tr><td>Ground habitat (fallen logs and undergrowth)</td><td>All herpetofauna</td></tr>
</table>
  • Maintain a minimum of 10 m buffer between Project components. Forest buffers of 45-50m width to be established/retained to maintain connectivity within the Project area and the CCNR. Where forest connectivity cannot be maintained, artificial techniques may be used (such as rope ladders).
  • Artificial connectivity elements must be considered where tree canopy growth or vegetation is immature or distances are too great to facilitate fauna movement. Measures such as nets and rope ladders should be used. Regular inspections must occur to ensure that the artificial connectivity is functioning and that fauna are not injured.
</td></tr>
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<tr><th>Phase / Activity</th><th>Specific Actions</th></tr>
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To mitigate impacts within the buffers during operation, the following additional landscaping measures are required

Supplement habitat resources outlined in the following table for ground dwelling herbivorous and den-dependent nursery species:

<table>
<tr><th>Habitat Resource</th><th>Target Species</th></tr>
<tr><td>Ground forage (native food plants)</td><td>Ground dwelling herbivorous mammals e.g. Lesser Mouse Deer</td></tr>
<tr><td>Artificial dens</td><td>Den-dependent nursery species. e.g. Sunda Pangolin</td></tr>
</table>

To maintain connectivity and reduce the risk of incursion by fauna into Project components and surrounding roads, the following mitigation has been designed:

Perimeter hoarding / fencing must: be of a maximum height of 2.4 m; exclude all resident fauna from fully closed enclosures (see separate requirement for enclosure design); exclude ground dwelling fauna from all Project components (including Sambar Deer and Wild Boar); exclude all ground dwelling fauna from accessing Mandai Lake Road and Mandai Road (daily inspections in the morning must occur along Mandai Lake Road to determine if fauna have become trapped within the Road verge; crush resistant fencing (to withstand tree fall) along the verge of the Eco-Link of maximum 2.4 m height to prevent fauna from entering the road verge and to protect the road verge from falling trees; low fences may be used to prevent fauna from entering high human traffic areas within vegetative barriers, such as the Arrival Nodes.

To maintain canopy connectivity between habitat within Project components, the following mitigations will be applied:

Maintain canopy connections where possible between trees to facilitate arboreal movement of fauna, including gliders. Maximum gliding distances for Malayan Colugo and Horsfield’s Flying Squirrel are approximately 100 m. For primates such as the Banded Lead Monkey, interlocking canopies are preferred.
Canopy connectivity should occur at the following locations:

Eco-Link deck;
Arrival Node tree canopies;
Retained vegetation within Project components adjacent to the CCNR;
Vegetation retained outside of enclosures within Project component area;
Adjacent to Disturbed Primary forest and the Planet Explorer and Sri Seletar Point;
Vegetation along the Boardwalk;
Across Mandai Lake Road (the development shall avoid the existing Alstonia trees along Mandai Lake Road which provide connections for arboreal fauna as a first priority; netting and rope ladders should be considered to facilitate movement across the road verge and to prevent access by fauna to the road);

Artificial connectivity elements must be considered where tree canopy growth or vegetation is immature or distances are too great to facilitate fauna movement. Measures such as nets and rope ladders should be used. Regular inspections must occur to ensure that the artificial connectivity is functioning and that fauna are not injured.

</td></tr>
</table>

Phase / Activity	Specific Actions

Monitoring	• The following monitoring will be undertaken during construction to determine impacts on connectivity and enable adaptive management:
	  • Wildlife camera traps will be installed along the boundary of Project component areas during construction activities. Cameras are to be placed to face forest or grassland areas. The wildlife camera traps are to be placed along wildlife corridors to determine wildlife corridor use during construction. These corridors include: temporary wildlife crossing point across Mandai Lake Road; along hoarding facing the CCNR (note time delays should be used so the cameras are active to capture nocturnal fauna); cameras are to be placed to face forest or grassland areas to determine use of areas adjacent to refuge areas; all wildlife camera traps must be inspected fortnightly to collect photographs and ensure they are functioning correctly.
	  • Prior to the opening of the *Eco-Link*, wildlife cameras are to be placed on both entrances to the *Eco-Link* (North and South). At least three (3) wildlife cameras are to be placed facing each entrance. Cameras are to be placed to face the CCNR and buffer zone to determine the use of the *Eco-Link* during operation. All wildlife camera traps must be inspected on fortnightly to collect photographs and ensure they are functioning correctly. The data will be used to monitor the use of the *Eco-Link* by target fauna.
	• The following monitoring measures will be applied during operations to determine species utilisation of habitat and connectivity:
	  • Wildlife camera traps will be installed permanently during operations at locations in and around the Project area, including along the buffers and *Eco-Link*. The specific location will be based on the layout of the project and long term monitoring of the refuge areas.
	  • Transect surveys will be undertaken during operation within the Project area at a frequency to be determined in consultation with the relevant technical agencies. The transect survey should occur at dawn/dusk. All species should be identified and recorded using a field data sheet. The data is to be used to inform the movement patterns and dispersal of species identified as requiring management and dispersal into refuge areas by ground dwelling fauna.
	  • All artificial habitat connectivity (rope ladders etc.) are to be inspected at a minimum of 6 monthly intervals to ensure they are functioning and are free from obstacles. All habitat connectivity structures must be repaired/replaced as necessary.
	• The following monitoring activities will be undertaken during operation to determine the adequate functioning of fences around Project components:
	  • All fencing structures must be maintained and regularly inspected for damage or breaches. Following a storm event, all fences must be inspected and repaired, as necessary.

Phase / Activity	Specific Actions

Management of Implementation	• The following measures will be applied to manage the implementation of the mitigation measures listed above:
	  • Contractor EHS manager or coordinator to undertake daily inspection of construction area.
	  • MPH to maintain a complaints procedure to log and track response to complaints received from stakeholders.
	  • MPH to implement an adaptive management framework and change procedure to manage changes to mitigation measures.

8.5.8.2 Residual Impacts

Impacts to species from the restriction of movement/loss of connectivity arise due to threats from the loss of habitat access, reducing the ability for fauna to seek refuge within surrounding habitats. This impact is assessed in terms of impacts within the Project Vicinity from threats posed by activities during construction and operation reducing connectivity and broader landscape connectivity within adjacent habitats (including the CCNR).

The magnitude of impact to species as a result of the loss of connectivity during construction and operation is considered to be **Medium** within the Project Vicinity without mitigation. The impact will affect a sufficient proportion of a species population that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it. Mitigation measures have been designed to reduce the intensity of impacts by providing temporary crossing corridors within the Project area (along the edges of the Upper Seletar Reservoir and across Mandai Lake Road). Buffer areas adjacent to the CCNR will maintain connectivity around construction areas. Canopy level connectivity will be enabled through the application of landscaping and forest restoration. Wildlife are still able to move within and utilise habitats within the CCNR and surrounding areas, however access to the northern areas of the CCNR will be restricted during construction of the *Eco-Link*. The application of mitigation to enable fauna movement during construction through the use of a temporary fauna crossing across Mandai Lake Road (see *Figure 3.5h* of *Annex 18*) and the construction of the *Eco-Link* will reduce the impacts to **Small**. Access to habitat will be maintained within the Project Vicinity during construction. The impact will affect a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself.

Table 8.46: Impact Assessment Summary – Restrictions to Wildlife Movement/Loss of Connectivity during Construction and Operation

Criterion	Rating	Comment
Restrictions to Wildlife Movement/Loss of Connectivity		
Nature	Negative	Restrictions to resident species within the Project area from the construction restricting movement/connectivity within the Project Vicinity.
Type	Direct	Construction hoarding and clearance of vegetation will have a direct impact on the ability of resident species within the Project area to readily move within and across the Project Vicinity.
Duration	Long-term	The impacts will commence upon erecting of hoarding prior to clearance of vegetation and will be permanent for certain ground dwelling fauna. Over the longer term, impacts to avifauna and arboreal species will diminish as they return to the Project Vicinity.
Extent	Local	Temporary and permanent hoardings and fences will be installed around the boundary of the Project area; and within the Project area to restrict movement of fauna during construction. During operation, the fencing will restrict terrestrial fauna movement into and from the Project area.
Scale	Medium	The impact scale within the Project Vicinity is considered to be Medium. Fauna will be able to move freely within adjacent areas; however north-south connectivity within the CCNR will be restricted during construction of the *Eco-Link*.
Magnitude	Medium	During construction and operation within the Project Vicinity, the impacts are likely to be Medium. Temporary movement will be restricted within the CCNR during construction of the *Eco-Link*. The impact will affect a sufficient proportion of a species population that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and contains species that are listed as CR on the SRDB and IUCN Red List.
Significance	Major	The significance of impacts to species within the Project Vicinity is considered to be Major. The impacts will commence during construction of the individual Project components and be permanent for larger ground dwelling species. Avifauna and arboreal species are expected to make limited use of habitat within the Project area over the longer term. Areas of habitat are available for fauna refuge around the Project site during construction; however, impacts to resident species are likely through restrictions to movement within the CCNR and East-West across the Project area during construction.
Residual Impact Magnitude	Small	The magnitude is considered to be Small in the Project Vicinity during construction and operation. Although ground dwelling fauna will be restricted in accessing the Project area, connectivity will be maintained within the CCNR and surrounding forested landscape. The impact will likely affect a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself
Residual Impact Significance	Moderate	The Residual Impact significance is considered to be Moderate within the context of the wider Project Vicinity (Small Magnitude; High Receptor Sensitivity).

8.5.9 Introduction and Proliferation of Weed / Invasive Species

8.5.9.1 Mitigation

Measures to mitigate the impacts due a reduction in connectivity during construction and operation activities are outlined in *Table 8.47*.

Table 8.47: Mitigation Measures for Introduction and Proliferation of Weed/Invasive Species

Phase / Activity	Specific Actions

General Management & Planning	• The following mitigation measures are to be implemented for the management of invasive species within the Project Vicinity during clearance activities:
	  • Specific measures will be undertaken to control and manage flora species within the Project area that have been identified to be invasive (i.e. *Spathodea campanulata; Cecropia pachystachya*; and *Falcataria moluccana*). Particular care will be exercised in managing *Falcataria moluccana* groves as the species serves as a nesting site for locally endangered species such as the Grey-Headed Fish Eagle (*Icthyophaga ichthyaetus*) and Changeable Hawk Eagle (*Nisaetus cirrhatus*). Other weed and invasive species may also provide important foraging resources. Inspections of these areas must be undertaken to identify nests or roosts, and individuals left to leave the site of their own accord prior to the commencement of any clearing works.
	  • All weed and invasive species cleared from the Project area must be separated and transported to an appropriate disposal location. Transport must be via a covered vehicle to ensure seed/vegetative matter does not dislodge. All vegetative matter and seeds must be rendered inert at the disposal location through incineration at a licensed waste disposal facility. The Project site must be carefully cleared of all remaining vegetative matter from the weeds/invasive species. Herbicides may be used to render any stumps/root systems inert. The cleared area will be inspected on a monthly basis (alongside inspections of trees and signs of edge effects) to identify any seedlings of invasive species. These individuals must be killed using herbicide or removed by hand weeding. Any seedlings or vegetative matter that may sprout must be disposed of at a licensed waste management facility.
	  • All flora used for planting must be from native indigenous stock or non-native species that are not listed as weed or invasive species or have a low seeding rate.

Transportation	• The following measures must be implemented in relation to the importation/transport of materials to and from the Project area:
	  • Material imported into the Project area to be checked for contamination from weed/invasive species seeds/vegetative matter at source. This is particularly important for imported building materials, such as clay and soil. Source site should be inspected to determine presence of weed/invasive species. Where weed or invasive species are identified, alternative supply sources should be used or decontamination must occur before the material is transported to site.
	  • Disposal of cleared weeds and invasive species shall be conducted off-site. All removed weeds and invasive species shall be treated to ensure that any seeds or branches are rendered inert and unable to germinate or sprout. Disposal must be undertaken by a licensed waste contractor.

Phase / Activity	Specific Actions
	• All vehicles and machinery used for construction purposes will be cleaned prior to use on site to remove any seeds, plant, contaminating material. If vehicles and machinery leave the site, they must be cleaned/washed down prior to re-entry or departure from the Project area. All construction vehicles to pass through a bunded wheel wash upon entry and exit of the construction work areas. • Water used in wheel wash to be sourced from mains supply and contained, pumped and periodically removed from site by a licensed wastewater collector or discharged to a surface water drain not connected to the unnamed stream parallel to the western boundary of the *Bird Park* and Upper Seletar Reservoir, in accordance with relevant regulations. Discharge to the unnamed stream along the Project western boundary and Upper Seletar Reservoir is strictly prohibited. • During operation, if invasive species infestations are identified through regular monitoring, these outbreaks must be controlled. • The use of herbicides and pesticides must be minimised. If herbicides or pesticides are used within the Project area, techniques that limit spray or non-target spray drift must be used. These techniques include but are not limited to: cut and paint techniques, drilling injection. All use of herbicides and pesticides must be conducted in accordance with the relevant Material Safety Data Sheet (MSDS). Any incidents of off label use, spillage or damage to non-target species must be reported and investigated.
Monitoring	• The following monitoring measures will be implemented to monitor the management, introduction and proliferation of invasive species: • Monitor the extent of invasive species within the Project area during construction and operation on a monthly basis to identify any new infestations. • Material imported into the Project area to be checked for contamination from weed/invasive species seeds/vegetative matter at source. This is particularly important for imported building materials, such as clay and soil. Source site should be inspected to determine presence of weed/invasive species.
Management of Implementation	• The following measures will be applied to manage the implementation of the mitigation measures listed above: • Contractor EHS team to undertake inspection of construction area for weed/invasive species. • Contractor EHS team to implement hygiene control measures (including wheel washes) to control the transmission of weeds/invasive species. • MPH to inspect the provenance of all imported materials to ensure that that it is free from weed/invasive species. • MPH to contract a licensed waste contractor to dispose of weed and invasive species at a licensed waste facility. • MPH to maintain a complaints procedure to log and track response to complaints received from stakeholders. • MPH to implement an adaptive management framework and change procedure to manage changes to mitigation measures.

8.5.9.2 *Residual Impacts*

Impacts to habitats from invasive species and weeds can reduce the integrity of habitats and impact the provision of resources to resident species. The impacts have been assessed in terms of the threats posed within the Project Vicinity by invasive species and weeds during construction and operation; and in terms of the possible transmission threat to/from the Project area to surrounding habitats.

Without mitigation, the magnitude of impact from weed and invasive species within the Project Vicinity during construction and operation is considered to be **Medium**. The impact may affect part of the habitat, but it is not considered that it will threaten the long-term viability / function of the habitat. It is noted that invasive and exotic species are already common within parts of the Project area.

Invasive and weed species can have negative impacts on native vegetation communities that are often exacerbated through soil disturbance and subsequent proliferation. Invasive species identified to occur within the Project site include: *Spathodea campanulata*; *Cecropia pachystachya*; and *Falcataria moluccana*. Considerable populations of other introduced flora exist within the surrounding landscape. Introduction of additional invasive species may also occur during construction from vehicles and other transmission pathways (waterways, humans and fauna) thereby affecting part of the habitat.

Mitigation measures to control and monitor invasive and weed species during construction and operation will reduce the potential for further proliferation within the Project Vicinity. There is a risk that invasive or weed species may be imported onto the site during construction and operation. Mitigation measures have been designed to reduce this risk by managing the importation of materials that may be sources of weed/invasive species. With the application of mitigation outlined in *Table 8.47*, the residual impact magnitude is expected to reduce to **Small**. The impact could be expected to affect a small area of habitat. However the mitigation measures are known to be particularly effective and it is considered that a loss of viability / function of the habitat is unlikely after the application of mitigation.

Table 8.48: Impact Assessment Summary – Introduction and Proliferation of Weed / Invasive Species

Criterion	Rating	Comment
Introduction and Proliferation of Weed / Invasive Species		
Nature	Negative	Potential introduction and proliferation of weeds and invasive species during construction impacting the integrity of habitats within the Project Vicinity.
Type	Direct	Weed and invasive species may have a serious impact on the integrity of ecosystems through competition and subsequent changes in the species mix.
Duration	Long-term	Introduction and proliferation of weed and invasive species may have long-term deleterious impacts to ecosystems.
Extent	Local	Weed and invasive species infestations can impact the Project area and transmit to surrounding landscapes or move from the Project Vicinity. Invasive species have been identified within the Project Vicinity.
Scale	-	Invasive species identified to occur within the Project site include: *Spathodea campanulata*; *Cecropia pachystachya*; and *Falcataria*

Criterion	Rating	Comment
Introduction and Proliferation of Weed / Invasive Species		
		moluccana. Considerable populations of other introduced flora exist within the surrounding landscape. Introduction of additional invasive species may occur during construction from vehicles and other transmission pathways (waterways, humans and fauna).
Magnitude	Medium	The introduction and proliferation of weed and invasive species during construction and operation within the Project Vicinity is considered to be of Medium magnitude. The impact may affect part of the habitat, but it is not considered that it will threaten the long-term viability / function of the habitat.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and the species of conservation significance are listed as CR on the SRDB and IUCN Red List.
Significance	Major	The impact significance is considered to be High given the potential magnitude of impact (Medium) and receptor sensitivity (High).
Residual Impact Magnitude	Small	Mitigation measures during construction will reduce the populations of weeds and invasive species within the Project Vicinity and reduce the residual impact magnitude to Small. Invasive species pose a risk to the Project Area during construction from proliferation in newly disturbed areas (and it is noted that the area already has a significant presence of invasive species). During operation, introduced species may compete against newly restored habitats if not appropriately controlled. Measures to manage invasive species are well understood and known to be effective for control of invasive species. Monitoring and adaptive management will also detect and suppress new outbreaks such that there is no loss of viability / function of the habitat.
Residual Impact Significance	Moderate	The residual impact significance is considered to be Moderate given the residual magnitude of impact and receptor sensitivity during construction. (Small Magnitude; High Receptor Sensitivity).

8.5.10 Competition for Resources / Conflict

8.5.10.1 Mitigation

Measures to mitigate impacts due to competition for resources/conflict during construction and operation activities are outlined in *Table 8.49*.

Table 8.49: Mitigation Measures for Competition for Resources / Conflict

Phase / Activity	Specific Actions
General Management & Planning and Monitoring	• To reduce competition for resources/conflict within the Project area during construction and operation, maintaining connectivity and movement for fauna will be necessary. The mitigation outlined in the residual impact assessment for the *Disturbance and Displacement of Fauna* (*Table 8.41*) will be applied to manage the relocation of fauna from the Project area to refuge areas. The following additional mitigation measures will be required to reduce competition for resources/conflict within the refuge areas: • Conduct fauna tracking using GPS trackers for Sambar Deer and Wild Boar to determine their movement within the CCNR and refuge areas during construction and operation (subject to agreement with and approval from the relevant land owner and/ or regulatory authority for areas external to the Project boundary). Permits will be obtained from NParks prior to affixing GPS trackers to individual Sambar Deer and Wild Boar; • Conduct monitoring of fauna using camera traps/ GPS tracking within refuge areas to determine movement patterns and habitat utilisation (subject to agreement with and approval from the relevant land owner and/ or regulatory authority for areas external to the Project boundary). • Monitor resources within refuge areas (such as the availability of fruiting and flowering plants) to determine if sufficient resources are available during construction and operation (subject to agreement with and approval from the relevant land owner and/ or regulatory authority for areas external to the Project boundary). Resource monitoring should occur during the inter monsoon period when rainfall is lower (Late March-May and October-November). • Monitor nests, dens, roosts, hollow trees, ground habitat, feed trees etc. to determine usage within refuge areas (subject to agreement with and approval from the relevant land owner and/ or regulatory authority for areas external to the Project boundary). These features will be marked using a GPS to enable future reference. • Supplement habitat resources if required and possible within identified refuge areas if monitoring indicates a reduction in available resources (subject to agreement with and approval from the relevant land owner and/ or regulatory authority for areas external to the Project boundary). Habitat resources that may be required to be supplemented are outlined in the following table:

<table>
<tr><th>Phase / Activity</th><th>Specific Actions</th></tr>
<tr><td></td><td>
<table>
<tr><th>Habitat Resource</th><th>Target Species</th></tr>
<tr><td>Ground and arboreal forage (native food plants)</td><td>Ground dwelling herbivorous mammals, e.g. Lesser Mouse Deer
Arboreal browsing species, e.g. Banded Leaf Monkey; Horsfield's Flying Squirrel</td></tr>
<tr><td>Artificial nests and roosts</td><td>Hollow-reliant nesting/roosting bird and arboreal species, e.g. White-rumped Shama; Blue-crowned Hanging Parrot</td></tr>
<tr><td>Artificial dens</td><td>Den dependent nursery species, e.g. Sunda Pangolin</td></tr>
<tr><td>Ground habitat (fallen logs and undergrowth)</td><td>All herpetofauna</td></tr>
</table>
Population control measures may be required if monitoring data indicates this is warranted. These measures may include: additional targeted shepherding activities; capture and release; and/or neutering (if over population is identified). Any population control measure can only be initiated with prior permission obtained from NParks and AVA.
</td></tr>
<tr><td>Management of Implementation</td><td>

The following measures will be applied to manage the implementation of the mitigation measures listed above:

MPH to work with NParks in monitoring the movement of fauna within the Project Vicinity/CCNR.
MPH to work with the relevant landowner or regulatory authority to implement monitoring of resources within the Project Vicinity and refuge areas.
MPH to maintain a complaints procedure to log and track response to complaints received from stakeholders.
MPH to maintain a system to record all mitigation measures and assign responsibility for implementation and monitoring.
MPH to implement an adaptive management framework and change procedure to manage changes to mitigation measures.

</td></tr>
</table>

8.5.10.2 Residual Impacts

Impacts to species from competition for resources/conflict to species can cause changes in the distribution of species populations and/or injury/mortality. These threats are considered in terms of the Project Vicinity due to the ecological connectedness of the Project area with surrounding habitats and the disturbance/displacement of fauna that will occur during construction.

Without mitigation, the magnitude of impact from competition for resources/conflict within the Project Vicinity during construction and operation is considered to be **Large**. Primarily, impacts will be to ground dwelling and arboreal fauna displaced from the Project area into surrounding habitat, including species such as the Lesser Mouse Deer (*Tragulus kanchil*), Sunda Pangolin (*Manis javanica*) and Malayan Colugo (*Cynocephalus variegatus*). However, all species displaced may suffer some form of conflict/competition for resources with existing populations. The impact will be permanent due to the reduction in available habitat for

resident species. Species requiring management may also be displaced, causing additional conflict for resources (See residual impact summary for *Species Requiring Management* at *Table 8.54*). The impact will affect an entire population or species at sufficient scale to cause a substantial decline in abundance and/or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) may not return that population or species, or any population or species dependent upon it, to its former level within several generations, or when there is no possibility of recovery.

Mitigation measures to foster the movement of fauna from the Project area to refuge areas will manage fauna conflict within the Project Vicinity. Additional mitigation measures to monitor and supplement resources if required within the refuge areas will reduce the severity of impacts. With the application of mitigation outlined in *Table 8.49*, the residual impact magnitude is expected to reduce to **Small**. The impact, if monitored and managed is expected to impact only a small number of individuals and would reduce in time as populations stabilise during operation.

Table 8.50: Impact Assessment Summary – Competition for Resources/Conflict

Criterion	Rating	Comment
Competition for Resources/Conflict		
Nature	Negative	Clearing of vegetation prior to construction will displace fauna, causing impacts to species in surrounding areas from competition for resources and conflict.
Type	Secondary impact	This is a secondary impact due to the disturbance and displacement of fauna during construction.
Duration	Long-term	Impact duration will occur during construction and continue during operation.
Extent	-	Primarily, impacts will be to ground dwelling and arboreal fauna displaced from the Project area, including species such as the Lesser Mouse Deer (*Tragulus kanchil*), Sunda Pangolin (*Manis javanica*) and Malayan Colugo (*Cynocephalus variegatus*).
Scale	Medium	The total amount of habitat cleared during construction will be 170,879 m^2. In addition, a total of 113,764 m^2 of habitat will be enclosed. Fauna relocated from these areas will experience competition for resources in the refuge areas. The impact scale within the Project Vicinity is considered Medium. Sufficient habitats exist within this area, including within the CCNR and land to the west of the Project area, however resource competition will arise during relocation activities and continue during operation.
Magnitude	Large	The magnitude of impact to species within the Project Vicinity is considered Large. The effect may cause a substantial change in abundance and/or reduction in distribution of a population over one, or more generations, and is likely to threaten the long term viability/function of a given population. Of particular concern are impacts to the Sunda Pangolin (*Manis javanica*), the Lesser Mouse Deer (T*ragulus kanchil*) and the Malayan Colugo (*Cynocephalus variegatus*).
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and contains threatened species listed as CR on the SRDB and IUCN Red List.

Criterion	Rating	Comment
Significance	Critical	The significance of impacts to species within the Project Vicinity is considered to be Critical. Areas of habitat are available within this radius for species to redistribute into during construction. It is likely that some conflict/competition for resources will occur within refuge areas.
Residual Impact Magnitude	Small	Application of mitigation will reduce impacts on species within the Project Vicinity. Wildlife will be displaced from the Project area in phases in accordance with the Wildlife Protection Plan (refer to *Annex 18*) which will reduce the intensity of competition for resources in adjacent refuge habitats as compared to relocating wildlife from the entire Project area all at once. A long-term wildlife and habitat monitoring programme, that will include refuge and dispersal habitat within and around the Project area, will be initiated from the commencement of site development. The phased relocation of wildlife from the Project area will allow for monitoring of wildlife and habitat for signs of conflict/ stress and for adaptive management techniques to be applied to reduce the severity of impacts during construction. In addition, habitat enhancement, which will commence before construction begins, will be carried out in the buffer areas to supplement habitat resources through the planting of native plants for food, nesting and to enhance connectivity. Provision of a temporary ground-level corridor within the *Bird Park* and *Rainforest Park North* sites during construction of the *Eco-Link* and, thereafter, provision of the *Eco-Link* across Mandai Lake Road will enable continued ground dwelling species movement across refuge areas, allowing individuals to move to avoid resource competition. The residual impact magnitude for the vicinity is therefore considered to be Small. The effect will not cause a substantial change in the population of species displaced or resident, or other species dependent on it.
Residual Impact Significance	Moderate	The residual impact significance is considered to be Moderate in the Project Vicinity. (Small Magnitude; High Receptor Sensitivity).

8.5.12 Mortality From Hunting and Poaching

8.5.12.1 Mitigation

Measures to mitigate impacts due to hunting and poaching are outlined in *Table 8.51*.

Table 8.51: Mitigation Measures for Mortality from Hunting and Poaching

Phase / Activity	Specific Actions

General Management & Planning	• The following mitigations will be applied during construction and operation to reduce the risk of hunting and poaching by the workforce and visitors to the Project area:
	  • Prior to clearance and construction activities, a briefing will occur with all involved personnel so that they are aware of their roles and responsibilities; including requirements regarding the prohibition of hunting/catching/taking of fauna and flora. Refresher training is to occur with new employees.
	  • Any individual suspected or caught with fauna and flora will be reported to the relevant authority.
	  • A visitor awareness program is to be conducted to provide information on the impacts on hunting on local flora and fauna during operations.
	Should an incident contravene the *Wild Animals and Birds Act*, the incident will be immediately reported to the AVA for further action. Random inspections of personnel arriving and leaving the Project area can be considered.

Monitoring	• The following monitoring will be undertaken to detect hunting and poaching of fauna and flora during construction and operation: • Camera traps will be installed permanently during operations at locations in and around the Project area, including within the buffers and on the *Eco-Link*. These will also detect the presence of hunting and poaching. The specific location will be based on the layout of the project and long term monitoring of the refuge areas.
Management of Implementation	• The following measures will be applied to manage the implementation of the mitigation measures listed above: • Contractor EHS manager or coordinator shall be responsible for providing training to the workforce concerning the no hunting/poaching policy.

8.5.12.2 Residual Impacts

Impacts from hunting and poaching can cause impacts to fauna through direct fauna mortality and impacts on flora from picking/damage. The impact assessment is considered in terms of the Project Vicinity due to the ecological connectedness of the Project area with surrounding habitats and the threat posed on species populations within the broader area.

Without mitigation, the magnitude of impact from hunting and poaching of fauna and flora within the Project Vicinity during construction and operation is considered to be **Medium**. Primarily, impacts will be to species such as the Sunda Pangolin (*Manis javanica*), which are a known target species. Additional impacts to flora may also occur during operation. A sufficient proportion of a species population may be affected such that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.

Mitigation measures have been designed to educate workers and visitors on the need to preserve local indigenous flora and fauna. With the application of mitigation, including publicising the no hunting/poaching policy to the construction workforce, the residual impact magnitude is expected to be **Small**. If hunting or poaching occurs it is likely to affect a small proportion of a population, but is not expected to substantially affect other species dependent on it, or the populations of the species itself.

Table 8.52: Impact Assessment Summary – Mortality from Hunting and Poaching

Criterion	Rating	Comment
Mortality from Hunting and Poaching		
Nature	Negative	Potential mortality of fauna from hunting and poaching during construction by workers.
Type	Direct	Impacts may directly affect wildlife populations during construction.
Duration	Long-term	Impacts will occur during the construction period and may continue through to operation.
Extent	Local	Impacts would be restricted to local populations within the Project area.
Scale	-	The scale of impacts may be large, especially to species such as the Sunda Pangolin (*Manis javanica*), which is a known target species.
Magnitude	Medium	Without controls, the magnitude is considered to be Medium. The impact will affect a sufficient proportion of a species population that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area hosts various species of conservation significance listed as CR on the SRDB and IUCN Red List that may be the target of hunting/poaching.
Significance	Major	The significance is considered to be Major without mitigation.
Residual Impact Magnitude	Small	If mitigation educates workers and strictly controls the poaching and subsequent mortality of fauna during construction, the residual impact magnitude is considered to be of Small magnitude. If it occurs at all, it would be expected to impact a small proportion of a population, but not to substantially affect other species dependent on it, or the populations of the species itself.
Residual Impact Significance	Moderate	It is expected that mitigation will lower the residual impact significance to Moderate. The receptor sensitivity remains High but it is expected that adequate controls can reduce the likelihood of mortality from hunting and poaching to Low. The residual impact will not cause a substantial change in the population of the species present (Small Magnitude; High Receptor Sensitivity).

8.5.12 Species Requiring Management

8.5.12.1 Mitigation

Measures to mitigate impacts due to the proliferation of species requiring management during construction and operation activities are outlined in *Table 8.53*.

Table 8.53: Species Requiring Management

Phase / Activity	Specific Actions
General Management & Planning	• The mitigation measures outlined in *Table 8.37, Clearing Vegetation / Habitats Prior to Construction* and *Table 8.49, Mitigation Measures for Competition for Resources / Conflict* will apply to the species requiring management. The fencing described in *Table 8.45, Mitigation Measures for Restriction to Wildlife Movement/Reductions in Connectivity* will apply to restrict access of ground dwelling fauna to the Project area during construction/operation. The following additional management measures are required to reduce the impact of these species during construction and operation: • All waste disposal areas and containers must be covered and heavy duty to prevent access by fauna (especially the Long Tailed Macaque); all waste must be cleared at least twice per day. • All workers must attend an induction program and be educated on ensuring that all work places are kept clean and waste is not left in open areas. All workers must be prohibited from feeding animals. • Mesh size of enclosures must be constructed to exclude resident fauna. A maximum of 25mm stainless steel wire mesh must be used for all enclosures that house fauna. Polyethylene or polypropylene may be used if suitable for the host species. Smaller mesh sizes may be used where the species requires additional protection. Larger mesh sizes may be used for large fauna (such as ground dwelling reptiles/mammals). All enclosures must contain a band of mesh or steel to prevent rodent and reptile access into the enclosures. • All drainage and effluent points will be covered with fine mesh to prevent ingress of outside fauna. An electronic CCTV system will be installed at critical areas (doors, perimeter fence). • The periphery of all enclosures will consist of a barrier system designed to not allow animals (such as mice, snakes and monitor lizards) to enter into the enclosures. A concrete skirting of at least 1 m deep will be sunk into the ground to deter ground burrowing animals. The mesh from ground to the height of 2.5 m will be sized to prevent the entry of ground animals. The mesh from 2.5 m above ground will be sized to prevent ingress of arboreal animals. • Monitoring of Sambar Deer and Wild Boar within the Project Vicinity is to occur (if possible). If monitoring indicates that an increase in population has occurred and/or damage is occurring to the CCNR, a program of population control using non-lethal methods may be conducted in conjunction with NParks. In addition, MPH will work with the relevant authorities on the management of these animals should it become a public nuisance. Any population control measure can only be initiated with prior permission obtained from NParks and AVA.

Phase / Activity	Specific Actions

Monitoring	• The following monitoring measures will be implemented to monitor the species requiring management:
	  • During operations, use CCTV to monitor waste disposal sites to determine if fauna are able to access waste facilities.
	  • Monitor and inspect enclosures on a weekly basis to determine if fauna species have entered enclosures.
	  • Conduct fauna tracking using GPS trackers for Sambar Deer and Wild Boar to determine their movement within the CCNR and refuge areas during construction and operation (if possible).
	  • Conduct monitoring for tracks/traces of Sambar Deer and Wild Boar within identified refuge areas (if possible).

Management of Implementation	• The following measures will be applied to manage the implementation of the mitigation measures listed above:
	  • Contractor EHS team to undertake daily inspection of construction area.
	  • MPH to maintain a complaints procedure to log and track response to complaints received from stakeholders.
	  • MPH to implement an adaptive management framework and change procedure to manage changes to mitigation measures.

8.5.12.2 Residual Impacts

Impacts from species requiring management can cause impacts to the ecological integrity of habitats and impacts to humans. The impact assessment is considered in terms of the Project Vicinity due to the threats posed to humans (especially during operations) and due to impacts that may arise due to the displacement of species requiring management into surrounding habitats.

Without mitigation, the magnitude of impact from species requiring management within the Project Vicinity during construction and operation is considered to be **Medium**. Populations of species such as the Sambar Deer (*Rusa unicolor*), Wild Boar (*Sus scrofa*), Long Tailed Macaque (*Macaca fascicularis*) and non-native rodents may increase due to the introduction of human-derived resources and lack of natural predation, increasing competition and increasing the chances for human/wildlife conflict. Resident species may also access enclosures, putting exhibited fauna at risk of predation. A sufficient proportion of a species population may be affected that may bring about a substantial change in abundance and /or reduction in distribution over one or more generations if not appropriately managed.

Mitigation measures have been designed to educate workers and visitors on the need to preserve local indigenous flora and fauna. Management of potential foraging resources (waste) and monitoring will enable adaptive management to manage populations of species requiring management within the Project Vicinity. If possible, MPH will work with NParks to monitor species such as the Sambar Deer and Wild Boar to determine impacts on the CCNR. Measures may be taken to control these species if monitoring indicates that populations are increasing and damage is occurring to the CCNR/refuge areas. In addition, MPH will work with the relevant authorities on the management of these animals in the event that these animals become a public nuisance. Any population control measure can only be initiated with prior permission obtained from NParks and AVA. Measures to control ingress of fauna

into the Project area will also manage potential predation of exhibited fauna. With the application of mitigations, the residual impact magnitude is expected to reduce to **Small**. The impacts are likely to affect a small proportion of a population, but do not substantially affect other species dependent on it, or the populations of the species itself.

Table 8.54: Impact Assessment Summary – Species Requiring Management

Criterion	Rating	Comment
Species Requiring Management		
Nature	Negative	Habitat creation during construction and operation may increase the populations of resident species requiring management through increases in available resources.
Type	Direct	Populations of species such as the Sambar Deer (*Rusa unicolor*), Wild Boar (*Sus scrofa*), Long Tailed Macaque (*Macaca fascicularis*) and non-native rodents may increase due to the introduction of human-derived resources and lack of natural predation, increasing competition and increasing the chances for human/wildlife conflict.
Duration	Long-term	If not adequately controlled, the impact may occur over the long-term with populations increasing in response to increased resources.
Extent	Local	The extent of the impact is considered to be local, impacting the Project area, the CCNR and natural areas within the Project Vicinity.
Scale	-	It is difficult to predict population increases in individual species; however the scale could be large if not appropriately managed. No natural predators exist within Singapore for these species to control their populations.
Magnitude	Medium	The impact on habitats is considered to be Medium. Increases in populations of these species may deplete resources and have substantial impacts on the integrity of ecological systems. Impacts can therefore affect a sufficient proportion of a species population that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and contains threatened species listed as CR on the SRDB and IUCN Red List.
Significance	Major	The significance of impacts to habitats is considered to be Major as the magnitude is considered to be Medium and receptor sensitivity is considered to be High.
Residual Impact Magnitude	Small	If resource availability is controlled during construction, it is considered that the impact magnitude for habitats will reduce to Small. The effect would impact a smaller area of habitat, such that there is no loss of viability/function of the habitat in the long-term. Fencing to prevent access to the Project area by Wild Boar and monitoring and control of populations will reduce potential impacts during operations. Resulting impacts may affect a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself.
Residual Impact Significance	Moderate	It is expected that mitigation will lower the residual impact significance to Moderate for species and habitats. The receptor sensitivity remains High but it is expected that adequate controls can reduce the chance of increases in populations of these species (Small Magnitude; High Receptor Sensitivity).

8.5.13 Noise Impacts to Fauna during Construction

8.5.13.1 Mitigation

Measures to mitigate impacts due to noise generated from the Project during construction activities are outlined in *Table 8.55.*

Table 8.55: Mitigation Measures for Noise Impacts to Fauna

Phase / Activity	Specific Actions
General Management & Planning	• To mitigate against noise impacts on fauna during construction, the mitigation measures to reduce noise generation during construction as outlined in *Table 8.18* should be implemented. The following additional mitigation measures are to be applied: • Locate construction worksite entrances and haul routes as far as possible from the CCNR. • Operation of machinery for construction is restricted to 08:00 and 18:00. • Include signs along nature trails, the *Boardwalk* and within 100m of the CCNR to request visitors to keep quiet and not make excessive noise. • Where possible, undertake a visitor introduction session to educate visitors to keep noise to a minimum when visiting the attractions. • Utilise noise attenuation devices to absorb and direct noise away from forested areas/habitats and to avoid a direct line of sight of the construction site.
Monitoring	• The following noise monitoring is to occur during construction: • Noise monitoring in accordance with Annex C & D of the Singapore Standard SS602:2014 to ensure compliance against limits in the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations and guideline values adopted for the Project EIA. • Noise monitoring is to occur adjacent to the eastern and western edges of the CCNR at the closest location to the source (during and dependent on the work package being constructed). Multiple sites may be implemented. • Adopt additional mitigation measures around work methods and timing or physical screening in the event that noise exceedances are recorded.
Management of Implementation	• The following measures will be applied to manage the implementation of the mitigation measures listed above: • MPH to maintain a complaints procedure to log and track response to complaints received from stakeholders. • MPH to undertake noise monitoring in the Project area. • MPH to implement an adaptive management framework and change procedure to manage changes to mitigation measures.

8.5.13.2 Residual Impacts

Impacts from noise can cause disturbance and displacement of resident species during construction. The impact is considered in terms of impacts to resident fauna within the Project Vicinity as these species will be impacted by noise generating sources that may impact their lifecycle.

Without mitigation, the magnitude of impact from noise on fauna within the Project Vicinity during construction is considered to be **Medium**. Noise impacts will last for a period of up to 7 years during construction. Demolition and piling works will give rise to the greatest noise impacts and will likely be completed within a shorter timeframe, i.e. within 6 months, for each relevant Project component. Noise impacts on species can cause disturbance and displacement, reducing species utilisation of habitats. If noise is not appropriately controlled, a sufficient proportion of a species population may be affected that may bring about a substantial change in abundance and /or reduction in distribution over one or more generations if not appropriately managed.

Mitigation measures have been designed to reduce the duration and intensity of noise at source during construction. Specific measures used to manage human receptor impacts will be sufficient to reduce noise impacts on fauna. It should be noted that no specific standards or guidelines exist for the reduction of noise impacts on fauna. Mobile powered equipment used during construction will be located away from the CCNR and buffer areas. With the application of mitigation, the residual impact magnitude is expected to reduce to **Small**. The impacts are likely to affect a small proportion of a population, but do not substantially affect other species dependent on it, or the populations of the species itself.

Table 8.56: Impact Assessment Summary – Impacts on Fauna from Noise during Construction

Criterion	Rating	Comment
Impacts from Noise on Fauna		
Nature	Negative	Impacts from noise to resident species within the Project Vicinity from construction noise sources.
Type	Direct	Construction noise will have a direct impact on resident species within and adjacent to the Project area through disturbance to lifecycle functions.
Duration	Long-term	The impacts will commence during construction and last for a period of up to 7 years during construction. Demolition and piling works will likely be completed within a shorter timeframe, i.e. < 6 months, for each relevant Project component.
Extent	Local	Habitats within and immediately adjacent to the Project area.
Scale	Large	The impact scale within and adjacent to the Project Vicinity is Large during the construction phase. The northern component of the CCNR will be exposed to levels between 70 – 82 dB(A), whereas the southern component of the CCNR may be exposed to levels up to 88 dB(A) at close proximity to the Project boundary.
Magnitude	Medium	The impact within the Project Vicinity is considered to be Medium as it will affect a sufficient proportion of a species population such that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and contains threatened species that are listed as CR on the SRDB and IUCN Red List.

Criterion	Rating	Comment
Impacts from Noise on Fauna		
Significance	Major	The significance to species within the Project area is considered to be Major. Sensitive species are located within the Project area and the CCNR. These include species such as the Lesser Mouse Deer (*Tragulus kanchil*), Malayan Colugo (*Cynocephalus variegatus*) and Sunda Pangolin (*Manis javanica*).
Residual Impact Magnitude	Small	Application of mitigation will reduce impacts on species within the Project Vicinity through the use of noise-reducing methods and equipment during piling and demolition works. Operation of construction machinery, including activities such as piling and demolition works, will only be undertaken in daylight hours between 08:00 and 18:00, reducing impacts on nocturnal species. The impacts will likely affect a Small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself.
Residual Impact Significance	Moderate	The Residual Impact significance is considered to be Moderate (Small Magnitude; High Receptor Sensitivity).

9 OPERATION PHASE IMPACT ASSESSMENT

9.1 AIR QUALITY

9.1.1 Impact to Human Receptors due to Increased Vehicular Emissions

9.1.1.1 Sources

Key substances related to vehicular emissions in Singapore include NO_2, $PM_{2.5}$, PM_{10} and CO. The major source of vehicular emission during the operation phase of the Project is associated with the transportation of visitors. An increase in the number of visitors will result in an increase in the number of vehicles, both HDVs (e.g. coaches, buses) and LDVs (cars, mini vans). The existing Mandai Lake Road will be modified to cater for the growth in the number of vehicles and the traffic volume is also expected to increase along Mandai Road.

9.1.1.2 Receptors

Human receptors located within 500 m [1] from Mandai Lake Road and Mandai Road comprises WRS personnel and visitors with sensitivity assessed to be Medium and High, respectively.

9.1.1.3 Impacts

The substances emitted from vehicles are 'criteria pollutants' [2] that could cause adverse impacts on human health and environment. Vehicular emissions may become a concern as the visitation and the volume of vehicles will grow once the new attractions commence operation. In order to evaluate the impacts associated with vehicular emissions during operation, the screening assessment also adopted for the construction impacts was used.

The approach to assessing operational impacts evaluated the increased number of vehicles associated with the new attractions. Since the new attractions will be opened in two phases, namely 2020 and 2023, the recommended approach based on the IAQM guidance would be to assess conditions for the opening years (i.e. first year) of each new phase [3]. As visitation information was only available for the projected visitation numbers used for the conceptual design (i.e. year 2036), the screening assessment was only completed on this basis.

The increased traffic flows due to the Project were obtained by subtracting the forecast total number of visitors to the existing WRS attractions (i.e. *Singapore Zoo, Night Safari* and *River Safari*) and new attractions by the number of visitors to the existing WRS site on the basis that the existing WRS site has reached its capacity and thus visitation growth is not expected to increase significantly under a "no development" scenario.

The change of LDV and HDV traffic flows in year 2036 are shown in *Table 9.1*.

[1] Health Effect Institute (2010) **Traffic-Related Air Pollution: A critical review of the literature on emissions, exposure and health effects.** Retrieved from http://pubs.healtheffects.org/getfile.php?u=553

[2] USEPA (2015) **Six Common Air Pollutants.** Retrieved from http://www3.epa.gov/airquality/urbanair/

[3] IAQM (2015) **Land-Use Planning & Development Control: Planning for Air Quality**

Table 9.1: Calculation of the Traffic Flow Change due to the Project

	Current	With New Development
Annual Visitation	3,830,000	12,270,000
Annual Number of Visitors travelling by LDVs		
Car	949,840 (24.8%)	2,490,810 (20.3%)
Taxi	1,237,090 (32.3%)	3,361,980 (27.4%)
Motorcycle	30,640 (0.8%)	85,890 (0.7%)
Annual Number of Visitors travelling by HDVs		
Coach	448,110 (11.7%)	883,440 (7.2%)
Bus	1,160,490 (30.3%)	5,312,910 (43.3%)
Annual Number of LDVs [(1)]		
Car	189,968	498,162
Taxi	309,273	840,495
Motorcycle	15,320	42,945
Annual Total	514,561	1,381,602
Annual Average Daily Traffic (AADT) [(3)]	1,410	3,785
Increase in AADT due to the Project		**2,375**
Annual Number of HDVs [(2)]		
Coach	9,958	19,632
Bus	13,982	64,011
Annual Total	23,940	83,643
Annual Average Daily Traffic (AADT) [(3)]	66	229
Increase in AADT due to the Project		**163**

Notes:

(1) Calculated based on the following capacity: Car - 5, Taxi - 4, Motorcycle - 2

(2) Calculated based on the following capacity: Coach - 45, Bus – 83

(3) Annual total divided by 365 days since the Zoo is operational all year round.

Source: MPH, 2015

Table 9.1 shows that the numbers of LDVs and HDVs are anticipated to increase by 2,375 and 163 respectively due to the new attractions and these are beyond the threshold limits described in *Annex 2, Table A2.1.3*. Consequently, the impact in relation to increased vehicular emissions during operation is assessed to be Potentially Significant.

At the time of writing, the Project proponent was exploring different transportation options that could affect the magnitude of impact from vehicular emissions assessed. It is therefore recommended that an updated screening assessment is undertaken at a later stage when the design is more mature. Where the screening assessment using the updated information concludes the same outcome (i.e. Potentially Significant), a detailed assessment is necessary to understand the extent of the impact. A summary of the impact assessment is provided in *Table 9.2*.

Table 9.2: Impact Assessment Summary

Criterion	Rating	Comment
Elevated Vehicular Emissions Due to Operation Activities		
Nature	Negative	Vehicular emissions of critical air pollutants (CO, $PM_{2.5}$, PM_{10} and NO_2).
Type	Direct	Direct health impacts to sensitive receptors, in particular those that are susceptible to air quality changes such as the young, the elderly and those suffering from respiratory conditions.
Duration	Long-term	Over the duration of operations (or until transport options change).
Extent	Local	Gaseous and particulate species from vehicular emission may impact receptors within 500 m from Mandai Road and Mandai Lake Road.
Scale	-	Increased vehicular emissions will mainly occur along Mandai Lake Road and Mandai Road since these are the main accesses to the Project area.
Frequency	Frequent	Daily throughout the operation stage.
Magnitude	Potentially Significant	Based on *Table 9.1*, the increase in numbers of LDVs and HDVs due to the new attractions are likely to be more than the threshold limits specified in *Table A2.1.3, Annex 2*, meaning that the impact is Potentially Significant.
Receptor Sensitivity	High	Sensitivity of visitors to the Zoo is High as the visitors will include receptors that are susceptible to vehicular emissions (e.g. young children, elderly).
	Medium	Sensitivity of Zoo personnel is assessed to be Medium as they will generally be healthy adults.
Significance	Potentially Significant	The change in LDV and HDV traffic flows is expected to be above the threshold limits for determining impact significance. Re-screening and where required, assessment, is recommended once the full design has been further developed and transport options are finalised.

9.2 SURFACE WATER

9.2.1 Impact to Surface Water from Operation Activities

9.2.1.1 Sources

Based on the Scoping Study, project description, and expected operation methods, impacts to surface water quantity and quality during the operation phase may arise from the following activities and conditions:

- Potential impacts on surface water quality and quantity arising from Project area runoff and Project area discharges:
    - Storage of fuel, chemicals, operation waste and stockpiling of spoil materials resulting in runoff carrying increased nutrient loading;
    - Possible operational dewatering of underground structures resulting in changes in groundwater flow which may indirectly alter the base flow of surface streams;

- Operation of aboveground and underground structures (e.g. *Eco-Link*, *West* and *East Arrival Nodes*, new quarantine area and nursery, new WTPs, surface and underground carparks) resulting in increased volume of direct runoff;

- Impacts on surface water aquatic ecosystems, damaging habitats and impacting on aquatic species; and

- Littering by visitors using attractions, trails and *Boardwalk*s.

- Unplanned events:

  - Overflow of surface runoff from surface water drainage and ancillary facilities and WTP within the Project area due to a major rainfall event. The surface runoff overflowing into the reservoir could carry animal wastes and pathogens that are detrimental to the Upper Seletar Reservoir, which is a drinking water reservoir;

  - Firefighting – firewater runoff; and

  - Leakage or spillage of fuels, chemicals, fertilisers, waste materials, etc. stored on the Project area during operation that could enter streams or the reservoir.

9.2.1.2 Receptors

The Scoping Study for the Project identified the Upper Seletar Reservoir and streams within the Sungei Mandai Water Catchment Area as the surface water sensitive receptors due to their proximity to the Project area. Surface water receptors in the Study Area consist of the following:

- Upper Seletar Reservoir, a drinking water supply; and
- Streams in the Sungei Mandai Water Catchment.

For the purposes of this assessment, the sensitivity of the receptors to surface water impacts from the Project is **High** due to the proximity of and connection to the Upper Seletar Reservoir (a drinking water supply).

9.2.1.3 Impacts

The Study Area encompasses several surface water features such as the Upper Seletar Reservoir, small streams draining into the reservoir, streams draining to the northwest and to the sea, and the existing stormwater drainage infrastructure in the WRS operated area. The primary use of the Upper Seletar Reservoir is for storage of raw water to be treated for potable use. Further description of the watershed and water quality baseline data are provided in *Chapter 6.4 Surface Water*.

The Project will involve operation activities such as stormwater management, wastewater treatment and disposal, possible maintenance dewatering, and operation of aboveground and underground structures (e.g. *Eco-Link*, *West* and *East Arrival Nodes*, new quarantine area and nursery, surface and underground carparks).

The Project's future operations will require some Project area to be paved. These areas will become impervious which will increase the amount of rain that is transformed to direct runoff. As described in *Chapter 2*, the project incorporates design measures to minimise overland flows directly into the Upper Seletar Reservoir, for example the water quality risk assessment which will be undertaken to ensure the drainage infrastructure design prohibits any polluted wastewater discharge to the reservoir. The drainage will also be such that it complies with the PUB's *Code of Practice for Surface Water Drainage*. The consequence of increased impervious and paved areas is a small increase in nutrient load from natural atmospheric loadings [(4)] that may enter the Upper Seletar Reservoir. However the scale of increase in surface area and hence runoff and nutrient loading attributable to the Project is expected to be insignificant when compared to the overall catchment area of the Upper Seletar Reservoir. An additional increase in nutrient loads to the Upper Seletar Reservoir would occur if the stormwater system is overwhelmed by runoff due to a major rainfall event. The surface runoff overflowing into the reservoir could carry animal bacteria and pathogens that are detrimental to the Upper Seletar Reservoir, which is a drinking water reservoir.

Changes to surface water quality within the Study Area may arise from chemical and waste storage and handling during the operation stage. Maintenance of underground carparks and other underground structures may require the location to be continuously dewatered. This activity may modify groundwater flow, discharge groundwater at the surface and alter the base flow component of surface streams. Surface drainage from carparks often contains oil, grease, and other hydrocarbons.

Existing and proposed animal waste streams will be treated to levels meeting national regulations and disposed of away from drinking water sources. Wastewater from fertilizer storage and maintenance activities will similarly be controlled and disposed according to national regulations.

The Project includes construction of a new shoreline *Boardwalk* around the perimeter of the WRS area. Considering its proximity to the Upper Seletar Reservoir, impact could arise from public littering to the Upper Seletar Reservoir from *Boardwalk* during operation. Littering may also occur in the general areas used by the public, such as visitors to the attractions; and users of the trails.

Unplanned events such as equipment failure and overflow of wastewater caused by a malfunction or major rainfall event or firewater could also impact surface water quality. The surface runoff could carry animal wastes and pathogens that are detrimental to the Upper Seletar Reservoir given its use as a drinking water supply. The purpose of the on-site WTPs is to serve as facilities to treat animal waste and used water from animal contact / enclosures, which will be captured by perimeter drains, before discharging to sea. Secondary methods for removal of wastewater from the Upper Seletar catchment during emergencies will be considered and incorporated into the design. Examples include equalization storage or bypass pumping to the effluent discharge line.

[4] Wetzel R. G., (2001). *Limnology: Lake and River Ecosystems*. Third Edition, Academic Press.

In the event of fire, firefighting efforts may generate large volumes of wastewater in the Project area. Should this occur, every effort should be made to direct the water into the stormwater drainage system and pumped away from the Upper Seletar Reservoir. Use of the stormwater system's temporary emergency storage basin may also be considered to allow suspended solids to settle out of the water and disposed separately from the water.

While such unplanned events have a low likelihood of occurrence, the impacts they may cause on sensitive receptors may be significant.

Considering the nature, type, duration, frequency, extent, scale, and the magnitude criteria defined for water resources in *Annex 2*, the magnitude of impact of surface water modifications caused by the Project's operation phase is **Small**. Given the **High** sensitivity of the receptors due to it being a drinking water supply, the significance of the surface water impacts is assessed to be **Moderate**. It is noted that, as the Project is at the concept masterplanning stage, the magnitude of surface water modifications caused by the Project's operation phase will be reviewed during the detailed design stage.

9.2.1.4 Mitigation

Measures to limit and minimise the magnitude of surface water impacts caused by the Project's operation phase are outlined in *Table 9.3*. It is noted that all mitigation measures should be reviewed and further details included at the operational planning stage.

Table 9.3: Mitigation Measures for Surface Water Operation Phase

Phase / Activity	Specific Actions
General Management & Planning	• Best practice waste management during the operation phase, including frequent collections and removal of waste from the Project in accordance with regulatory requirements. • Protect surface water sources during operation by ensuring functioning and management of sanitary facilities for workers and visitors. • Properly store and manage hazardous materials used during operation activities. Strategically locate areas for temporary storage of hazardous materials away from surface water resources. Chemicals and fuels must be properly labelled and stored in bunded areas on pallets. Storage of hazardous materials on-site should be limited to minimise the impact of any spillage or mitigation failure. • Develop and implement a spill response plan for drips/leaks/spillage of hazardous materials. Plan should include training requirements for staff; spill control equipment (e.g. spill kits, absorbent material); implementation protocols; clean up measures and emergency contact details. • Upon availability of drainage design details, undertake a risk assessment to determine appropriate containment systems and incorporate these in the EMMP.
Operation and Maintenance	• Locate stockpiles (e.g. associated with operational landscaping; cleaning of attractions etc) as far as possible from drainage swales. For example, avoid stockpiling next to streams. • Re-vegetate exposed ground as soon as possible to stabilise surfaces. • Provide litter bins and regular housekeeping on *Boardwalk* and trails. Maintain active clearing of waste from *Boardwalk* and the areas near the reservoir. • Discharge of pumped dewatered groundwater from excavations to Upper

Phase / Activity	Specific Actions
	Seletar Reservoir and the unnamed stream (due to ecological sensitivities) will be strictly prohibited. This water may be suitable for use in water features proposed at the *West Arrival Node*. Subject to agreement with PUB, ultimate discharge to the drainage system that flows to the sea may represent the environmentally preferred option. • The design of the WTP will include alarms and standby pumps to protect against equipment failure as well as emergency power provision. Secondary methods for removal of wastewater from the Upper Seletar catchment during emergencies will be considered and incorporated into the design. Examples include equalisation storage or bypass pumping to the effluent discharge line. • In case of a hydrocarbon spill, implement a contingency and response plan. Include equipment needed to recover and clean up the spilled hydrocarbon (i.e., absorbent material). • Prevent illegal disposal of operation wastes. • Disposal of waste into streams, stormwater channels or Upper Seletar Reservoir is strictly prohibited. • Vehicle maintenance and mechanical repairs are to occur in dedicated, designed locations, bunded to capture and control oil, grease, and other spills to prevent flow into surface water resources.
Monitoring	• Implement a continued surface water monitoring programme. Programme should be undertaken immediately prior to operations / post construction and thereafter on a bi-annual basis. Parameters assessed should be consistent with that of the baseline assessment and compared against the standards outlined in the EMMP. In the event that contamination is detected in surface water, further investigation may be required and the frequency of monitoring adjusted accordingly. Monitoring locations should be above and below hydrogeological gradient of the Project area.
Management of Implementation	• Contractor EHS team to undertake daily inspection of operation area. • Maintain a procedure to log and track complaints from stakeholders and the Contractor's responses.

9.2.1.5 Residual Impacts

Surface water impacts from operation activities can be managed by implementation of the mitigation measures listed in *Table 9.3*. The magnitude of residual impact following implementation of mitigation measures is assessed to be **Small**. A summary of the impact assessment before and after implementation of mitigation measures is presented in *Table 9.4*.

Table 9.4: Surface Water Operation Phase Impact Assessment Summary

Criterion	Rating	Comment
Surface Water Quality and Quantity due to Operation Activities		
Nature	Negative	Potential changes in surface water quality due to possible operational dewatering of underground structures, increased stormwater runoff and nutrient loading, improper storage of operation materials and waste, public littering, and other unplanned events.
Type	Direct	Operation activities directly affect surface water resources, quantity and quality.
Duration	Long term	Estimated at least 20 years of operation
Extent	Regional	Surface water resources migrate beyond the Project boundaries into the Upper Seletar Reservoir and the Sungei Mandai

Criterion	Rating	Comment
Surface Water Quality and Quantity due to Operation Activities		
		Catchment.
Scale	-	Project boundary consists of 6% of Sungei Mandai catchment and 8% of the Upper Seletar Reservoir catchment.
Frequency	Continuous	Estimated at least 20 years of continuous Project activities throughout the Project boundaries and frequent stormwater events.
Magnitude	Small	Negligible change in Upper Seletar Reservoir trophic index assuming drainage design takes risk assessment (during construction phase) findings into consideration.
Receptor Sensitivity	High	Due to drinking water supply.
Significance	Moderate	High sensitivity of drinking water supply increases the significance of this small magnitude impact.
Residual Impact Magnitude	Small	After implementation of proposed mitigations, surface water quality monitoring programme, and best practices related to protection of surface water quality.
Residual Impact Significance	Moderate	Residual impact significance is unchanged.

9.3 SOIL & GROUNDWATER

9.3.1 Impact to Soil and Groundwater from Operation Activities

Based on the results of the Scoping Study as summarised in *Chapter 5*, the types of Project-related impacts on soil and groundwater resources that will be considered in this assessment include:

- Potential impacts on groundwater quality arising from Project runoff and Project discharges;
- Potential impacts on the existing groundwater elevation and flow, due to operation of underground structures; and
- Unplanned events such as accidental spills and overflow of stormwater drainage system and ancillary facilities due to major rainfall events and overflows from the WTP.

Changes to the soil and groundwater quality within the Study Area may arise from chemical and waste storage and handling during the operation phase of the Project. The operation of underground carparks and other underground structures may require continuous removal of groundwater at the base of the structures. This activity may modify groundwater flow and the base flow component of surface streams. This may also cause secondary effects on groundwater-dependent vegetation and any surface waterbodies hydraulically connected to the intercepted groundwater.

9.3.1.1 Sources

Operation activities causing impacts to soil and groundwater resources are likely to include the following:

- Operation of underground structures;
- Modifications to existing surface water drains within the Project area; and
- Leakage or spillage of fuels, chemicals, fertilisers, waste materials, etc. stored on the Project area during operation that could enter the groundwater aquifer.

9.3.1.2 Receptors

The Scoping Study for the Project identified the Upper Seletar Reservoir and streams within the Sungei Mandai Water Catchment Area as the surface and groundwater sensitive receptors due to their proximity to the Project area. Soil and groundwater receptors in the Study Area therefore consist of the following:

- Upper Seletar Reservoir, a drinking water supply; and
- Streams in the Sungei Mandai Water Catchment.

For the purposes of this assessment, the sensitivity of the receptors to soil and groundwater impacts from the Project are evaluated to be **Low** on the west side of the Project where surface and groundwater naturally migrate to the northwest, and **High** on the east side of the Project, on the peninsula of land surrounded on three sides by the Upper Seletar Reservoir (a drinking water supply).

9.3.1.3 Impacts

The primary potential groundwater impact will be changes to the elevation of the groundwater table. Groundwater elevations in the area are generally correlated to topographic elevations. Water initially enters the surficial aquifer from rainfall infiltration and it flows downgradient, from higher elevations to lower elevations. Groundwater in the Study Area flows to one of two sinks: directly into the Upper Seletar Reservoir or as baseflow to the streams in the Sungei Mandai Catchment.

In order to characterise the groundwater table in the Study Area, a GMS/MODFLOW conceptual groundwater model was created using available data as described in *Chapter 8*. See *Figure 8.2* for a contour map of the groundwater elevations under existing conditions generated by the model.

Carparks and other underground structures have been proposed as part of the Project. From a groundwater perspective, Project activities that cause potential impacts to groundwater during the operation phase include the following:

- Maintenance dewatering of underground carparks; and
- Maintenance dewatering of other underground structures.

While engineering details are not yet available, it is possible that dewatering will be required to maintain the groundwater elevation below the floor elevation of some structures. These activities were input to the model as internal boundary conditions. A contour map of

groundwater during the construction phase is shown in *Chapter 8*, *Figure 8.3*, while the existing groundwater elevations, construction groundwater elevations, the difference in elevations, and the pumping flow rates required to dewater the structure excavations are summarised in *Chapter 8, Table 8.9*.

Results of the modelling show that Project operation activities will be the same as construction activities, with lower groundwater levels beneath and adjacent to the proposed underground structures. Model results also indicate that during operation, groundwater will continue to flow towards the Upper Seletar Reservoir in the eastern portion of the Study Area. In the western portion of the Study Area, groundwater will flow into the Sungei Mandai Catchment area. Generally, a lowered groundwater table will result in less base flow entering surface drainage channels, such as the unnamed stream to the west of the Project Area, and therefore reduced flow in these channels but modelling indicates that the direction of groundwater flow will not be affected. There are not anticipated to be impacts to any natural streams within the CCNR as a result of groundwater drawdown.

Considering the influencing factors and the magnitude criteria defined for water resources in *Annex 2*, the magnitude of soil and groundwater impacts caused by the Project's operation phase is evaluated to be **Medium** in the western portion of the Study Area and **Small** in the eastern portion of the Study Area. While the scale of the impact in the east is less than the west, the sensitivity in the east is greater than that in the west. Given the High sensitivity of the receptors in the east and the Low sensitivity in the west, the significance of the soil and groundwater impacts are assessed to be **Moderate** in the east and **Minor** in the west.

9.3.1.4 Mitigation

Measures to avoid, minimise, and limit the magnitude of soil and groundwater impacts caused by the Project's operation phase are outlined in *Table 9.5*. Mitigations include best practices, monitoring, and general housekeeping activities.

Table 9.5: Mitigation Measures for Soil and Groundwater Operation Phase

Phase / Activity	Specific Actions
General Management & Planning	• Best practice waste management during the operation phase. Management activities will include frequent collections and removal of waste from the Project in accordance with regulatory requirements. • Protect groundwater sources during operation by ensuring functioning and management of sanitary facilities for park visitors, animals, and employees. • Implement a regular maintenance programme for all equipment and machinery to prevent fuel spillage or leakage during operation activities. • Properly store and manage hazardous materials used during operation activities. Strategically locate areas for temporary storage of hazardous materials away from groundwater resources, Upper Seletar Reservoir and the unnamed stream. Chemicals and fuels must be properly labelled and stored in bunded areas on pallets. Storage of hazardous materials on-site should be limited to minimise the impact of any spillage or mitigation failure. • Develop and implement a spill response plan for drips/leaks/spillage of hazardous materials. Plan should include training requirements for staff; spill control equipment (e.g. spill kits, absorbent material); implementation protocols; clean up measures and emergency contact details.

Phase / Activity	Specific Actions
Operation and Maintenance	• Locate stockpiles (e.g. associated with operational landscaping; cleaning of attractions etc) as far as possible from drainage into the ground. For example, avoid stockpiling next to carpark dewatered areas. • Cover stockpiles with tarpaulin when not in use. • Re-vegetate exposed ground as soon as possible to stabilise surfaces. • Prohibit illegal disposal of waste by using licensed third party waste contractors. • Discharge of pumped dewatered groundwater from excavations to Upper Seletar Reservoir and the unnamed stream (due to ecological sensitivities) will be strictly prohibited. This water may be suitable for use in water features proposed at the *West Arrival Node*. Subject to agreement with PUB, ultimate discharge to the drainage system that flows to the sea may represent the environmentally preferred option. • Inspect and schedule preventive maintenance to all vehicles used. Vehicle maintenance and mechanical repairs are to occur in dedicated, designed locations, bunded to capture and control oil, grease, and other spills to prevent infiltration into groundwater resources.
Monitoring	• Implement a groundwater monitoring programme. Programme should be undertaken immediately prior to operations / post construction and thereafter on a bi-annual basis. Parameters assessed should be consistent with that of the baseline assessment and compared against the standards outlined in the EMMP. In the event that contamination is detected in groundwater, immediate measures to be implemented to stop contamination source and contain contamination; PUB will be informed; further investigation undertaken (if required); and the frequency of groundwater monitoring adjusted accordingly. Monitoring locations should be above and below hydrogeological gradient of the Project area.
Management of Implementation	• Contractor EHS team to undertake frequent inspection of receptors and dewatered area. • Maintain a procedure to log and track complaints from stakeholders and the Owner's responses.

9.3.1.5 Residual Impacts

Soil and groundwater impacts from operation activities can be managed by implementation of the mitigation measures listed in *Table 9.5*. Protection of groundwater resources is imperative due to the connectivity of groundwater at the eastern portion of the Project area to the Upper Seletar Reservoir. The magnitudes of residual impacts following implementation of mitigation measures are unchanged, and therefore the significance remains as **Minor** for the western portion and **Moderate** for the eastern portion of the Study Area. A summary of the impact assessment criteria including the implementation of mitigation measures is presented in *Table 9.6*.

Table 9.6: Soil and Groundwater Operation Phase Impact Assessment Summary

Criterion	Rating	Comment
Groundwater Quality and Water Table Levels		
Nature	Negative	Decrease in groundwater table elevations, potential changes in groundwater quality due to dewatering, improper storage of materials, and other unplanned events.
Type	Direct	Operation activities directly affect groundwater resources, quantity and quality.
Duration	Long-term	Essentially permanent changes for the life of the attractions.
Extent	Regional	Groundwater resources migrate beyond the Project boundaries.
Scale		5 to 10 ha of drawdown, approximately 5 m of drawdown at the *West Arrival Node* Carpark. 1 to 5 ha of drawdown, approximately 1 m of drawdown at the *East Arrival Node* Carpark.
Frequency	Continuous	Continuous over at least 20 years of operation activity with dewatering possibly occurring at carparks and other underground structures as identified in *Chapter 2, Table 2.2*.
Magnitude	Medium Small	West side of the Study Area – due to area and depth of drawdown. East side of the Study Area – due to area and depth of drawdown.
Receptor Sensitivity	Low High	West side – groundwater is not hydraulically connected to drinking water supply (Upper Seletar Reservoir). East side – direct and unimpeded hydraulic connection to drinking water supply (Upper Seletar Reservoir).
Significance	Minor Moderate	West side East side
Residual Impact Magnitude	Medium Small	West side – mitigations do not change the residual impact magnitude but the implementation of a groundwater quality monitoring programme and best practices related to protection of groundwater quality provides additional warning of impacts greater than expected and allows the opportunity to apply additional corrective actions. East side – mitigations do not change the residual impact magnitude but the implementation of a groundwater quality monitoring programme and best practices related to protection of groundwater quality provides additional warning of impacts greater than expected and allows the opportunity to apply additional corrective actions.
Residual Impact Significance	Minor Moderate	West side – due to low sensitivity of resource. East side – due to high sensitivity of resource.

9.4 BIODIVERSITY

9.4.1 Impact to Terrestrial and Aquatic Biodiversity during Operation

Operation activities may have temporary or permanent, and positive or negative impacts on biodiversity values. These impacts may be directly caused by operational activities (such as the management of waste); or indirect impacts caused by secondary effects (such as bird collisions with enclosure structures).

9.4.1.1 Sources

The sources of impact to biodiversity values are derived from the operational activities that will occur on site as outlined in *Chapter 2, Project Description*. The operational hours, visitation and operational components of the project are the primary sources that may impact on biodiversity values. The sources, project components and operational schedule are outlined in the following subsections.

Source Descriptions

The activities or features associated with the operation of these project components that are considered likely to impact biodiversity include:

- Number of visitors (visitation);
- Opening hours;
- Generation and management of waste and wastewater;
- Discharge of hazardous substances or pollution;
- Transition of habitats/habitat loss during operation;
- Generation of domestic waste providing a food source for species requiring management;
- Delivery of materials to facilities after hours;
- Growth of fodder species and feed species;
- Interaction of visitors with fauna;
- Aerial collision risk with enclosure structures and netting;
- Potential escape of species from enclosures;
- Import of exotic pests and weeds within feed or from visitors;
- Increase in visitor vehicles and subsequent fauna collision risk;
- Management of weeds impacting non-targeted species;
- Potential spread of diseases to native populations from exhibited fauna; and
- Noise impacts on fauna during operation.

Project Components

The Project Description (*Chapter 2*) outlines the activities proposed for the Project area during operation. The key project components identified in relation to sources of impacts during operation to biodiversity are as follows:

- *East and West Arrival Nodes;*
- Mandai Lake Road modifications;
- *Eco-Link;*
- *Bird Park* and *Rainforest Park North;*
- *Rainforest Park South;*
- *Boardwalk*;

- *Eco-Lodge*; and
- *Planet Explorer* and *Sri Seletar Point.*

The relationship between sources and project components is outlined in *Table 9.7*.

Table 9.7: Relationship between Project Components and Impact Sources during Operation

Sources / Project Component	East and West Arrival Nodes	Mandai Lake Road modifications	Eco-Link	Bird Park and Rainforest Park North	Rainforest Park South	Boardwalk	Eco-Lodge	Planet Explorer and Sri Seletar Point
Number of visitors (Visitation)	X	X		X	X	X	X	X
Opening hours	X	X	X	X	X	X	X	X
Generation and management of waste and wastewater	X	X		X	X	X	X	X
Discharge of hazardous substances or pollution	X	X	X	X	X	X	X	X
Transition of habitats/habitat loss during operation	X	X	X	X	X	X	X	X
Generation of domestic waste providing a food source for species requiring management	X	X		X	X	X	X	X
Delivery of materials to facilities after hours	X	X	X	X	X	X	X	X
Growth of fodder/feed species				X	X			
Interaction of visitors with fauna	X	X		X	X	X	X	X
Aerial collision risk with enclosure structures and netting				X	X			
Escape of species from enclosures				X	X			
Import of exotic pests and weeds within feed or from visitors	X	X		X	X	X	X	X
Increase in visitor vehicles and subsequent fauna collision risk	X			X	X	X	X	X
Management of weeds and pests impacting non-targeted species	X	X	X	X	X	X	X	X
Potential spread of diseases to native populations from exhibited fauna				X	X			
Noise impacts on fauna during operation	X	X		X	X	X	X	X

Number of visitors (visitation) and hours of operation

Visitation

The projected number of visitors for the Project attractions during operation is outlined in *Table 9.8*. As would be expected, the *Arrival Nodes* will have the highest level of visitation. The highest visitation rates for individual project components will be for the *Rainforest Park (North and South)* and *Bird Park*. Both of these facilities are within a carefully controlled environment and will consist of a range of enclosed areas. Facilities that are less controlled (being outside of designated attraction areas) including the *Boardwalk* are projected to have lower levels of visitation. For the purposes of the impact assessment, discussion of the impacts on project components from visitation is discussed in the *Table 9.11* for habitats and *Table 9.12* for species.

Table 9.8: Projected Visitation of Project Components During Operation

Zone/ Attraction	Annual Attendance (2014/2015)	Peak Day Attendance (1) (2014/2015)	Projected Annual Attendance (2036)	Projected Peak Day Attendance (2) (2036)
East Zone				
Zoo (Existing)	1,680,000	14,280	1,800,000	15,300
River Safari (Existing)	1,140,000	11,970	1,100,000	11,600
Night Safari (Existing)	1,180,000	7,080	1,100,000	6,600
Planet Explorer			1,200,000	12,600
Sri Seletar Point			1,200,000	12,600
East Ungated			1,200,000	10,200 (4)
(A) East Zone Total			7,600,000	53,200
West Zone				
Rainforest Park North			2,000,000	15,200
Rainforest Park South				3,800
Bird Park	740,000 (Jurong)	5,850	1,500,000	14,300
West Ungated			1,200,000	10,200
(B) West Zone Total			4,700,000	32,900 (3)
Mandai Precinct Total (A+B)			12,300,000	86,100

Notes:

(1) Peak day is derived from the average attendance for the 2nd and 3rd highest days of the year – a more consistent figure than the absolute peak day attendance.

(2) Peak day projections are derived from annual visitation numbers (*Table 2.3*) that are conservative estimates which include a 12% buffer.

(3) The East and West Zone totals are not the sum of individual park attendances because the parks have similar, but not identical, patterns of daily attendance distributions (i.e. Peak days do not occur on the

Zone/ Attraction	Annual Attendance (2014/2015)	Peak Day Attendance [1] (2014/2015)	Projected Annual Attendance (2036)	Projected Peak Day Attendance [2] (2036)

same days) thus the total peak day figures for each zone and the overall Mandai Precinct has been reduced by 24%.

(4) The ungated East area also includes visitor projections for *Boardwalk*.

Hours of Operation

The opening hours proposed for the project components and corresponding potential nocturnal/diurnal disturbances are shown in *Table 9.9*.

Table 9.9: Opening Hours and Potential Daily Disturbances

Attraction / Activity	Operational Hours	Species disturbance periods
Rainforest Park	07.00 – 19.00 daily	Diurnal
Bird Park	09.00 – 18.00 daily	Diurnal
Eco-Lodge	24 hours / day	Crepuscular/Nocturnal/Diurnal
Planet Explorer and Sri Seletar Point	08.00 – 21.00 daily	Crepuscular/ Nocturnal/Diurnal
East Arrival Node	06.00 – 24.00 daily	Crepuscular/ Nocturnal/Diurnal
West Arrival Node	06.00 – 19.00 daily	Diurnal
Nature trails and Boardwalk (public areas)	06.00 – 19.00 daily	Diurnal
Back of House	06.00 – 22.00 daily	Crepuscular/ Nocturnal/Diurnal
Security	24 hours / day	Crepuscular/Nocturnal/Diurnal
Emergency	24 hours / day	Crepuscular/Nocturnal/Diurnal

Noise Sources

Operational noise sources will have a direct impact on resident species within and adjacent to the Project area through disturbance to lifecycle functions. Noise sources will include visitors, traffic, bird calls from the *Bird Park* and vehicle/machinery noise during operational hours. Bird calls from within the *Bird Park* by native species to Singapore may interfere with lifecycle functions of local residents of the same species. The impacts will be permanent and continue during operation and will likely affect resident species in habitats immediately adjacent to project components, including the CCNR. The proposed exhibited bird list has not been finalised at the time of the impact assessment. However, disruptions to native bird populations from exhibited birds are acknowledged and have been assessed as part of the species impact assessment (*Table 9.12*).

Light Sources

External lighting arrangements will be under the purview of the LTA in accordance with safety requirements first and foremost. Where needed for safety or operational reasons, lighting will be installed in such a way as to be sympathetic to the animal requirements and be energy efficient as much as possible, such as using Light Emitting Diode (LED) lighting and control systems. The anticipated lighting requirements developed at detailed design, will consider the operational hours (*Table 2.5)*. Further discussion and mitigations are contained in the impact assessment below.

9.4.1.2 Receptors

The Project footprint and adjacent areas contain biodiversity and conservation significant values as outlined in *Chapter 6*. These baseline studies identified a diversity of flora and fauna species, and ecosystems, including species listed on the SRDB and IUCN Red List of threatened species, endemic species and migratory species.

The habitats identified on site through the baseline surveys host a variety of flora and fauna that are listed as Critically Endangered, Endangered and Vulnerable on the SRDB and IUCN Red List. The Project area is located within the internationally recognised Central Forest Important Bird Area, and near the Mandai Important Bird Area. Priority habitats identified during the impact assessment are as follows:

- Vegetation/habitats located within the CCNR;
- Habitats associated with priority species (primary and secondary forests; and grasslands);
- Remnant forests (primary and secondary forests); and
- Riparian areas (forested freshwater habitat).

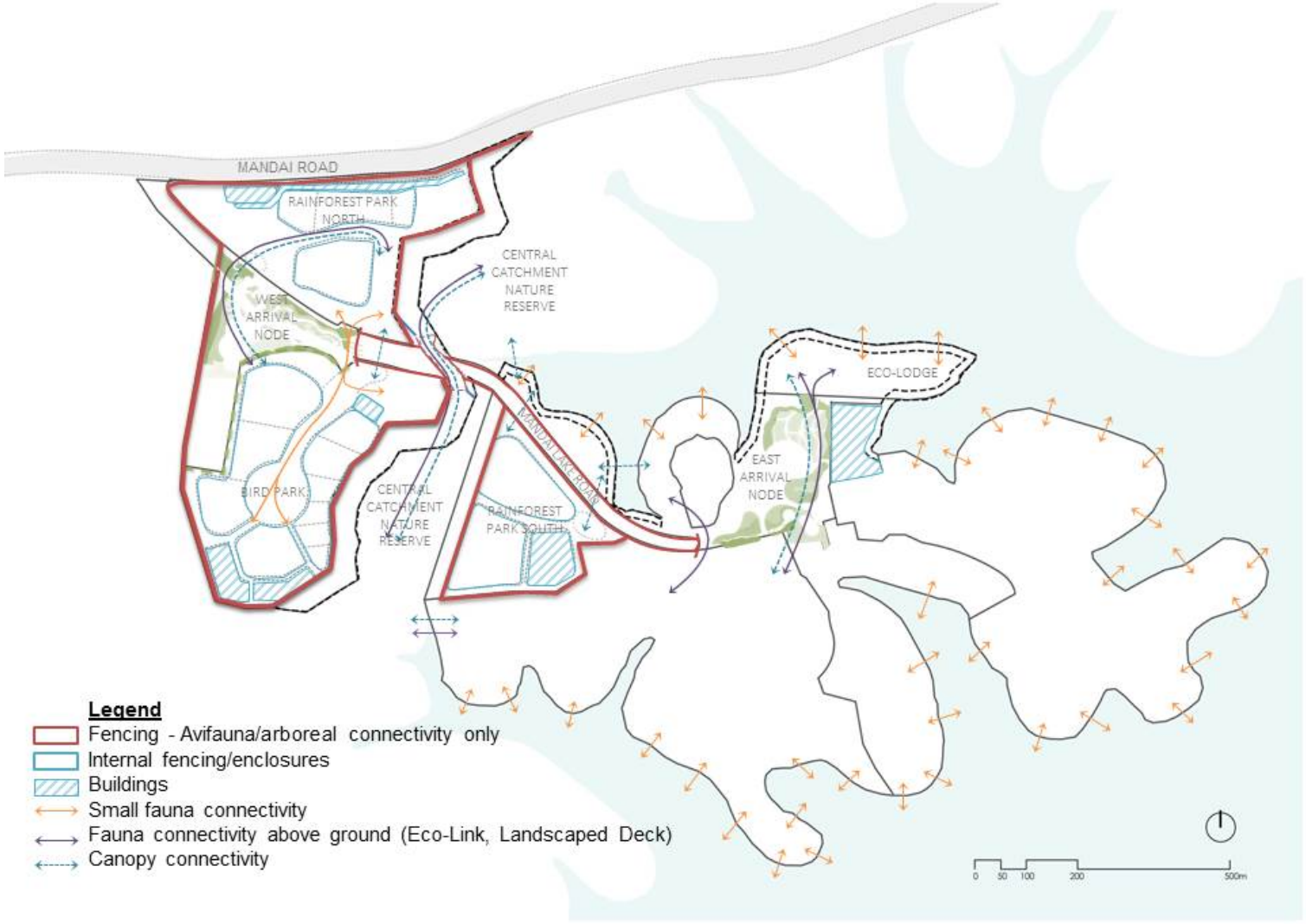
Habitats

Wildlife corridors and connectivity

Impacts to wildlife corridors can disrupt forest connectivity within a fragmented landscape where forest persists within a mosaic of other land uses. The Project will restrict movement of wildlife between forest patches and this may restrict the exchange of genetic material between populations and disrupt key processes such as seed dispersal that may contribute to the regeneration of disturbed forests.

The fencing strategy will prevent the access of large ground dwelling fauna to the Project area. Existing east-west connectivity across the Project site will consequently be disrupted. All hoarding and fencing structures must not use barbed wire as this poses a danger to arboreal animals. Arboreal fauna and avifauna will have access to open Project areas (excluding enclosures), including canopy level connectivity between the Project area and the CCNR and across Mandai Lake Road. The wildlife corridors and fencing strategy is shown in *Figure 9.1*.

Figure 9.1: Fencing Strategy During Operation



Retained Habitats

To determine impacts on habitats, ERM overlaid the development footprint of the Project area onto the habitat map. The impacts to habitats are shown in Chapter 8, *Figure 8.11* and *Figure 8.12*.

Edge Effects

Edge effects are negative impacts that occur when a habitat is exposed to a different adjacent habitat type or structure. These impacts can include increased risk of parasitism or disease, increased risk of predation, adverse microclimate conditions (including drying out and subsequent fire risk), and competition from invasive species [5].

The Project area has previously been subject to high intensity microburst storm events that have disturbed forested habitats and caused significant destruction of trees. These natural events may be exacerbated by the Project from the creation of wind tunnels from buildings and enclosures. During operation, this phenomenon may increase the risk of tree fall, impacting on enclosures and other built structures within the Project area. A subsequent risk may occur where enclosures are breached, resulting in the escape of enclosed fauna in the *Bird Park* and *Rainforest Park* project components. Further consideration of these impacts and mitigations are outlined in the impact assessment below.

The *Forest Restoration Plan* (*Annex 15*) and landscaping strategy outlines strategies to establish vegetation within the Project area and on the deck of the *Eco-Link*. The 30 m width of the *Eco-Link* has the potential to expose forest edges and cause subsequent edge effects. Successful establishment of landscaping and forest restoration will be required to reduce potential edge effects from buildings and enclosures in areas adjacent to the CCNR and remnant forest patches.

As described in *Chapter 2, Project Description*, a 45-50 m buffer will extend adjacent to the western edge of the CCNR within the *Bird Park* and *Rainforest Park North*. This buffer will reduce impacts to the CCNR from negative edge effects associated with the operation of the *Bird Park* and *Rainforest Park North* project components.

Forest Restoration and Landscaping

Forest restoration will continue during operation within all project components where habitats are retained. A *Forest Restoration Plan* has been prepared to outline the approach to forest restoration activities (see *Annex 15*). Guidelines have been included in the Plan for the *Eco-Link* and buffers; *Arrival Nodes*; *Rainforest Park (North and South)* and *Bird Park*. The Plan also includes specific guidance on flora planting strategies to attract native fauna to project components. The proposed planting strategies and associated fauna habitat are contained in *Annex 15.2*.

Specific planting strategies are included in the *Forest Restoration Plan* (see *Annex 15*) to attract species likely to utilise the *Eco-Link* (see *Chapter 8* for further information on species likely to use the *Eco-Link*). The Plan also contains specific measures to restore and transition existing forests that are non-native dominated and contain invasive species. Multi-tiered

[5] USDA (2012) Conservation Buffer, Guidelines V2.0. United States Department of Agriculture, National Agroforestry Center.

planting will be used to allow for gradual transition from the existing surrounding forest to be retained, promoting animal movement across the *Eco-Link*. The 3- and 4-tier planting along the edges of the deck serves to discourage high human activity in those areas. Trees will be planted in clusters with minimum edge to area ratio to maintain quality of microhabitats.

The landscaping strategy will aim to maintain habitats within project components, including providing refuge habitats in sensitive areas such as the *East and West Arrival Node*s that will play host to fauna, particularly at night time. Details of the landscaping strategy have been included in *Chapter 2, Project Description.*

Threatened Species

For the purposes of the impact assessment, priority species were selected if they met any of the following criteria:

- Listed on the IUCN Red List or the SRDB as CR, EN or VU;
- Migratory or restricted range species; or
- Species of interest within the Project area.

Reference has been made to data analysis in *Chapter 8* and the additional analysis outlined below.

Fauna Likely to Return to the Project Area during Operation

Some fauna displaced during construction are likely to return to the Project area within a relatively short period, while others may not return at all. It is difficult to predict the outcome of in-migration that may occur during operation. Given the adaptability of species and the provision of required resources from the replanting strategy, it is anticipated that, over time, species of conservation significance may return.

Resident Fauna Sensitive to Disturbance during Operation

Fauna located within the Project area are susceptible to disturbance from visitation and hours of operation. Disturbance and displacement may occur from direct interaction with humans, vehicles and species retained in the *Bird Park* attractions.

From the baseline data in *Chapter 6,* and the threatened species profiles contained in *Annex 11*, ERM has determined species that will be susceptible to disturbance during operation. Species have been listed based on their: territoriality that may cause restrictions to movement patterns if disturbed and conflicts occur; limited home ranges that may cause restrictions on the ability to move within the Project area; sensitivity to noise and human presence; and the species' preferred activity period. It is assumed that all resident bird species may be disturbed by calls from enclosed individuals of the same species. This information has been used for the purposes of the impact assessment for species during operation. Sensitive species susceptible to disturbance are shown in *Table 9.10*.

Table 9.10: Species Susceptible to Disturbance during Operation

Species	Territorial	Limited Home Range	Sensitive to noise/human presence	Activity period
*Mammals**				
Long-tailed Macaque	Yes	-	-	Diurnal
Banded Leaf Monkey	Yes	-	Yes	Diurnal
Malayan Colugo	Yes	Yes	-	Crepuscular/ Nocturnal
Sunda Slow Loris	Yes	Yes	Yes	Crepuscular/ Nocturnal
Common Palm Civet	-	-	No	Nocturnal
Birds				
Oriental Magpie Robin	Yes	-	No	Diurnal
Red Junglefowl	-	Yes	No	Diurnal
Mangrove Pitta	Yes	-	Yes	
Straw-headed Bulbul	Yes	-	Yes	Diurnal
Blue-crowned Hanging Parrot	Yes	-	Yes	Diurnal
White-rumped Shama	Yes	Yes	Yes	Diurnal
Red-legged Crake	Yes	-	Yes	Diurnal
Red-crowned Barbet	-	-	Yes	Diurnal
Drongo Cuckoo	Yes	-	Yes	Diurnal
Yellow-eared Spiderhunter	Yes	-	Yes	Diurnal
Brown-chested Jungle Flycatcher	Yes	-	Yes	Diurnal
Blue-eared Kingfisher	-	Yes	Yes	Diurnal
Chestnut-bellied Malkoha	-	Yes	Yes	Diurnal
Thick-billed Green Pigeon	No	-	Yes	Diurnal
Herpetofauna				
King Cobra	-	-	Yes	Diurnal
Tokay Gecko**	Yes	-	No	Nocturnal
Black Bearded Flying Dragon	Yes	-	Yes	Diurnal
Golden-eared Rough-sided Frog	-	Yes	Yes	Nocturnal
Lim's Black Sticky Frog	-	Yes	Yes	Nocturnal
Spotted Tree Frog	-	Yes	Yes	Nocturnal

Notes:

Depicts Low Sensitivity Species | Depicts Medium sensitive species | Depicts Highly sensitive species

* Ground dwelling mammal species will be excluded from the Project area during operation and are not listed.

** Introduced species

Flora and fauna requiring management

Chapter 6, Baseline Environment, has identified a number of flora and fauna species that may require management within the Project area. These species include:

- Wild boar (*Sus scrofa*);
- Sambar Deer (*Rusa unicolor*);
- Long tailed Macaque (*Macaca fascicularis*);
- Rodents (non-native mice and rats);
- *Spathodea campanulata* (Invasive Flora);

- *Cecropia pachystachya* (Invasive Flora); and
- *Falcataria moluccana* (Invasive Flora).

For the purposes of the impact assessment, the fauna and invasive flora species requiring management listed have been considered in the species impact assessment (*Table 9.12*).

9.4.2 Impact Assessment for Habitats During Operation

The impact assessment for biodiversity focuses on project components given their likely similar impacts or location within the Project area. The project components are as follows:

- *East* and *West Arrival Nodes*;
- Mandai Lake Road;
- *Eco-Link;*
- *Bird Park* and *Rainforest Park Nort*h;
- *Rainforest Park South;*
- *Eco-Lodge;*
- *Boardwalk;* and
- *Planet Explorer* and *Sri Seletar Point.*

A description of the anticipated impacts for habitats (*Table 9.11*) and for species (*Table 9.12*) provides a description of the impacts likely to occur during operation. These impacts are highlighted in **bold** in these tables and require mitigation to reduce the severity of impacts.

Table 9.11: Impacts to Habitats during the Operation Phase

Project Component	Impact Description
Generic Impacts: (applies to all project components)	**Direct Impacts (Specific impacts for each project component are outlined below):** • **Transition of habitats** from one habitat type to another and replanting and maintenance of vegetation within landscaped features, across the *Eco-Link*, *Arrival Nodes* and vegetation established within the *Bird Park* and *Rainforest Park* (*North and South*). Impacts include changes in habitat availability and subsequent changes in species composition and abundance. It is anticipated that the transition of habitats within project components will, over time, provide habitat resources suitable for certain resident species. The *Forest Restoration Plan* (*Annex 15*) contains specific measures to guide the planting of suitable species within attractions to provide habitat and foraging resources for resident species, reducing the magnitude of effect. • **Loss of habitat resources** (such as foraging resources, nesting hollows, refuge areas and access to water resources). Impacts may include increased wildlife conflict and potential injury/mortality within project component areas. It is expected that these impacts will be localised and impacted species will primarily be potentially those with small home ranges or are territorial (see *Table 9.10*). During the masterplanning phase, the *Forest Restoration Plan* (see *Annex 15*) and landscaping strategy have considered the needs of wildlife to create habitat for resident species. • **Edge effects on habitats** (changes in moisture differentials/habitat composition) from pathways, buildings and enclosures. Impacts include changes in moisture differentials and subsequent species mix in adjacent forested areas. Edge impacts management has been inbuilt into the design through the masterplanning phase. These measures will reduce the intensity of impacts; however edge effects may still occur where forest edges are exposed to newly constructed buildings. Edge effects may also occur in relation to forest restoration activities, especially within re-established forest habitats on the *Eco-Link* deck and *Bird Park* areas. • **Disturbance and displacement of resident species** due to human presence, noise, light, dust or vibration and the installation of perimeter fencing. Impacts include changes in behaviours such as foraging times, impacts to vegetation from dust deposition and feeding resources, barriers to movement and fauna disturbance/retreat. Sensitive species to potential disturbance during operation are shown in *Table 9.10*. These species may be impacted in high visitation areas.

Project Component	Impact Description
	• **Creation of barriers to wildlife movement** from perimeter fencing, buildings, retaining walls and enclosures. Impacts include changes to movement patterns and access to resources from changes in access. As outlined in the sub-section within Section 9.4.1.2 titled *Wildlife Corridors and Connectivity*, the masterplanning design process has developed a proposed fencing strategy that will restrict access to ground dwelling fauna during Project operations. All hoarding and fencing structures must not use barbed wire as this poses a danger to arboreal animals. While east-west fauna mobility across the site will largely be restricted, the *Eco-Link* will improve north-south mobility. • **Mortality or injury to wildlife as a result of vehicle/machinery strike**. Impacts may include reductions in species populations within the Project area. Vehicle strike may arise during the delivery of materials to project components during operation. **Indirect Impacts** • **Changes in water quality** from runoff from all project components and hardstand areas. Impacts include changes in the physico-chemical characteristics of aquatic habitats having subsequent changes to trophic levels and possible injury/mortality of vegetation, aquatic plants and animals. Water sources available to wildlife may also be polluted from the accidental release of contaminated water from project components, including the wastewater treatment plant, *Bird Park* and *Rainforest Park (North and South)* wastewater collection systems. • **Degradation of habitat by invasive species** as a result of introduction, proliferation and/or competition with native species. The invasive species identified that currently occur on the site include: *Spathodea campanulata*; *Cecropia pachystachya*; and *Falcataria moluccana*. As part of the *Forest Restoration Plan* (see *Annex 15*) during construction, these species will be progressively removed from within Project areas. Additional invasive species may be introduced and proliferate during operation from transport from visitors and also vehicles entering the Project area. • **Degradation of aquatic habitat in the event of the accidental release of hazardous substances** or pollution from plant and equipment, water and sewerage infrastructure. Sources include the waste water from the *Bird Park*, *Rainforest Park (North and South)* and *Arrival Node* infrastructure. Contaminated water may enter waterways, including the Upper Seletar Reservoir if not adequately controlled. Further assessment of impacts in relation to water (including mitigations) can be found at *Section 9.2, Surface Water*.

Project Component	Impact Description
	• **Competition for resources/conflict for wildlife** from changes in habitat resource availability and exclusion from habitats. Impacts can cause increased stress, potential injury or mortality to species. Impacts to wildlife from conflict for resources are difficult to predict. Sensitive species have been identified that may be impacted during operation (*Table 9.10*). • **Exacerbation of impacts from human induced events** (e.g. haze) **and natural events** (e.g. microbursts). Impacts are likely to occur to terrestrial plant species (reduction in availability of light/dust deposition) and waterways (increased flows causing bed and bank scouring and subsequent impacts to habitats. These events may also have secondary impacts (especially microbursts) where impacts to enclosures within the *Bird Park* and *Rainforest Park (North and South)* project components may be breached or damaged, enabling enclosed fauna to escape. The project masterplanning phase has considered this risk and has inbuilt measures into the design of the enclosures to reduce this risk (see *Chapter 2, Project Description*). • **Changed access to resources by species requiring management** such as the Sambar Deer (*Rusa unicolor*), Wild Boar (*Sus scrofa*) and Long tailed Macaque (*Macaca fascicularis*). Large ground dwelling species will be restricted from accessing the Project area, placing increased pressure within the CCNR and surrounding lands. Impacts may include reductions in available forage and damage to vegetation. It is anticipated that these species are likely to seek replacement forage within the vicinity of the Project. Species that are able to access the project area, such as the Long tailed Macaque and non-native rodents and the increase in available resources may cause an increase in population of these species if not appropriately managed. **Related Species Impacts (specific impacts to species is considered in detail in *Table 9.12*)** • Ground dwelling mammals, including Sunda pangolin (*Manis javanica*) and Lesser Mouse Deer (*Tragulus kanchil*) will be restricted from accessing the Project area during operations. • Bird species that utilise trees for roosting, nesting and feeding including the White-rumped Shama (*Copsychus malabaricus*), Blue-crowned hanging Parrot (*Loriculus galgulus*) and the Red-crowned barbet (*Megalaima rafflesii*) from a reduction in available habitat and resources. • Migratory and temporary resident species from a reduction in available habitat and resources.

Project Component	Impact Description
	• Arboreal mammal species including the Malayan Colugo (*Cynocephalus variegatus*), Lesser Bamboo Bat (*Tylonycteris pachypus*) and Horsfield's Flying Squirrel (*Lomys horsfieldii*) from a reduction in available tree habitat and resources. • Forest dwelling herpetofauna, including the Singapore Bent-toed Gecko (*Cyrtodactylus majulah*), Red-necked Bronzeback (*Dendrelaphis kopsteini*), Black Bearded Flying Dragon (*Draco melanopogon*) and Striped Sun Skink (*Eutropis multifasciata*) from a reduction in available habitat and resources. • Freshwater dependent birds and herpetofauna including the Purple Heron (*Ardea purpurea*), Grey Heron (*Ardea cinerea*), Black Crowned Night Heron (*Nycticorax nycticorax*), Grey-Headed Fish Eagle (*Ichthyophaga ichthyaetus*), Yellow-ringed Cat Snake (*Boiga dendrophila*) and Golden-eared Rough-sided Frog (*Hylarana baramica*) from a reduction in available aquatic habitat and resources. • Insects reliant on forests for breeding and foraging, including the Spotted Judy (*Abisara geza niya*), Yellow Chequered Lancer (*Plastingia pellonia*) and Handsome Grenadier (*Agrionoptera sexlineata*) from a reduction in available forest and aquatic habitat and resources. • Aquatic macroinvertebrates and fish from operational water runoff and pollution. • CR, EN and VU listed plant species from direct impacts from forest clearing activities.
Specific Impacts from Operation of *East* and *West Arrival Nodes*	**Direct Impacts** • **Transition of habitats** will result from landscaping of the *East and West Arrival Nodes*. It is possible that these areas will be used by insectivorous birds and bats at dawn and dusk for foraging. Habitat values may also exist for arboreal mammals that may use the area for day-time roosting or resting. These areas will be subject to high visitation during the day and evening and hence are likely to discourage fauna use. Ground dwelling fauna will be excluded from the *Arrival Nodes* by the perimeter fence. • **Creating habitat for species requiring management** such as non-native rodents. Both Sambar Deer (*Rusa unicolor*) and

Project Component	Impact Description
	Wild Boar (*Sus scrofa*) will be excluded from the *East* and *West Arrival Nodes* through the fencing strategy. Non-native rodents may increase in population as a result of access to foraging resources such as rubbish and litter. Impacts may include increased competition with native fauna for foraging resources and create hygiene related issues for food and beverage outlets within the *Arrival Nodes* and other project components. • **Edge effects** on habitats will occur in areas adjacent to the *Arrival Nodes* during operation, however these edge effects will likely reduce as the Project area matures (>5 years from completion). Edge effects may be related to human disturbance from high visitation numbers during peak times, including impacts on vegetative barriers and retained trees. Impacts may also occur from off-trail incursion by visitors, especially during peak visitation periods. Litter discarded by visitors may impact habitats adjacent to paths and trails. Impacts from micro-burst storm events may also cause severe edge effects within the *Arrival Nodes*. The frequency of these events is unpredictable. • **Interaction of visitors with fauna and flora**, impacting behavioural patterns, including nocturnal/diurnal behaviours, habitat use and breeding and foraging behaviours within the *Arrival Nodes*. Interaction with fauna within the *Arrival Nodes* may occur during opening hours and is likely to be greatest during weekends and holiday periods. The habitat replanted within the *East* and *West Arrival Nodes* will likely play host to herpetofauna, birds and bats, primarily during night time when the areas are closed. Aerial and arboreal fauna may use the area during nocturnal and diurnal periods; however this will be species dependent. Sensitive species are likely to avoid the *Arrival Nodes* completely during operation. Species such as the Long-tailed Macaque may be attracted to the *Arrival Nodes* due the availability of foraging resources, increasing opportunities for negative human interactions. Visitors may also interact with retained and planted flora within the *Arrival Nodes* through off-trail incursion, picking and damaging leaves and branches. The impacts will be a combination of restricted access to diurnal species; reduction in access and habitat availability for sensitive species; and damage to landscaping and retained vegetation within the *Arrival Nodes* if not managed appropriately. • **Delivery of materials to facilities after hours** impacting on habitats and behavioural patterns. The delivery of materials to the *Arrival Nodes* may occur outside the operational hours detailed in *Table 2.5*. These deliveries will likely use the underground car parking arrival and delivery dock to the south of the *West Arrival Node*. Vehicles delivering materials to the *East Arrival Node* will use Mandai Lake Road to access this Node. As outlined in the *Figure 9.1 Fencing Strategy During Operation*, fauna will be excluded from using Mandai Lake Road, however there is a risk that nocturnal arboreal species and birds may enter the road reserve and be at risk of vehicular strike if not appropriately managed.

Project Component	Impact Description
	• **Restrictions to wildlife movement** will occur from barriers, buildings, retaining walls within and surrounding the *Arrival Nodes*. *Figure 9.1* Fencing Strategy During Operation and the proposed design layout of the *Arrival Nodes* illustrates the internal and external barriers to wildlife movement during operations. For the *East Arrival Node*, fauna moving from the *Planet Explorer/Sri Seletar Point* area, remnant Disturbed Primary forest areas and WRS land may transit the *Arrival Node*. For the *West Arrival Node*, fauna moving between the *Bird Park* and *Rainforest Park North* and to the land west of the Project area may transit the *Arrival Node.* The sensitivity of the species and whether they are primarily nocturnal or diurnal will determine the extent to which they will utilise the *Arrival Nodes*. Impacts will include permanent restrictions on the ability for ground dwelling fauna to access the *Arrival Nodes*. Arboreal and avifauna will be less restricted. **Indirect Impacts** • **Impacts on water quality and quantity** from runoff from the *Arrival Nodes*, Mandai Lake Road and *Eco-Link* impacting on aquatic ecosystems. Water sources available to wildlife may also be polluted. The impact assessments relevant to water quality and quantity can be found at *Section 9.2 Surface Water* and *Section 9.3 Soil and Groundwater*.
Specific Impacts from Operation of the *Bird Park* & *Rainforest Park North*	**Direct Impacts** • **Edge effects** on habitats will occur in areas adjacent to the enclosures and facilities of the *Bird Park* and *Rainforest Park North* during operation. These edge effects will likely reduce as the Project area vegetation matures (>5 years from completion). Edge effects may be related to human disturbance from high visitation numbers during peak times (up to 15,200 persons to *Rainforest Park North* and 14,300 persons to the *Bird Park*), including impacts on vegetative barriers and retained trees. Impacts may also occur from off-trail incursion by visitors during peak visitation periods. Litter discarded by visitors may also impact habitats adjacent to paths and trails. The acoustic barrier and 2 storey structure constructed along the edge of Mandai Road will reduce noise impacts from traffic along the road, however vegetation may be impacted adjacent to the wall, including a reduction in available sunlight from the north. Impacts from micro-burst storm events may cause severe impacts. The frequency of these events is unpredictable but may cause long-term damage to habitats within the project component areas. Edge impacts from the activities described is likely and may impact on flora and fauna within the buffers and CCNR if not managed.

Project Component	Impact Description
	• **Transition of habitats** following construction and forest restoration, will result in 101,964 m^2 of secondary forested habitat remaining, outside of enclosures during operation and available for resident species to utilise. Approximately 141,290 m^2 of landscaped area (including 101,047 m^2 of secondary forest habitat) will exist within enclosed enclosures. This will result in an overall reduction in available habitat. Grassland habitats existing within the Project area will be converted to landscaped areas which may contain some grassland habitat features but will not be the same type of grassland habitat currently (being a tall open grassland). • **Aerial collision risk with enclosure structures and netting** impacting bird and bat species, and potentially arboreal mammals. The location of nets will be adjacent to forested areas, including the buffer areas. Some species may avoid interaction with enclosures and move to alternative habitats over time. The impact to species may mean direct mortality to some species and local reductions in species populations. • **Generation of domestic waste and litter from facilities** impacting habitats and providing a food source for species requiring management such as non-native rodents and Long tailed Macaque (*Macaca fascicularis*). Visitation rates of up to 15,200 persons to *Rainforest Park North* and 14,300 persons to the *Bird Park* per day. Given the amount of visitation, waste and litter may arise that may attract species requiring management if not adequately managed. • **Accidental germination of seeds used for exhibit feed**. These species may become weeds/invasive within the Project area, competing with existing species. The *Bird Park* and *Rainforest Park (North and South)* will use feed species imported onto the site as well as forage grown on site. These species may germinate and grow within enclosures or be transported outside of enclosures by visitors or workers during operation, resulting in proliferation of these species within surrounding areas if not controlled. • **Interaction of visitors with fauna and flora** impacting behavioural patterns. Visitation rates of up to 15,200 persons to *Rainforest Park North* and 14,300 persons to the *Bird Park* per day. Interaction with flora and fauna is likely within and outside of attractions. Impacts to flora may include damage to leaves and branches from incursions into retained vegetation and landscaping. The impacts are likely to result in negative interactions with fauna outside of attractions as well as edge effect damage to flora within landscaping and retained vegetation if not appropriately managed.

Project Component	Impact Description
	• **Delivery of materials and maintenance of facilities after hours** impacting on habitats and behavioural patterns. The delivery of materials to the *Bird Park* and *Rainforest Park North* may occur outside the operational hours detailed in *Table 2.5*. These deliveries will likely use internal access roads within the project components. As a result, there is a risk that nocturnal species active within non-enclosed areas of the *Bird Park* and *Rainforest Park North* may suffer vehicle strikes at night if not appropriately managed. • **Potential escape of enclosed bird species from enclosures** impacting ecological functions in surrounding habitats, including competition for resources. Accidental release of species native to Singapore may increase competition and conflict with natural populations (including impacts to local gene pools) and has been raised as a key concern by Nature Groups. Escape of species may arise from failure of controls to manage potential escapees; and breaching of enclosures from tree falls or failure of enclosure structures. Micro-burst storm events may cause a higher risk of enclosure breaches. • **Restrictions to wildlife movement** will occur from perimeters fencing, enclosures, buildings, retaining walls within and adjacent to the *Bird Park* and *Rainforest Park North* project components. The hours of operation proposed for the project components are 07.00 hrs to 19.00 hrs daily for the *Rainforest Park North* and 09.00 hrs to 18.00 hrs daily for the *Bird Park*. Visitation rates of up to 15,200 persons to *Rainforest Park North* and 14,300 persons to the *Bird Park* per day. The impacts will mean a restriction of movement for wildlife within open areas (outside of enclosures) outside of opening hours. This time coincides with crepuscular and nocturnal species being active. Diurnal ground dwelling fauna will therefore be restricted from using these areas due to visitation. Diurnal arboreal and avifauna may still access these areas. Certain small nocturnal species may access and transit through the *Bird Park* and *Rainforest Park North* components outside of operating hours. Sensitive species are likely to completely avoid the area during operating hours. Perimeter fencing will prohibit ground dwelling fauna from accessing the Project area. All hoarding and fencing structures must not use barbed wire as this poses a danger to arboreal animals. • **Predation on wildlife exhibits** may occur from reptiles or birds seeking food resources. Within the *Bird Park* and *Rainforest Park North*, areas outside of enclosures may be accessed by reptiles and birds. Closed enclosures will be restricted in access through design measures (such as mesh size). Species such as the Water Monitor Lizard (*Varanus salvator*) may enter these areas and predate on exhibited fauna.

Project Component	Impact Description
	• **Potential impact on native/migratory birds from an avian disease outbreak.** Exhibited bird species in the *Bird Park* may be infected with transmissible diseases, including avian influenza. The impacts may include transmission of diseases to local bird populations if not adequately managed. • **Weed and animal control measures impacting non-target species** may occur through the use of pesticides/herbicides. Ongoing management of invasive and weed species may require the selective use of herbicides. Use of techniques such as spraying may mean that non-target species are impacted. **Indirect Impacts** • **Increases in runoff from paved surfaces** and from surface water controls during operation. Paved areas will be maintained for the operation of the *Bird Park* and *Rainforest Park North*, increasing runoff. Impacts may include scouring of the bed and banks of waterways, changing the morphology of habitats. The impact assessments relevant to water quality and quantity can be found at *Section 9.2 Surface Water* and *Section 9.3 Soil and Groundwater*. • **Water quality impacts from runoff of contaminated water from enclosures**, hard stand areas and back of house facilities. Contaminated runoff from these areas may cause habitat impacts including changes in species composition and potential eutrophication of waterways. The impact assessments relevant to water quality and quantity can be found at *Section 9.2 Surface Water* and *Section 9.3 Soil and Groundwater*. **Related Species Impacts** (see Species Impact Assessment, *Table 9.12*) • Ground dwelling mammals, including Sunda Pangolin (*Manus javanica*) and Lesser Mouse Deer (*Tragulus kanchil*) will be restricted from accessing the Project area during operations. • Native bird species impacted by escaped species, including competition for resources and potential genetic impacts through inter-breeding. • Bird species that utilise trees for roosting, nesting and feeding including the White-rumped Shama (*Copsychus malabaricus*), Blue-crowned hanging Parrot (*Loriculus galgulus*) and the Red-crowned barbet (*Megalaima rafflesii*) from a reduction in

Project Component	Impact Description
	access to forest habitats and resources. • Arboreal mammal species including the Malayan Colugo (*Cynocephalus variegatus*), Greater Bamboo Bat (*Tylonycteris pachypus*) and Horsfield's Flying Squirrel (*Iomys horsfieldii*) from a reduction in access to habitats and resources. • Forest dwelling herpetofauna, including the Singapore Bent-toed Gecko (*Cyrtodactylus majulah*), Red-necked Bronzeback (*Dendrelaphis kopsteini*), Black Bearded Flying Dragon (*Draco melanopogon*) and Striped Sun Skink (*Eutropis multifasciata*) from changes to available forest habitat types and subsequent changes in access to resources. • Insects reliant on forests and grasslands for breeding and foraging, including the Spotted Judy (*Abisara geza niya*), Yellow Chequered Lancer (*Plastingia pellonia*) and Handsome Grenadier (*Agrionoptera sexlineata*) from changes in forest structure and access to resources. • Aquatic macroinvertebrates and fish from operational water runoff and pollution. It should be noted that a commitment has been made to prevent all runoff water from the Project area from entering the Upper Seletar Reservoir. Some minor impacts may occur in surface drains. The impact assessments relevant to water quality and quantity can be found at *Section 9.2 Surface Water* and *Section 9.3 Soil and Groundwater*.
Specific Impacts from Operation of Mandai Lake Road	**Direct Impacts** • **Edge effects** on habitats may occur in areas adjacent to the Mandai Lake Road modifications. The modified road is predicted to result in an increase in transportation used to access the Project. Car parking will be split between the *East* and *West Arrival Nodes.* Additionally, a People Mover System (PMS) will operate along Mandai Lake Road. Visitation is likely to be concentrated between the opening hours of the Project. The resulting increase in traffic along Mandai Lake Road may increase edge effects on vegetation along the route. The modified road will also be wider in width, although within the existing road reserve. This may also increase the proximity of vehicles and pollution to vegetation and trees along the route, increasing the risk of edge effects on individuals. The existing illumination of the road is not expected to increase, meaning that there is not expected to be any changes to current baseline levels. Potential heat retention and reflection of the road surface may create a heat source, potentially increasing the drying out of adjacent vegetation.

Project Component	Impact Description
	• **Generation of domestic waste and litter** from passing vehicles. The increase in visitation and traffic along Mandai Lake Road may mean an increase in discarded waste along the road, potentially impacted flora and fauna along the road verge if not managed appropriately. • **Delivery of materials to facilities after hours** impacting on habitats and behavioural patterns. The delivery of materials may occur outside the operational hours detailed in *Table 2*.5. This may impact nocturnal species that utilise the road verge or transit areas close to the road. This includes fauna using the *Eco-Link* at night that may be disturbed by vehicular traffic at night delivering materials. This impact however is considered to be minor given the small numbers of deliveries expected. • **Restrictions to wildlife movement** will occur from barriers along Mandai Lake Road. As illustrated by the fencing strategy, wildlife will be restricted from accessing Mandai Lake Road. This is likely to be a positive impact given existing road kills impacting species such as the Sunda Pangolin (*Manis javanica*) and Sambar Deer (*Rusa unicolor*). However, there is a risk that avifauna and arboreal species that enter the road verge may be trapped and be exposed to traffic along the road. This is a risk for nocturnal species that may enter the road verge and then become exposed to traffic during operation. • **Mortality or injury to wildlife as a result of vehicle/machinery strike along Mandai Lake Road.** As discussed in potential impacts from restriction of wildlife movement, avifauna and arboreal species trapped along the road verge may be subject to an increased risk of mortality if they cannot escape. **Indirect Impacts** • **Impacts on water quality and from runoff** from Mandai Lake Road impacting on aquatic ecosystems. Water sources available to wildlife may also be polluted. Water runoff from Mandai Lake Road, including oil and grease from vehicles may pose a risk to aquatic ecosystems. The impact assessments relevant to water quality and quantity can be found at *Section 9.2 Surface Water* and *9.3 Soil and Groundwater*. **Related Species Impacts** (see separate Impact Assessment in *Table 9.12*) • Restriction of movement for mobile ground dwelling fauna will occur, limiting opportunities to cross Mandai Lake Road. Whilst this reduces the overall opportunities for these species to move north-south across the Road, the *Eco-Link*

Project Component	Impact Description
	will provide a safer crossing point by reducing the chances of injury/mortality from vehicle strike. Species likely impacted include the Sunda Pangolin (*Manis javanica*), Wild Boar (*Sus scrofa*) and Sambar Deer (*Rosa unicolor*). Avifauna and arboreal species that enter the road reserve and become stranded may also be impacted by the operation of Mandai Lake Road.
Specific Impacts from Operation of the *Rainforest Park South*	**Direct Impacts** • **Edge effects** on habitats will occur in areas adjacent to the enclosures and facilities of the *Rainforest Park South* during operation. These edge effects will likely reduce as the Project area vegetation matures (>5 years from completion). Edge effects may occur related to human disturbance from high visitation numbers during peak times (on peak days, 3,800 persons per day are expected to enter the *Rainforest Park* from the *Rainforest Park South entrance*) including impacts on vegetative barriers and retained trees. Impacts may also occur from off-trail incursion by visitors during peak visitation periods. Litter discarded by visitors may also impact habitat adjacent to paths and trails. Impacts from micro-burst storm events may also cause severe impacts. The frequency of these events is unpredictable but may cause long-term damage to habitats within the project areas. • **Transition of habitats** following construction and forest restoration. It is anticipated that 23,545 m^2 of secondary forest habitat will be retained and will be available to non-ground dwelling mammals during operation as part of the *Rainforest Park South* facilities. This will result in an overall reduction in available habitat compared to the baseline environment. The impact may mean a displacement of fauna and subsequent in-migration into surrounding areas within the vicinity. • **Aerial collision risk with enclosure structures and netting** impacting bird and bat species, and potentially arboreal mammals. The location of nets will be adjacent to forested areas, including areas adjacent to the CCNR. Some species may avoid interaction with enclosures and move to alternative habitats over time. The impact to species may mean direct mortality to some species and local reductions in species populations. • **Generation of domestic waste and litter from facilities** impacting habitats and providing a food source for species requiring management such as non-native rodents and the Long tailed Macaque (*Macaca fascicularis*). Visitation rates for the *Rainforest Park South* of approximately 3,800 persons per day. Given the amount of visitation, waste and litter may arise that may attract species requiring management if not adequately managed.

Project Component	Impact Description
	• **Accidental germination of seeds used for exhibit feed**. These species may become weeds/invasive within the Project area, competing with existing species. These species may germinate and grow within enclosures or be transported outside of enclosures by visitors or workers during operation, resulting in proliferation of these species within surrounding areas if not controlled. • **Interaction of visitors with fauna and flora** impacting behavioural patterns. Visitation rates for the *Rainforest Park South* indicate that up to 3,800 persons per day will visit. Interaction with flora and fauna is likely within and outside of attractions. These interactions are likely with mobile ground dwelling diurnal species within areas outside of attractions. Impacts to flora may include damage to leaves and branches from incursions into retained vegetation and landscaping. The impacts are likely to result in negative interactions with fauna outside of attractions as well as edge effect damage to flora within landscaping and retained vegetation if not appropriately managed. • **Delivery of materials and maintenance of facilities after hours** impacting on habitats and behavioural patterns. The delivery of materials to the *Rainforest Park South* may occur outside the operational hours detailed in *Table 2.*5. These deliveries will likely use internal access roads within the project components. As a result, there is a risk that nocturnal species active within non-enclosed areas of the *Rainforest Park South* may suffer vehicle strikes at night if not appropriately managed. • **Potential escape of enclosed bird species from netted enclosures** impacting ecological functions in surrounding habitats, including competition for resources. Accidental release of species native to Singapore may increase competition and conflict with natural populations (including impacts to local gene pools) and has been raised as a key concern by Nature Groups. Escape of species may arise from failure of controls to manage potential escapees; and breaching of enclosures from tree falls or failure of enclosure structures. Micro-burst storm events may cause a higher risk of enclosure breaches. **Restrictions to wildlife movement** will occur from permanent perimeter fencing, enclosures, buildings, retaining walls within and adjacent to the *Rainforest Park South* project components. The hours of operation proposed are 07.00 hrs to 19.00 hrs daily for the *Rainforest Park South*. Visitation during these times is expected to be a peak level of up to 3,800 persons per day. The impacts will mean a restriction of movement for wildlife within open attraction areas (outside of enclosures) outside of opening hours. This time coincides with crepuscular and nocturnal species being active. Diurnal ground dwelling fauna will therefore be restricted from using these areas due to visitation. Diurnal arboreal and avifauna

Project Component	Impact Description
	may still access these areas. Certain nocturnal species may access and transit through the *Rainforest Park South* components outside of operating hours towards the CCNR from WRS and north eastern project components. Sensitive species are likely to completely avoid the area during operating hours. The fencing strategy will prevent access to the Project site by ground dwelling fauna. All hoarding and fencing structures must not use barbed wire as this poses a danger to arboreal animals. • **Predation on wildlife exhibits** may occur from reptiles or birds seeking food resources. Within the *Rainforest Park South*, areas outside of enclosures may be accessed by reptiles and birds. Closed enclosures will be restricted in access through design measures (such as mesh size). Species such as the Water Monitor Lizard (*Varanus salvator*) may enter these areas and predate on exhibited fauna if adequate measures are not in place. • **Weed and animal control measures impacting non-target species** may occur through the use of pesticides/herbicides. Ongoing management of invasive and weed species may require the selective use of herbicides. Use of techniques such as spraying may mean that non-target species are impacted. **Indirect Impacts** • **Increases in runoff from paved surfaces** during operation. Paved areas will be maintained for the operation of the *Rainforest Park South*, increasing runoff. Impacts may include scouring of the bed and banks of waterways, changing the morphology of habitats. The impact assessments relevant to water quality and quantity can be found at *Section 9.2 Surface Water* and *9.3 Soil and Groundwater*. • **Water quality impacts from runoff of contaminated water from enclosures**, hard stand areas and back of house facilities. Contaminated runoff from these areas may cause habitat impacts including changes in species composition and potential eutrophication of waterways. The impact assessments relevant to water quality and quantity can be found at *Section 9.2 Surface Water* and *9.3 Soil and Groundwater*. **Related Species Impacts** (see Species Impact Assessment, *Table 9.12*) • Ground dwelling mammals, including Sunda Pangolin (*Manus javanica*) and Lesser Mouse Deer (*Tragulus kanchil*), from a

Project Component	Impact Description
	reduction in access to habitats utilised for movement, breeding and foraging. Impacts may also occur due to vehicle strike along Mandai Lake Road causing injury/mortality. • Native bird species impacted by escaped species, including competition for resources and potential genetic impacts through inter-breeding. • Bird species that utilise trees for roosting, nesting and feeding including the White-rumped Shama (*Copsychus malabaricus*), Blue-crowned hanging Parrot (*Loriculus galgulus*) and the Red-crowned barbet (*Megalaima rafflesii*) from a reduction in access to forest habitats and resources. • Arboreal mammal species including the Malayan Colugo (*Cynocephalus variegatus*), Greater Bamboo Bat (*Tylonycteris pachypus*) and Horsfield's Flying Squirrel (*Iomys horsfieldii*) from a reduction in access to habitats and resources. • Forest dwelling herpetofauna, including the Singapore Bent-toed Gecko (*Cyrtodactylus majulah*), Red-necked Bronzeback (*Dendrelaphis kopsteini*), Black Bearded Flying Dragon (*Draco melanopogon*) and Striped Sun Skink (*Eutropis multifasciata*) from changes to available forest habitat types and subsequent changes in access to resources. • Insects reliant on forests and grasslands for breeding and foraging, including the Spotted Judy (*Abisara geza niya*), Yellow Chequered Lancer (*Plastingia pellonia*) and Handsome Grenadier (*Agrionoptera sexlineata*) from changes in forest structure and access to resources. • Aquatic macroinvertebrates and fish from operational water runoff and pollution. It should be noted that a commitment has been made to prevent all runoff water from the Project area from entering the Upper Seletar Reservoir. The impact assessments relevant to water quality and quantity can be found at *Section 9.2 Surface Water* and *9.3 Soil and Groundwater* above.
Specific Impacts from the Operation of the *Planet Explorer* and *Sri*	**Direct Impacts** • **Edge effects** on habitats will occur in areas adjacent to the *Planet Explorer* and *Sri Seletar Point* project components. Particularly sensitive will be the patch of disturbed primary forest habitat retained to the west of the project component.

Project Component	Impact Description
Seletar Point	These edge effects will likely reduce as the Project area vegetation matures (>5 years from completion). Edge effects may occur related to human disturbance from high visitation numbers during peak times (up to 25,200 persons per day), including impacts on vegetative barriers and retained trees. Impacts may also occur from off-trail incursion by visitors during peak visitation periods. Litter discarded by visitors may impact habitat adjacent to paths and trails which may be exacerbated by run-off during storm events. Impacts from micro-burst storm events may also cause severe impacts to surrounding vegetation. The frequency of these events is unpredictable but may cause long-term damage to habitats within the project areas. • **Generation of domestic waste and litter from facilities** impacting habitats and providing a food source for species requiring management such as non-native rodents and the Long tailed Macaque (*Macaca fascicularis*). Visitation rates to the *Planet Explorer* and *Sri Seletar Point* indicate that up to 25,200 persons per day will visit. Given the amount of visitation, waste and litter may arise that may attract species requiring management if not adequately managed. **Restrictions to wildlife movement** will occur from permanent barriers, buildings, retaining walls adjacent to the *Planet Explorer* and *Sri Seletar Point* project components. Opening hours for the facilities are planned to be from 08:00 to 21:00 daily. The visitation proposed for the project component is up to 25,200 persons per day. The resulting impacts on fauna will restrict diurnal and crepuscular species from utilising the Project area and also transiting fauna from the west (remnant Disturbed Primary forest habitat) and from the north (Upper Seletar Reservoir). The area is expected to serve as a transit area for certain nocturnal species (from 21:00 hrs to 08:00 hrs). Avifauna may also utilise the area at dawn and dusk for foraging. Arboreal species may also transit the area moving from the WRS site to the remnant disturbed primary forest habitat. The impact restriction on access will be for ground dwelling diurnal species and sensitive nocturnal species. • **Interaction of visitors with fauna and flora** impacting behavioural patterns. Visitation rates for the *Planet Explorer* and *Sri Seletar Point* project component areas indicate that up to 25,200 persons per day will visit. Interaction with flora and fauna is likely within and outside of the facilities as visitors enter and exit the facilities. These interactions may occur with mobile ground dwelling diurnal species within areas outside of attractions. The project component area will enable access to species, including the Wild Boar (*Sus scrofa*) and Sambar Deer (*Rosa unicolor*), increasing opportunities for human interaction with these species in the crepuscular (if these species frequent this area during operation). Impacts to flora may include damage to leaves and branches from incursions into retained vegetation and landscaping. The impacts are likely to result in damage to flora within landscaping and retained vegetation if not appropriately managed.

Project Component	Impact Description
	• **Delivery of materials and maintenance of facilities after hours** impacting on habitats and behavioural patterns. The delivery of materials to the *Planet Explorer* and *Sri Seletar Point* may occur outside the operational hours detailed in *Table 2.5*. These deliveries will likely use internal access roads within the project components. As a result there is a risk that nocturnal species active within non-enclosed areas of the *Planet Explorer* and *Sri Seletar Point* may suffer vehicle strikes at night if not appropriately managed. • **Generation of domestic waste and litter from facilities** impacting habitats and providing a food source for species requiring management such as non-native rodents, the Long tailed Macaque (*Macaca fascicularis*) and Wild Boar (*Sus scrofa*). Visitation rates for the *Planet Explorer* and *Sri Seletar Point* indicate that up to 25,200 persons per day will visit the facilities. Given the amount of visitation, waste and litter may be discarded that will attract species requiring management if not adequately managed. **Indirect Impacts** • **Increases in runoff from paved surfaces** and from surface water controls during operation. Paved areas will be maintained for the operation of the *Planet Explorer and Sri Seletar Point*, increasing runoff. Impacts may include scouring of the bed and banks of waterways, changing the morphology of habitats. It should be noted that a commitment has been made to prevent all runoff water from the Project area from entering the Upper Seletar Reservoir. The impact assessments relevant to water quality and quantity can be found at *Section 9.2 Surface Water* and *9.3 Soil and Groundwater*. **Related Species Impacts** (See Species Impact Assessment, *Table 9.12*) • Ground dwelling mammals, including Sunda Pangolin (*Manus javanica*) and Lesser Mouse Deer (*Tragulus kanchil*), will be restricted from accessing the Project site through the use of perimeter fencing. Impacts from disturbance and displacement from visitors and vehicle access may occur during operational hours. Impacts may also occur due to vehicle strike causing injury/mortality. • Bird species that utilise trees for roosting, nesting and feeding including the White-rumped Shama (*Copsychus malabaricus*),

Project Component	Impact Description
	Blue-crowned hanging Parrot (*Loriculus galgulus*) and the Red-crowned barbet (*Megalaima rafflesii*) from a reduction in access to forest habitats and resources. • Arboreal mammal species including the Malayan Colugo (*Cynocephalus variegatus*), Greater Bamboo Bat (*Tylonycteris pachypus*) and Horsfield's Flying Squirrel (*Iomys horsfieldii*) from a reduction in access to habitats and resources. • Forest dwelling herpetofauna, including the Singapore Bent-toed Gecko (*Cyrtodactylus majulah*), Red-necked Bronzeback (*Dendrelaphis kopsteini*), Black Bearded Flying Dragon (*Draco melanopogon*) and Striped Sun Skink (*Eutropis multifasciata*) from changes to available forest habitat types and subsequent changes in access to resources. • Insects reliant on forests and grasslands for breeding and foraging, including the Spotted Judy (*Abisara geza niya*), Yellow Chequered Lancer (*Plastingia pellonia*) and Handsome Grenadier (*Agrionoptera sexlineata*) from changes in forest structure and access to resources.
Specific Impacts from Operation of the *Eco-Link*	**Direct Impacts** • **Approximately 3,000 m^2 of the deck of the *Eco-Link* will be planted to create refuge sites and provide resources to enhance connectivity between the Nature Reserves.** Multi-tiered planting will be used to allow for gradual transition from the existing surrounding forest to be retained, promoting animal movement across the deck. Trees will be planted in clusters with minimum edge to area ratio to maintain quality of microhabitats. It is likely that the area will be used by diurnal and nocturnal species that currently cross Mandai Lake Road. Visitors will not be able to access the *Eco-Link*. • **Edge effects** on habitats will occur in areas adjacent to the *Eco-Link* deck. The length of edge effect disturbance along the buffer is 50m (north of Mandai Lake Road) and 55m (south of Mandai Lake Road). The width of the *Eco-Link* will be 30 m. Relocation and planting of trees will be restricted to the forest edges to reduce the chance of potential tree fall onto the road below. Some canopy interconnection will be available between trees as well as ground level and mid-storey connectivity once flora becomes established. Edge effects may exist along the *Eco-Link* given that the sparse forest structure will enable light penetration. Wind will blow along Mandai Lake Road, exposing the vegetation on the *Eco-Link*. Microburst storm events may also cause tree fall.

Project Component	Impact Description
	• **Mortality or injury to wildlife as a result of vehicle/machinery strike along Mandai Lake Road.** Impacts may include a reduction in species populations within the Project area. Fauna may accidentally enter the road reserve by falling or climbing over fences. A fencing strategy will be put in place to prohibit ground dwelling fauna (including the Sambar Deer (*Rosa unicolor*)). All hoarding and fencing structures must not use barbed wire as this poses a danger to arboreal animals. Arboreal fauna may be able to climb or glide over the fence and may accidently land within the road, becoming susceptible to vehicle strike. This is more likely to occur at night time when traffic volumes will be lower. If fauna remain stranded in the road reserve during daylight hours, they may become further susceptible to injury or mortality as traffic volumes rise during the day. • **Restrictions to wildlife movement** will occur through a funnelling effect caused by the *Eco-Link*. Fauna previously able to cross freely (although at risk of vehicle strike) will now be restricted from accessing the road by the fencing strategy. Fauna will be funnelled from the CCNR, buffer areas and development components to use the *Eco-Link*. This will primarily affect ground dwelling fauna and arboreal fauna that rely on direct canopy linkages for movement. Avifauna is unlikely to be impacted, apart from dedicated forest dwelling birds. Fauna that are territorial may be particularly impacted. The impact may mean increased levels of conflict within the area immediately adjacent to the *Eco-Link* and on the deck. • **Diurnal disturbance and displacement may occur during operating hours from traffic.** There will be an increase in transportation use of Mandai Lake Road. Car parking will be split between the *East* and *West Arrival Nodes*. Additionally, a People Mover System (PMS) will operate along Mandai Lake Road. The traffic along the road may displace sensitive diurnal species from using the *Eco-Link*. Crepuscular activity and nocturnal species are likely to be less impacted given the reduction of vehicular traffic, particularly from 24.00 hrs to 06:00 hrs. **Related Species Impacts** (see separate Impact Assessment in *Table 9.12*) • Restriction of movement for mobile ground dwelling fauna through the use of fencing, limiting opportunities to cross Mandai Lake Road. Whilst this reduces the overall opportunities for these species to move north-south across the Road, the *Eco-Link* will provide a safer crossing point by reducing the chances of injury/mortality from vehicle strike. Species likely impacted include ground dwelling mammals such as the Sunda Pangolin (*Manis javanica*), Wild Boar (*Sus scrofa*) and Sambar Deer (*Rosa unicolor*). Avifauna and arboreal species that enter the road reserve and become stranded may also be impacted by the operation of Mandai Lake Road.

Project Component	Impact Description
Specific Impacts from the Operation of the *Eco-Lodge*	**Direct Impacts** • **Edge effects** on habitats will occur in areas adjacent to the facilities of the *Eco-Lodge* during operation. The *Eco-Lodge* is scheduled to be open 24 hours per day, however it is expected that peak operational times will occur from 06:00 hrs to 22:00 hrs. These edge effects will likely reduce as the Project area vegetation matures (>5 years from completion). Edge effects may occur related to human disturbance from high visitation numbers during peak times, including impacts on vegetative barriers and retained trees. Impacts may also occur from off-trail incursion by visitors during peak visitation periods. Litter discarded by visitors may also impact habitats adjacent to paths and trails which may be exacerbated by run-off during storm events. The *Eco-Lodge* building height will be restricted to 4 storeys, reducing overshadowing of the Upper Seletar Reservoir and adjacent forested areas. Design measures have been recommended that will reduce the overall intensity of edge effects, including the use of a suitable colour palate and roof gardens. Impacts from micro-burst storm events may also cause severe impacts in forested areas surrounding the *Eco-Lodge*, potentially impacting the building structures. The frequency of these events is unpredictable but may cause long-term damage to habitats within the project areas. • **Transition of habitats** following construction and forest restoration, replanting and maintenance of vegetation will result in a reduction of available habitat within the *Eco-Lodge* project component area. The area of impact cannot be confirmed as this project component is still undergoing concept design. However, it is expected that there will be an overall reduction in available habitat compared to the baseline environment. The impact may mean a displacement of fauna and subsequent in-migration into surrounding areas within the vicinity. • **Generation of domestic waste and litter from facilities** impacting habitats and providing a food source for species requiring management such as non-native rodents and the Long-tailed Macaque (*Macaca fascicularis*). The proposed size of the *Eco-Lodge* is 400 rooms. Each guest can be expected to generate approximately 0.5 kg of domestic waste. Assuming 90% occupancy and 1.5 guests per room, a total of 260 kg of domestic waste will be generated daily that will need to be transported from the hotel by a licensed third party. Persons staying overnight at the *Eco-Lodge* will have access to the grounds and edges of the Upper Seletar Reservoir. Visitors may discard waste when walking around the facility and surrounds. • **Interaction of visitors with fauna and flora** impacting behavioural patterns. Visitation rates for the *Eco-Lodge* are

Project Component	Impact Description
	undetermined at this stage, however up to 400 rooms are proposed to be built as part of the facility. Interaction with flora and fauna is likely within the grounds of the *Eco-Lodge*, especially at night as the hours of operation will be 24 hours per day. These interactions are likely with mobile ground dwelling diurnal and nocturnal species. Impacts to flora may include damage to leaves and branches from incursions into retained vegetation and landscaping. The impacts are likely to result in negative interactions with fauna within the grounds as well as edge effect damage to flora within landscaping and retained vegetation if not appropriately managed. • **Delivery of materials and maintenance of facilities** impacting on habitats and behavioural patterns. The delivery of materials to the *Eco-Lodge* may occur 24 hours a day. These deliveries will likely use internal access roads to access the loading dock of the *Eco-Lodge*. As a result, there is a risk that nocturnal species may suffer vehicle strikes at night if not appropriately managed. **Related Species Impacts** (see separate Impact Assessment in *Table 9.12*) • Ground dwelling mammals, including Sunda Pangolin (*Manus javanica*) and Lesser Mouse Deer (*Tragulus kanchil)* will be restricted from accessing the Project area during operations. Impacts from disturbance and displacement from visitors and vehicle access during operational hours. Impacts may also occur due to vehicle strike causing injury/mortality. • Bird species that utilise trees for roosting, nesting and feeding including the White-rumped Shama (*Copsychus malabaricus*), Blue-crowned hanging Parrot (*Loriculus galgulus*) and the Red-crowned barbet (*Megalaima rafflesii*) from a reduction in access to forest habitats and resources. • Arboreal mammal species including the Malayan Colugo (*Cynocephalus variegatus*), Greater Bamboo Bat (*Tylonycteris pachypus*) and Horsfield's Flying Squirrel (*Iomys horsfieldii*) from a reduction in access to habitats and resources. • Forest dwelling herpetofauna, including the Singapore Bent-toed Gecko (*Cyrtodactylus majulah*), Red-necked Bronzeback (*Dendrelaphis kopsteini*), Black Bearded Flying Dragon (*Draco melanopogon*) and Striped Sun Skink (*Eutropis multifasciata*) from changes to available forest habitat types and subsequent changes in access to resources.

Project Component	Impact Description
	• Insects reliant on forests and grasslands for breeding and foraging, including the Spotted Judy (*Abisara geza niya*), Yellow Chequered Lancer (*Plastingia pellonia*) and Handsome Grenadier (*Agrionoptera sexlineata*) from changes in forest structure and access to resources.

9.4.3 *Impact Assessment for Species During Operation*

Table 9.12 outlines the likely impact on priority species in the Project area due to the operation of the Project.

Table 9.12: Impacts to Species during the Operation Phase

Species Groups	Impact Description
Ground Dwelling Mammals	• Ground dwelling mammals (such as the Sunda Pangolin (*Manis javanica*) and Lesser Mouse Deer (*Tragulas kanchil*)) will be prevented from entering the Project site during operations through the use of perimeter fencing. These species may be prone to vehicle strike causing subsequent injury/mortality to individuals from delivery vehicles or if trapped within the Mandai Lake Road corridor. The loss of habitat availability for breeding and foraging (including den sites for the Sunda Pangolin) may impact populations of the species in the medium to long-term. • Sambar deer (*Rusa unicolor*) and Wild Boar (*Sus scrofa*) populations may increase, impacting on habitat availability/competition with other species within the Project area. These species will be restricted from accessing the *Bird Park*, *Rainforest Park North* and *Rainforest Park South* but can access other areas of the Project area, including the buffer areas.

Arboreal Mammals **Forest Dwelling Herpetofauna** **Forest Dependent Bird Species** **Invertebrates**	• Arboreal mammals such as the Malayan Colugo (*Cynocephalus variegatus)*) and forest dwelling herpetofauna species will experience a net reduction of available habitat during operation due to the creation of enclosed areas and changes in habitat availability/connectivity. The *Eco-Link* will provide access for species to cross between the northern and southern components of the CCNR. Impacts are likely to include: reductions in populations across the Project area and increased injury/mortality due to competition for resources. These impacts will be exacerbated for less mobile species that are unable to disperse into surrounding areas. It is likely that arboreal species may return if sufficient habitat is re-established and maintained during operation. The Banded Leaf Monkey may return to the CCNR adjacent to Mandai Road during operation. Specific flora species have been identified to be planted across the *Eco-Link* and more broadly across the Project area. • Species such as the Long-tailed Macaque (*Macaca fascicularis*) may increase in abundance due to access to available resources. Increases in populations may impact habitats and resources. Impacts to humans may also occur through interaction/conflict. These species may also be able to scale fences and enclosures, entering enclosures that are open to the sky as well as the Mandai Lake Road corridor. • More mobile species (such as birds and bats) are likely to return to the Project area from the CCNR and adjacent forested lands. Competition for resources in these areas may occur within the Project area in the short term, increasing competition and possible injury/mortality.
Grassland Dependent Birds & Bats **Invertebrates**	• Grassland dependent bird and bat species are likely to experience a reduction in available habitat resources due to the decrease in available grassland areas for foraging. Impacts are likely to include reductions in local populations and potential injury/mortality due to increased competition for resources. More mobile species are likely to utilise resources in surrounding areas (the CCNR and land west of the Project area). It is likely that these species will return to the Project area if sufficient habitat is re-established and maintained during operation.

Aquatic Dependent Birds & Herpetofauna **Freshwater Fish & Macroinvertebrates** **Waterside Dwelling Birds** **Invertebrates**	• Aquatic dependent birds and herpetofauna; freshwater fish and macroinvertebrates as well as waterside dwelling birds are not expected to experience significant adverse impacts as a result of the routine operations of the new attractions and facilities. Habitat availability will be maintained and, in the case of riparian forests and habitats beside the Upper Seletar Reservoir, improved through forest restoration and provision of improved access across the drain around the Upper Seletar Reservoir. • Accidental spills of chemicals or pollutants may impact aquatic environments, including fauna and flora within waterways such as the unnamed stream to the west of the Project area and the Upper Seletar Reservoir. A commitment has been made to release no Project related discharges into the reservoir during operation.
CR, EN and VU listed Plants	• The design intent is to preserve all CR, EN and VU SRDB listed trees. Any attempt to fell trees in this category can only be done with prior approval from NParks. The *Forest Restoration Plan* (see *Annex 15*) will detail replanting and restoration of habitats for these species, increasing populations if appropriately implemented and maintained.

9.4.4 Transition of Habitats during Operation

9.4.4.1 Mitigation

Measures to mitigate the impacts due to transition of habitats during operation are outlined in *Table 9.13*.

Table 9.13: Mitigation Measures for Transition of Habitats during Operation

Phase / Activity	Specific Actions

General Management & Planning	• The following mitigation measures are required to reduce impacts from transition of habitats/habitat loss within the Project area:
	  • Vegetative barriers will be used at ground level to discourage human incursion into vegetated areas. These vegetative barriers should consist of native indigenous flora that is planted at a density that is impenetrable to humans.
	  • All recommendations outlined in the Forest Restoration Plan (*Annex 15*) must be implemented to ensure adequate establishment and restoration of vegetation within the Project area. MPH is to contract as necessary specialist advice on forest restoration activities. Suitable tree recruitment strategies must be put into place for all trees within enclosures.
	• A community based forest restoration project may be developed to engage local community members to participate in forest restoration activities. The community forest restoration activities will not be conducted on an ad-hoc basis based on visitor demand but will follow the recommendations within the Forest Restoration Plan in Annex 15. This project is to work with local community groups to undertake weeding and planting strategies; public awareness activities and undertake workshops. The community based project may also participate in the establishment and maintenance of the Project's nursery, including seedling propagation.
	• The following mitigation measures will be implemented to ensure habitat resources lost during construction and operation will be replaced/compensated including: habitat resources such as artificial nesting boxes, ground habitats, refugia, and other necessary micro habitat components will be installed. The compensatory habitat installed within the Project area will consist of a replacement ratio sufficient to compensate for the habitat resources lost; advice will be sought from a suitably qualified ecological specialist on the required replacement habitat resources, including the type, location, density and suitability for target species; where required, habitat resources will be modified or replaced if they are deemed not suitable or effective. Monitoring will continue for replaced habitat resources to determine their effectiveness; the location of all habitat resources installed will be recorded and mapped for future monitoring and review. Restore/enhance aquatic habitat features if identified from monitoring; restoration activities can include: establishment of habitat features (in-stream debris etc.); removal of weeds; targeted control of exotic species; where monitoring indicates that impacts to species groups/individuals are occurring due to the operation or maintenance of the Project, advice will be sought from suitably qualified specialists and an appropriate action plan developed and implemented.
	• Training will be prepared for visitors to the attractions to raise their awareness of biodiversity protection and management within Singapore

Phase / Activity	Specific Actions
	and the Project site. This training shall screen or be shown on arrival or opportunistically and include: introduction to important biodiversity at Mandai; threatened species and their conservation; conservation initiatives developed as part of the Mandai project; weeds and invasive species management; community conservation and involvement. • All retained and planted vegetation must be monitored for health and disease during operation. A suitably qualified horticulturalist must assess the project area on a regular basis (every 1 month or if disease is identified) during establishment and operation. Where disease outbreaks are identified, the horticulturalist must advise on measures to manage any outbreaks. • A horticultural maintenance schedule will be implemented to regularly check and prune trees and plants around enclosures to protect against trees damaging the integrity of the mesh and animals using branches to enter the aviaries. • Where trees and vegetation are moved or translocated to/within the Project area, a suitably qualified arborist should advise on the methods and approach necessary to ensure the trees' health during translocation. Translocated trees must be managed through adequate watering and monitoring of their health to ensure their long term survival. Advice should be sought from an arborist if any tree exhibits signs of stress.
Monitoring	• The following monitoring measures are required during operation for habitats within the Project area: • A suitably qualified arborist must assess and provide advice on any sick or stressed trees and provide advice on their health and future management. All retained and planted vegetation must be monitored for health and disease during operation (every 3 months or sooner). • A suitably qualified horticulturalist must assess the Project area on a regular basis (every 1 month or immediately if disease is identified) during establishment and operation. Where disease outbreaks are identified, the horticulturalist must advise on measures to manage these outbreaks. • A community based flora and fauna monitoring project may be developed that engages the community in flora and fauna monitoring within the Project area. This will include conducting workshops on monitoring techniques; data collection and reporting. Monitoring equipment (including permanent camera traps) will be installed to assist in the community monitoring program. • Minimise operating machinery within 10 m of trees to avoid impacts to root systems through soil compaction. Where machinery is required to be used close to a tree or retained vegetation, it must be a machine that exerts a low pressure on the ground (such as a tracked machine).

9.4.4.2 Residual Impacts

Impacts from habitat transition will change the distribution and condition of habitat within the Project area and immediate Project Vicinity during operation. This will affect the resources necessary to sustain resident species. The impact has been considered in terms of the

Project Vicinity (being the CCNR and immediately adjacent habitats) as the impacts will be restricted to this area.

Without mitigation, the magnitude of impact from habitat transition within the Project Vicinity during operation is considered to be **Medium**. Without maintenance and management of habitats within the Project Vicinity (including the buffers and CCNR adjacent to the Project site), forest degradation may occur or continue, leading to a reduction in habitat values. As a result, a sufficient proportion of the habitat will be affected such that the viability/function of part of the habitat or the entire habitat is reduced, but does not threaten the long-term viability of the habitat or species dependent on it.

Mitigation measures have been designed to ensure management of habitat values and to restore habitats within the Project area and Vicinity. The mitigations are designed to restore and maintain forests; manage edge effects and involve the community in forest restoration activities. With the application of mitigations, the residual impact magnitude is expected to reduce to **Small**. The impacts are likely to affect a small area of habitat, but without the loss of viability/function of the habitat. The impact assessment summary is provided in *Table 9.14.*

Table 9.14: Impact Assessment Summary –Transition of Habitats/Habitat Loss

Criterion	Rating	Comment
Transition of Habitats/Habitat Loss		
Nature	Negative	Habitat distribution and resource availability within the Project Vicinity will change and improve over time during operations, however there will be a permanent loss of habitat within the Project area (from construction).
Type	Direct	Transition of habitats and habitat loss will lead to a reduction in habitat availability for species within the Project Vicinity.
Duration	Long-term	Impacts will be long-term for ground dwelling species as they will not be able to access the Project area.
Extent	Local	The extent of impact will generally be limited to the Project area, however some localised impacts within the Project Vicinity are likely.
Scale	Medium	Impacts will primarily occur during the construction period (7 years), however ongoing impacts on habitat loss and degradation may occur during operation. The impact scale within the Project Vicinity would be considered as Medium.
Magnitude	Medium	The impact within the Project Vicinity is considered to be Medium as it will affect a sufficient proportion of the habitat such that the viability/function of part of the habitat or the entire habitat is reduced, but does not threaten the long-term viability of the habitat or species dependent on it.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and contains threatened species listed as CR on the SRDB and IUCN Red List.
Significance	Major	The significance magnitude for species within the Project Vicinity is considered to be Major. The magnitude of impact is Medium and the receptor sensitivity is High.

Criterion	Rating	Comment
Transition of Habitats/Habitat Loss		
Residual Impact Magnitude	Small	Application of mitigation will reduce impacts on species within the Project Vicinity by managing and restoring habitat values. The residual impact magnitude is therefore considered to be Small. The impact will affect a small area of habitat, but without the loss of viability/function of the habitat.
Residual Impact Significance	Moderate	The Residual Impact significance is considered to be Moderate (Small Magnitude; High Receptor Sensitivity).

9.4.5 Generation of Domestic Waste and Litter from Facilities

9.4.5.1 Mitigation

Measures to mitigate the impacts due to waste are outlined in *Table 9.15*.

Table 9.15: Mitigation Measures for Waste

Phase / Activity	Specific Actions

General Management & Planning	• To manage waste within the Project area, the following mitigations will be applied.
	  • Domestic waste management so as to reduce the availability of food for species requiring management.
	  • Litter bins will be installed (closed and fire proof), regular housekeeping on *Boardwalk* and trails, frequent collections and removal of waste from the Project in accordance with regulatory requirements. Recycling initiatives to be adopted as much as possible. The operator will also require regular maintenance checks and EHS inspection of the entire site to ensure members of the public and the staff are not littering.
	  • All waste from Food and Beverage outlets will be managed using licensed waste contractors. Storage of waste on site shall be within closed and locked storage facilities that are animal proof.

Operation and Maintenance	• To maintain waste management within the Project area, the following mitigations will be applied.
	  • All waste bins are to be inspected twice daily and emptied. The frequency of clearing waste may be greater during periods of high visitation;
	  • Signage must be placed near waste disposal areas to discourage littering and feeding of animals;
	  • Education must be undertaken through site introductions or signage for visitors of the need to dispose of waste in waste bins; and
	  • All Food and Beverage outlets must be advised of obligations to manage waste to reduce the risk of animal feeding.

Monitoring	• The following monitoring measures must be implemented during operation:
	  • Inspections of waste disposal areas must occur on a daily basis; and
	  • CCTV will be installed at centralised waste collection locations to determine whether species are active within the areas (both day and night time). Where species are determined to be active around waste management areas, measures must be employed to reduce the source of the attractant.

9.4.5.2 *Residual Impacts*

The impacts from the generation of waste and litter can lead to species impacts by increasing foraging resources for certain species. This impact has been considered in terms of the Project Vicinity as the populations of species that may be impacted inhabit this broader area.

Without mitigation, the magnitude of impact from the generation of waste and litter within the Project Vicinity during operation is considered to be **Medium**. Poor management of waste will lead to increases in the populations of species requiring management and possible human/wildlife conflicts. Populations of species requiring management such as non-native rodents and the Long tailed Macaque (*Macaca fascicularis*) may increase, increasing competition and increasing the chances for human/wildlife conflict. As a result of this impact, a sufficient proportion of species' populations may be affected that may bring about a substantial change in abundance and /or reduction in distribution over one or more generations.

Mitigation measures have been designed to manage waste from visitors, facilities and food and beverage outlets within the Project area. The mitigations are designed to reduce the availability of food resources to fauna within the Project area through the enclosure of waste and the monitoring/disposal of waste, especially during times of high visitation. With the application of mitigations, the residual impact magnitude is expected to reduce to **Small**. The impacts are likely to affect a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself. The impact assessment summary is provided in *Table 9.16*.

Table 9.16: Impact Assessment Summary - Generation of Waste

Criterion	Rating	Comment
Generation of Domestic Waste Providing a Food Source for Species requiring Management		
Nature	Negative	Generation of domestic waste and litter during operations may increase the populations of resident species through increases in available resources.
Type	Direct	Populations of species requiring management such as non-native rodents and the Long tailed Macaque (*Macaca fascicularis*) may increase, increasing competition and increasing the chances for human/wildlife conflict.
Duration	Long-term	If not adequately controlled, the impact may occur over the long-term with populations increasing of species in response to the provision of resources.
Extent	Local	The extent of the impact is considered to be local, impacting the Project area, the CCNR and natural areas within the Project Vicinity.
Scale	-	It is difficult to predict population increases in individual species; however the scale could be large if not appropriately managed. No natural predators exist within Singapore for these species to control their populations.
Magnitude	Medium	The impact for species is considered to be Medium. Increases in populations of species requiring management will have impacts on other species that utilise the habitat. The impacts may cause a substantial change in abundance and/or reduction in distribution

Criterion	Rating	Comment
Generation of Domestic Waste Providing a Food Source for Species requiring Management		
		of a population over one, or more generations, but does not threaten the long term viability/function of that population.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and contains species of conservation significance listed as CR on the SRDB and IUCN Red List.
Significance	Major	The significance of impacts to species is considered to be Major as the magnitude is considered to be Medium and receptor sensitivity is considered to be High.
Residual Impact Magnitude	Small	If waste and litter is managed during operation (through the use of closed-top bins; physical barriers etc.), it is considered that the impact magnitude for species will reduce to Small. Mitigation will reduce the availability of resources for species requiring management within the Project area through the management of waste and exclusion from enclosure areas. The impact will therefore be reduced and will be unlikely to cause substantial change in the population of the species, or other species dependent on it.
Residual Impact Significance	Moderate	It is expected that mitigation will lower the residual impact significance to Moderate for species. The receptor sensitivity remains High but it is expected that adequate controls will reduce the chance of increases in populations of these species (Small Magnitude; High Receptor Sensitivity).

9.4.6 After Hours Delivery Vehicles Colliding with Fauna

9.4.6.1 Mitigation

Measures to mitigate the risk of vehicle collisions due to after-hours delivery are outlined in *Table 9.17*.

Table 9.17: Mitigation Measures for After Hours Delivery Vehicles Colliding with Fauna

Phase / Activity	Specific Actions

General Management & Planning	• The fencing measures as outlined in *Chapter 8* will reduce the risk of vehicle strikes during operation. The following additional mitigation measures are required to minimise impacts on fauna from after-hours delivery vehicles colliding with fauna:
	  • Roadside reflectors must be used along Mandai Lake Road and attached to posts 20-50m apart at a height of at least 2m from the ground surface.
	  • A 40 km/h speed limit is to be placed along Mandai Lake Road.
	  • Speed bumps to be installed at appropriate distances along Mandai Lake Road to control speed.
	  • A 'Vehicle-Activated Speed Display' is to be installed along Mandai Lake Road to inform drivers of their speed.

Operation and Maintenance	• The following additional mitigation measures are required during operation: • Develop, implement and maintain a protocol to identify the roles and responsibilities and specific actions to manage injured wildlife within the Project. Protocol will include: immediate assessment of injured wildlife

Phase / Activity	Specific Actions
	by suitably qualified veterinary professionals; investigative measures into the cause of injuries or mortality to wildlife within the Project area; recording procedures for injured wildlife/ investigations and identification of management of change measures necessary to reduce the risk of future events.

Monitoring	• The following monitoring will be undertaken during operations to determine impacts on potential road kills and enable adaptive management:
	  • Daily inspections are to occur along Mandai Lake Road to determine if there are any fauna trapped between the road and the fence or if injury has occurred with any individuals.
	  • Wildlife camera traps will be installed along the boundary of project component areas during operational activities. Cameras are to be placed to face forest or grassland areas (note time delays should be used so the cameras are active to capture nocturnal fauna); wildlife camera traps will be inspected on a weekly basis to collect photographs and ensure they are functioning correctly.
	  • A register and investigation process is to be established to determine the cause of any road kills during operations. All deaths are to be investigated and any gaps identified in mitigation measures that may have led to the death/injury should be identified and changes made to the mitigation strategy.

9.4.6.2 Residual Impacts

The impact from after-hours delivery vehicles colliding with fauna could cause changes in species populations due to injury/mortality from vehicles delivering goods and materials after hours, predominately along Mandai Lake Road. The impact has been considered in terms of the Project Vicinity as Mandai Lake Road runs through this area and will be the main source of threats.

Without mitigation, the magnitude of impact to fauna from accidental collisions after-hours by delivery vehicles could have a negative impact on fauna populations within the Project Vicinity. The magnitude of impact therefore is considered to be **Medium**. As a result of this impact, a sufficient proportion of species' populations may be affected that may bring about a substantial change in abundance and /or reduction in distribution over one or more generations.

Mitigation measures have been designed to reduce the opportunity for fauna to enter the road reserves along Mandai Road and Mandai Lake Road through the fencing strategy (*see Figure 9.1).* All hoarding and fencing structures must not use barbed wire as this poses a danger to arboreal animals. Further measures will be employed to reduce the risk of collision, including establishing a speed limit of 40 km/h along Mandai Lake Road. With the application of mitigation, the residual impact magnitude is expected to reduce to **Small**. The impacts are likely to affect a small area of habitat, but without the loss of viability/function of the habitat. The impact assessment summary is provided in *Table 9.18*.

Table 9.18: Impact Assessment Summary – After Hours Delivery Vehicles Colliding with Fauna

Criterion	Rating	Comment
After Hours Delivery Vehicles Colliding with Fauna		
Nature	Negative	Delivery of materials to facilities after hours is expected to impact nocturnal species during operation.
Type	Direct	Delivery of materials to facilities after hours may have a direct impact on resident species due to vehicle strikes within and around the Project area.
Duration	Long-term	The impacts will be during night time when deliveries occur for the life of the project.
Extent	Local	The impact is expected to occur along roads and internally within the Project area near facilities.
Likelihood	Possible	The likelihood of this event is considered to be Possible. However, the use of fences and barriers will reduce the risk of the event occurring.
Scale	-	There is likelihood that nocturnal species may be impacted by the delivery of goods after hours.
Magnitude	Medium	The impact is considered to be Medium. The impact may affect a sufficient proportion of a species population such that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and contains species that are listed as CR on the SRDB and IUCN Red List.
Significance	Major	The significance to species within the Project area is considered to be Major, resulting from a combination of a Medium impact magnitude and High receptor sensitivity.
Residual Impact Magnitude	Small	Application of mitigation (such as the use of speed limits and fencing) will reduce the likelihood of mortality/injury to wildlife from the delivery of materials during night time such that the magnitude is reduced to Small. Reduction in speed limits may reduce impact as this increases alert and response time of drivers. The impacts will affect a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself.
Residual Impact Significance	Moderate	The significance to species within the Project area is considered to be Moderate. The magnitude is considered to be Small whilst the receptor sensitivity is considered to be High.

9.4.7 Visitor Interaction with Flora and Fauna

9.4.7.1 Mitigation

Measures to mitigate the impacts due to visitor interaction with flora and fauna are outlined in *Table 9.19*.

Table 9.19: Mitigation Measures for Visitor Interaction with Flora and Fauna

Phase / Activity	Specific Actions

General Management & Planning	• The measures outlined in *Table 9.13* are relevant to the management of habitats within the Project area during operation and are designed to sustain habitats/flora damage within enclosures, including from negative human interaction. The following additional mitigation measures are required to minimise impacts on visitor interaction with flora and fauna:
	  • Signage is to be placed at the entrance point, near waste disposal locations and other points to request visitors not to feed or interact with fauna and pick/take flora within the Project area.
	  • Along the *Boardwalk*, measures to be taken will include patrolling, installation of signage to inform visitors not to go off-trail, and prohibitions on fishing.
	  • The buffers, *Eco-Link* and area of high value forest adjacent to the *Sri Seletar Point/Planet Explorer* facility will be out of bounds for visitors at all times.
	  • Passive training will be prepared for visitors to the attractions to raise their awareness of biodiversity protection and management within Singapore and the Project area. This can include: introduction to important biodiversity at Mandai; threatened species and their conservation; conservation initiatives developed as part of the Mandai project; weeds and invasive species management; community conservation and involvement;
	  • A community based education program may be established to enable volunteers to provide education services to visitors during operation. This program will develop education materials and standard presentations to enable community members to undertake these education programs.

Monitoring	• The community based flora and fauna monitoring project will be developed that engages the community in flora and fauna monitoring within the Project area. This will include conducting workshops on monitoring techniques; data collection and reporting. It is recommended that monitoring equipment (including permanent camera traps) be established to assist in the community monitoring program. • CCTV will be installed to monitor visitor interactions with flora and fauna and incursions into locations that are forbidden for all visitors (including the buffers, *Eco-Link* and the area of high value forest adjacent to *the Sri Seletar Point/Planet Explorer* facility). Where visitor incursions to these areas are detected or inappropriate visitor interaction occurs, it is to be investigated to determine the causal factors. Additional mitigation measures must be designed and implemented to reduce the risk of further negative fauna interaction with visitors.

9.4.7.2 Residual Impacts

The impacts due to visitor interaction with fauna may cause negative impacts to fauna. This impact has been considered in terms of the Project Vicinity as resident populations of fauna are generally restricted to this area. Impacts from visitors on flora will be restricted to the vegetation within the Project area, but may impact adjacent vegetation within the Project Vicinity (CCNR and adjacent areas).

Without mitigation, the magnitude of impact to fauna from interaction between visitors and flora and fauna within the Project Vicinity will be **Medium**. The impact will affect a sufficient proportion of a species population such that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it. Negative interactions between visitors and fauna as well as the picking/taking of flora during operation will have a negative impact on habitat values within the Project Vicinity. Incursion into areas of high biodiversity value may also negatively impact flora within the Project Vicinity. With mitigation, including measures to protect sensitive areas from incursion by humans and education of visitors, the magnitude of impact will be reduced to **Small**. As a result, the effects will impact a small proportion of a population, but is not expected to substantially affect other species dependent on it, or the populations of the species itself.

Table 9.20: Impact Assessment Summary – Visitor Interaction with Flora and Fauna

Criterion	Rating	Comment
Interaction of Visitors with Fauna and Flora		
Nature	Negative	Potential visitor interaction between flora and fauna causing increases in populations or injury or mortality to individuals. Potential injury to humans. Visitors may pick or damage flora during operations.
Type	Direct	Potential interaction may have a direct impact on individuals and humans. Negative impact to flora from visitors picking/damaging plants within the Project Vicinity.
Duration	Long-term	Will occur over the life of the Project.
Extent	Local	The impact will be restricted to certain parts of the Project Vicinity.
Scale	Medium	Interaction with species may occur with the Long tailed Macaque (*Macaca fascicularis*) and rodents. Human visitors may pick/damage vegetation in ecologically sensitive areas.
Magnitude	Medium	The impact is likely to be Medium. The effect will not cause a substantial change in the population of the species, or other species dependent on it. However, the impact may be of concern if interactions with humans are negative and lead to injury. The impact will affect a sufficient proportion of a species population such that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and contains species that are listed as CR on

Criterion	Rating	Comment
Interaction of Visitors with Fauna and Flora		
		the SRDB and IUCN Red List.
Significance	Major	The significance is considered as Major. The magnitude is considered Medium and the Sensitivity is considered High.
Residual Impact Magnitude	Small	The impact is likely to be Small if appropriately managed through education of visitors and management of species through physical barriers and monitoring. The effect following mitigation will not cause a substantial change in the population of the species, or other species dependent on it.
Residual Impact Significance	Moderate	The significance is considered Moderate. The magnitude is considered Small and the Sensitivity is considered to be High (Small Magnitude; High Receptor Sensitivity).

9.4.8 *Accidental Proliferation of Feed Species*

9.4.8.1 *Mitigation*

Measures to mitigate the impacts due to accidental proliferation of feed species are outlined in *Table 9.21*.

Table 9.21: Mitigation Measures for Accidental Proliferation of Feed Species

Phase / Activity	Specific Actions

General Management & Planning and Monitoring	• The following additional mitigation measures are required to minimise impacts from the accidental proliferation of feed species:
	  • The location of the fodder area will be away from the CCNR and buffer areas. The area is to be fenced and measures taken to control any seeds within fodder placed within enclosures.
	  • Manage fodder species within the Project area by monitoring; where fodder/feed species are detected outside of designated areas, they will be controlled using appropriate means; and investigations into the pathway for fodder/weed species to move from designated areas/enclosures. Remedial measures subsequently identified will be implemented and further monitoring to prevent re-occurrence.
	  • The fodder area will be fenced to restrict access by native fauna. The fencing will be maintained at a maximum height of 2.4m and be fully enclosed (using a smooth, non-mesh material) to reduce the risk of seed escape.
	  • Monitoring (using video cameras) is to occur to determine whether pest species or native fauna access the fodder area. If pest/native fauna are accessing the fodder area, remedial measures are to be developed and subsequently implemented and further monitoring to prevent re-occurrence.

9.4.8.2 *Residual Impacts*

Impacts from fodder species may cause changes in the integrity of habitats and impact the provision of resources to resident species. The impacts have been assessed in terms of the threats posed within the Project Vicinity as the fodder and feed species will be restricted to the Project area but may be transmitted within the vicinity during operation through seed dispersal or transport on vehicles or equipment.

Without mitigation, the magnitude of impact from the accidental proliferation of feed species is considered to be **Medium**. The impact will affect a sufficient proportion of the habitat such that the viability/function of part of the habitat or the entire habitat is reduced, but does not threaten the long-term viability of the habitat or species dependent on it. The identified fodder species to be grown on site include: *Morus alba*; *Morus nigra*; *Morus rubra*; and *Hibiscus sp*. None of these species are considered invasive however they can proliferate and become weed species. Accidental release of fodder and feed species may directly impact habitats and species through proliferation and changes in resource availability.

Mitigation measures have been designed to place the fodder area away from sensitive environments such as the CCNR and buffer. The growth of fodder will be monitored and mitigations used to control any accidental spread of fodder species outside of the dedicated fodder growth area. With the application of mitigation, the residual impact magnitude is expected to reduce to **Small**. The impacts are likely to affect a small area of habitat, but without the loss of viability/function of the habitat. The impact assessment summary is provided in *Table 9.22*.

Table 9.22: Impact Assessment Summary – Accidental Proliferation of Feed Species

Criterion	Rating	Comment
Accidental Proliferation of Feed Species		
Nature	Negative	Accidental proliferation of fodder and feed species, impacting the integrity of habitats and potentially increasing resource availability.
Type	Direct	Accidental release of fodder and feed species may directly impact habitats and species through proliferation and changes in resource availability.
Duration	Long-term	Introduction of fodder and feed species can have long-term deleterious impacts to ecosystems.
Extent	Local	Fodder and feed species infestations may impact the Project Vicinity and also transmit to surrounding landscapes or move from surrounding areas to the Project area. Invasive species have been identified within the Project area.
Likelihood	Possible	The likelihood of this event is considered Possible. Fodder species may disburse seed that may carry into adjacent areas of the Project area.
Scale	-	The identified fodder species to be grown on site include: *Morus alba*; *Morus nigra*; *Morus rubra*; and *Hibiscus sp*. None of these species are considered invasive however they can proliferate and become weed species. It is currently unknown what other feed will be used for bird enclosures.
Magnitude	Medium	It is considered that the accidental release of fodder and feed species would have a Medium magnitude within the Project area. The impact may affect a sufficient proportion of the habitat such that the viability/function of part of the habitat or the entire habitat is reduced, but does not threaten the long-term viability of the habitat or species dependent on it.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest

Criterion	Rating	Comment
Accidental Proliferation of Feed Species		
		Important Bird Area) and contains species that are listed as CR on the SRDB and IUCN Red List.
Significance	Major	The magnitude is considered to be Medium and the receptor sensitivity is considered to be High, therefore the significance is Major without mitigation.
Residual Impact Magnitude	Small	The residual impact magnitude will be reduced by mitigations within the EMMP to monitor and control fodder and feed species within the Project area. The fodder area will be located away from the CCNR and buffer to avoid accidental proliferation in sensitive areas. Monitoring will occur to determine if species have escaped and control measures implemented if species are detected outside of the fodder area. The residual impact magnitude will reduce to Small as a result of these mitigations, as the likely effects will only impact a small area of habitat, such that there is no loss of viability/function of the habitat.
Residual Impact Significance	Moderate	The magnitude is considered to be Moderate. The receptor sensitivity is considered to be High, and the residual impact significance is considered to be Small (Small Magnitude; High Receptor Sensitivity).

9.4.9 *Aerial Collision of Fauna with Enclosed Structures and Netting*

9.4.9.1 *Mitigation*

Measures to mitigate the impacts due to aerial collision of fauna with enclosed structures and netting are outlined in *Table 9.23*.

Table 9.23: Mitigation Measures for Aerial Collision of Fauna with Enclosed Structures and Netting

Phase / Activity	Specific Actions

General Management & Planning	• The following mitigation measures are required to minimise impacts from aerial collision of fauna with enclosure structures and netting:
	  • Mesh size of enclosures must be constructed to be visible for resident fauna. A maximum of 25mm stainless steel wire mesh must be used for all enclosures that house fauna. Polyethylene or polypropylene may be used if suitable for the host species. Smaller mesh sizes may be used where the species requires additional protection. Larger mesh sizes may be used for large fauna (such as ground dwelling mammals). All enclosures must contain a band of mesh or steel to prevent rodent and reptile access into the enclosures.
	  • Immediately assess injured wildlife by suitably qualified veterinary professionals; undertake investigative measures into the cause of injuries or mortality to wildlife within the Project area; record injured wildlife/ investigations; and identify management of change measures necessary to reduce the risk of future events.

Monitoring	• The following monitoring measures are required to minimise impacts from aerial collision of fauna with enclosed structures and netting: • Where recurrent patterns in collisions occur, investigations will be

Phase / Activity	Specific Actions
	undertaken to identify the risks/threats associated with injury/mortality. Further advice will be sought from suitably qualified professionals on potential remedial measures to reduce injury/mortality.

9.4.9.2 *Residual Impacts*

The impacts from accidental collision with enclosures can have impacts on the local populations of birds and bats. The impact has been assessed based on the Project Vicinity as it is anticipated that the impact will be restricted to the resident populations within the Project area and vicinity.

Without mitigation, the magnitude of impact from the aerial collision of fauna with enclosure structures and netting is considered to be **Medium**. Bird and bat species may collide with structures or become entangled in netting causing injury or mortality. As a result of this impact, a sufficient proportion of a species population will be affected such that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.

Mitigation measures have been designed for enclosures to ensure that they are robust and visible for species. The risk to bird and bat species of injury or mortality will persist over the life of the project, however, it is likely that species will learn to avoid the location of the structures and netting with mortality reducing over time. The size and location of enclosures will ensure that species are aware of them in the landscape (through visual or echo-location for bats). With the application of mitigations, the residual impact magnitude is expected to reduce to **Small**. The impacts are likely to affect a small area of habitat, but without the loss of viability/function of the habitat. The impact assessment summary is provided in *Table 9.24*.

Table 9.24: Impact Assessment Summary – Aerial Collision with Enclosure Structures and Netting

Criterion	Rating	Comment
Aerial Collision with Enclosure Structures and Netting		
Nature	Negative	Aerial collision risk with enclosure structures and netting may impact on species populations within the Project area.
Type	Direct	Bird and bat species may collide with structures or become entangled in netting causing injury or mortality.
Duration	Long-term	The risk to bird and bat species of injury or mortality will persist over the life of the project. However, it is likely that species will learn to avoid the location of the structures and netting with mortality reducing over time.
Extent	Local	The risk of collision with enclosure structures and netting will be limited to the *Bird Park* and *Rainforest Park*.
Likelihood	Possible	The likelihood of this event is considered to be Possible. The risk immediately following construction will be greater until fauna can more readily identify enclosures in the Project area.
Scale	-	The Project area provides habitat to a number of bird and bat species. It is unknown how many individuals may be injured or

Criterion	Rating	Comment
Aerial Collision with Enclosure Structures and Netting		
		killed by collision with enclosure structures and netting.
Magnitude	Medium	The impact is considered to be Medium. The impact may affect a sufficient proportion of a species population such that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it. Species are likely to learn to avoid the enclosures, reducing impacts over time.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project Area is within an internationally designated area (Central Forest Important Bird Area) and contains species that are listed as CR on the SRDB and IUCN Red List.
Significance	Major	The magnitude is considered to be Medium and the receptor sensitivity is considered to be High, therefore the significance is Major without mitigation.
Residual Impact Magnitude	Small	The residual impact magnitude will be reduced by mitigations through the Project design such as mesh size and the location of structures to limit impacts to individuals. The residual impact magnitude will reduce to Small, as the effect is unlikely to cause a substantial change in the population of species following application of mitigations over the long term.
Residual Impact Significance	Moderate	The magnitude is considered to be Moderate. The receptor sensitivity is considered to be High, and the residual impact significance is considered to be Small (Small Magnitude; High Receptor Sensitivity).

9.4.10 Potential Escape of Species From Enclosures

9.4.10.1 Mitigation

Measures to mitigate the impacts due to potential escape of species from enclosures are outlined in *Table 9.25*.

Table 9.25: Mitigation Measures for Potential Escape of Species from Enclosures

Phase / Activity	Specific Actions

General Management & Planning	• The following mitigation measures are required to minimise impacts from the potential escape of species from enclosures:
	  • All trees susceptible to wind throw along forest verges, the *Eco-Link*, Mandai Road, Mandai Lake Road and within enclosures must be anchored to prevent wind throw during storm events (including microburst events). Advice on anchoring techniques must be provided by a suitably qualified arborist. Anchoring is to be placed using a scarf around the tree to prevent damage. Anchoring should be fixed to structures or anchorage points set into the ground surface. Anchoring is to be placed via at least 4 ties to the tree. All wires are to be of suitable strength to hold the weight of the tree.
	  • Monitor all anchored trees susceptible to wind throw. All trees must be inspected following significant storm events, such as micro-burst events.

Phase / Activity	Specific Actions
	Where damage to trees occur, a suitably qualified arborist must provide advice on tree maintenance and stability within the Project area. • Aviaries will be built with a minimum distance of 10 m away from trees in the CCNR to minimise contact with the aviary structure. Selected trees (depending on height, species and condition) surrounding the aviaries will be secured to prevent enclosures from being impacted from tree fall; The periphery of the aviaries will be built with at least 1 m deep concrete skirting to prevent animal ingress/egress; and the mesh of aviaries will be made of stainless steel and sized to prevent captive birds from flying through. Detailed information on the size of the mesh was not available at the time of writing. As a guiding principle, the size of the mesh will not be larger than the smallest bird to be kept in each aviary; therefore, the actual mesh size will be dependent on the bird collection plan (which has not been developed at the time of writing). • Develop and implement protocols in case of release and for the capture of any individuals, which will include but not be limited to: methods to attract bird(s) and recapture using attractants/ feed; fixing of GPS tracking location devices to birds of high flight risk. • Install a displaced double door system at all entry and exit points of each aviary at the *Bird Park*; the door mechanism must be designed to ensure that one door remains shut when the other is open. Visual inspections/sensors must be installed to ensure that birds have not escaped into the entrance corridors before the remaining door is opened; CCTV and other suitable technologies will be used to monitor possible theft, vandalism and escapees.
Operation and Maintenance	• The following operation and maintenance measures are required to minimise impacts from the potential escape of species from enclosures: • All enclosures are to be inspected on a daily basis. Regular maintenance inspections are also to occur at least every three months. Following a storm event, all enclosures must be inspected for breaches/damage.
Monitoring	• The following monitoring measures are required to minimise impacts from potential escape of species from enclosures: • CCTV is to be installed at all entrances/exits to enclosures. Sensors are to be installed within all entrance corridors to detect potential escapees. GPS tracking locational devices are to be installed on high flight-risk exhibited species. • Undertake regular monitoring of animal inventory within the enclosures. Monitoring will be carried out via daily counts and the installation of sensors at locations such as feeding stations and nests within the enclosures to enable automated detection and tracking of animals (potential technological solutions were under study at the time of writing). In the event that bird escapes are discovered, the following key actions will be carried out: • Inspect the transition area between double doors and the immediate vicinity of the aviary for the escaped bird; • Illicit conditioned responses from birds (e.g. keepers to use food lures and calls) to draw the escaped bird back; • Inspect the mesh for any defects and carry out any necessary repair works; and • Notify and engage the relevant regulatory authorities including NParks on a coordinated effort to recover the escaped bird.

9.4.10.2 *Residual Impacts*

Potential escape of species from enclosures may negatively impact on the surrounding ecosystem, including: potential breeding with native species, impacting local genetics; changes to predation/resource availability; and competition with native species. This impact is considered in the context of the Project Vicinity as the impacts are likely to impact resident populations in this area. Without mitigation, the magnitude of impact from the potential escape of species from enclosures is considered to be **Medium**. The impact may impact a sufficient proportion of a species population that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.

Mitigation measures have been designed for enclosures to ensure that they are robust and visible for species. The design of the enclosures to reduce the risk of breaches from falling trees and collisions will reduce the risk of escape of exhibited fauna. The application of strict controls for the accidental release of exhibited fauna such as double gates and locking procedures from enclosures; the use of motion sensors and inspection systems, and measures to track and attract birds that may escape will reduce the likelihood of escape. Monitoring during opening phases and during operation will further manage the risks. Although the risk of escape can be reduced, the impact on surrounding populations will still exist in the case that an escape does occur. Therefore, the residual impact magnitude is considered to be of **Small** magnitude. The impacts may affect a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself. The impact assessment summary is provided in *Table 9.26*.

Table 9.26: Impact Assessment Summary – Potential Escape of Species from Enclosures

Criterion	Rating	Comment
Potential Escape of Species from Enclosures		
Nature	Negative	Potential escape of species from enclosures may negatively impact on the surrounding ecosystem, including: potential inbreeding with native species, impacting local genetics; changes to predation/resource availability; and competition with native species. It has been raised as a key concern by Nature Groups.
Type	Direct	Escapees from enclosures may have a serious long-term impact by disrupting natural ecosystem processes.
Duration	Long-term	Escapees could have a long-term impact to the ecosystem if they are not captured.
Extent	Local	Impacts from escapees would likely be local or within the project vicinity.
Likelihood	Possible	The likelihood of this event is considered to be Possible. The risk will continue during operation.
Scale	-	Escapees that are not captured may cause significant impacts to local populations of native species. The scale of impacts is difficult to determine as the impact would be dependent on the species that escaped and their effect on the ecology of the surrounding environment.
Magnitude	Medium	Without adequate controls, the magnitude is considered to be Medium. The impact may affect a sufficient proportion of the habitat such that the viability/function of part of the habitat or the

Criterion	Rating	Comment
Potential Escape of Species from Enclosures		
		entire habitat is reduced, but does not threaten the long-term viability of the habitat or species dependent on it.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and the species of conservation significance are listed as CR on the SRDB and IUCN Red List.
Significance	Major	Without appropriate mitigation, the impact significance is considered to be Major. The receptor sensitivity is High. The magnitude is considered to be Medium.
Residual Impact Magnitude	Small	If mitigation strictly controls the risk of accidental release of fauna such as double gates and locking procedures from enclosures, the residual impact magnitude is considered to be of Small magnitude. The impact would affect a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself.
Residual Impact Significance	Moderate	It is expected that mitigation will lower the residual impact significance to Moderate. The use of double doors, protocols for entering and exiting enclosures as well as curved entrance/egress will reduce the overall risk; however some minor risk of escape will remain. The receptor sensitivity remains High but it is expected that adequate controls can reduce the chance of accidental escape of exhibited species to Low (Small Magnitude; High Receptor Sensitivity).

9.4.11 *Import of Exotic Pests and Weeds*

9.4.11.1 *Mitigation*

Measures to mitigate the impacts due to importation of exotic pests and weeds are outlined in *Table 9.27*.

Table 9.27: Mitigation Measures for Importation of Exotic Pests and Weeds

Phase / Activity	Specific Actions

General Management & Planning	• The following mitigation measures are required to minimise impacts from the importation of exotic pests and weeds:
	  • Signs are to be included at the entrance to the new attractions explaining that exotic pests and weeds are prohibited from being taken into the Project area.
	  • Undertake invasive and weed survey to identify the spatial extent of weed infestation within the immediate Project area and surrounding vicinity. The survey will produce a map and GPS records of the location of invasive and weed species; and include a list of invasive and weed species; and schedule of short and long term programmes. Plan will cover the Project area and surrounding vicinity (including the WRS operated area). Management options will refer to best practice control techniques such as those contained in *Koh et al 2012*; *Chenoweth EPLA et al 2012*.
	  • Training for visitors to raise their awareness of biodiversity protection and management within Singapore and at Mandai. This training shall screen or be shown on arrival or opportunistically and include: introduction to

Phase / Activity	Specific Actions
	important biodiversity at Mandai; threatened species and their conservation; conservation initiatives developed as part of the Mandai project; weeds and invasive species management; community conservation and involvement. • A community based education program may be established to enable volunteers to provide education services to visitors during operation. This program will develop education materials and standard presentations to enable community members to undertake these education programs.
Monitoring	• The following monitoring measures will be implemented to monitor importation of exotic pests and weeds: • Monitor the extent of weed/invasive species within the Project area during construction and operation to identify any new infestations. • Material imported into the Project area to be checked for contamination from weed/invasive species seeds/vegetative matter at source. This is particularly important for imported building materials, such as sand and soil. Source site should be inspected to determine presence of weed/invasive species.

9.4.11.2 Residual Impacts

Potential importation of exotic pests and weeds within imported feed for exhibits or release by visitors may negatively impact the surrounding ecosystem, including: potential proliferation of invasive species, impacting local genetics; changes to predation/resource availability; and competition with native species. The impact has been assessed in the context of the Project Vicinity as impacts from exotic pests and weeds may spread beyond the Project area. Without mitigation, the magnitude of impact from the importation of exotic pests and weeds is considered to be **Medium**. The impact may affect a sufficient proportion of the habitat such that the viability/function of part of the habitat or the entire habitat is reduced, but does not threaten the long-term viability of the habitat or species dependent on it.

Mitigation measures have been designed to educate visitors to reduce the chance of exotic fauna and flora being brought to the Project area. In addition, mitigation measures will include regular inspections and control of weeds and pests within the Project area. The residual impact magnitude is considered to be of **Small** magnitude. The impact will affect a small area of habitat, but without the loss of viability/function of the habitat. The impact assessment summary is provided in *Table 9.28*.

Table 9.28: Impact Assessment Summary – Import of Exotic Pests and Weeds

Criterion	Rating	Comment
Import of Exotic Pests and Weeds within Feed or from Visitors		
Nature	Negative	Potential importation of exotic pests (especially invertebrates) and weeds within imported feed for exhibits or release by visitors may negatively impact the surrounding ecosystem, including: potential proliferation of invasive species; impacting local genetics; changes to predation/resource availability; and competition with native species.

Criterion	Rating	Comment
Import of Exotic Pests and Weeds within Feed or from Visitors		
Type	Direct	Import of exotic pests and weeds within feed or release by visitors may have a direct impact by disrupting natural ecosystem processes.
Likelihood	Possible	The likelihood of this event is considered to be Possible. The use of imported feed and visitation rates indicate that there is a possible likelihood that feed may contain exotic pests and weeds. It is also possible (but unlikely) that visitors will release pests and weeds.
Duration	Long-term	Impacts on the ecosystem may be long-term if exotic pests and/or weeds take hold in the local area.
Extent	Local	Impacts would likely be local or within the project vicinity.
Scale	-	Import of exotic pests and weeds within feed or release by visitors may cause significant impacts to local populations of native species. The scale of impacts is difficult to determine as the impact would be dependent on the species that were introduced and their effect on the ecology of the surrounding environment.
Magnitude	Medium	Without adequate controls, the magnitude is considered to be **Medium**. The proliferation of exotic pests and weeds may change key ecological functions and the impact may affect a sufficient proportion of the habitat such that the viability/function of part of the habitat or the entire habitat is reduced, but does not threaten the long-term viability of the habitat or species dependent on it.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and the species of conservation significance are listed as CR on the SRDB and IUCN Red List.
Significance	Major	Without appropriate mitigation, the impact significance is considered to be Major, arising from the combination of High receptor sensitivity and the Medium magnitude of the impact.
Residual Impact Magnitude	Small	The implementation of mitigation actions will reduce the likelihood of impacts. The provenance of feed will be checked to reduce the risk of contamination. The residual impact magnitude is considered to be of Small magnitude. The impact will affect a small area of habitat, but without the loss of viability/function of the habitat.
Residual Impact Significance	Moderate	It is expected that mitigation will lower the residual impact significance to Moderate. The implementation of the weed management plan, monitoring and control will reduce the overall number of weed and invasive species within the Project area. However, the risk of weed and invasive species transmission from outside of the Project area will remain. The receptor sensitivity remains High but it is expected that adequate controls can manage the import of exotic pests and weeds within feed or release by visitors (Small Magnitude; High Receptor Sensitivity).

9.4.12 Fauna Strikes from Visitor Vehicles

9.4.12.1 Mitigation

Measures to mitigate the impacts due to the increase in visitor vehicles are outlined in *Table 9.29*.

Table 9.29: Mitigation Measures for Fauna Strikes from Visitor Vehicles

Phase / Activity	Specific Actions
General Management & Planning	The mitigation measures outlined in *Table 9.17, Mitigation Measures for the After Hours Delivery Vehicles Colliding with Fauna* are relevant for the management of potential impact on fauna from the increase in visitor vehicles.
Monitoring	The monitoring measures outlined in *Table 9.17, Mitigation Measures for the After Hours Delivery Vehicles Colliding with Fauna* are relevant for the management of potential impact on fauna from the increase in visitor vehicles.

9.4.12.2 Residual Impacts

Records of road kills on surrounding roads and within the Project area indicate that mortality occurs to resident species on a regular basis. This impact is assessed according to the Project Vicinity as impacts may occur along Mandai Lake Road and surrounding roads due to the project. However, since visitor vehicle rates will increase during operation; the frequency of the impact may increase if not adequately controlled. Without mitigation, the magnitude of impact to fauna from visitor vehicles could have a negative impact on fauna populations within the Project area. The magnitude of impact therefore is considered to be **Medium**. As a result of this impact, a sufficient proportion of species' populations may be affected that may bring about a substantial change in abundance and /or reduction in distribution over one or more generations.

Mitigation measures have been designed to reduce the opportunity for fauna to enter the road reserves along Mandai Road and Mandai Lake Road by the fencing strategy (see *Chapter 8*). Further measures will be employed to reduce the risk of collision, including restricting the hours of delivery and enforcing a speed limit of 40 km/h along Mandai Lake Road. With the application of mitigations, the residual impact magnitude is expected to reduce to **Small**. The impact assessment summary is provided in *Table 9.30*.

Table 9.30: Impact Assessment Summary – Fauna Strikes from Visitor Vehicles

Criterion	Rating	Comment
Increase in Visitor Vehicles		
Nature	Negative	Potential mortality of fauna as the result of visitor vehicles.
Type	Direct	Impact arises from an increase in the number of visitor vehicles.
Likelihood	Possible	The likelihood of visitor vehicles colliding with fauna during operation is Possible. There is currently a pattern of mortality from vehicle strikes along Mandai Road and Mandai Lake Road.
Duration	Long-term	The duration of the impact would be throughout the operational period.
Extent	Local	Impacts are possible along Mandai Lake Road and Mandai Road to the north.
Scale	-	Records of road kills on surrounding roads and within the

Criterion	Rating	Comment
Increase in Visitor Vehicles		
		development footprint indicate that mortality occurs to resident species on a regular basis. It is not possible to accurately predict increases in mortality as a result of vehicle strike from the project development. However, since visitor vehicle rates will increase during operation, the scale of the impact may be large if not adequately controlled.
Magnitude	Medium	The magnitude of impact is expected to be Medium without mitigation. The impact may affect a sufficient proportion of a species population such that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project Area is within an internationally designated area (Central Forest Important Bird Area) and contains species that are listed as CR on the SRDB and IUCN Red List.
Significance	Major	Vehicle strikes may substantially increase during operation as a result of increased traffic. The significance of impact is expected to be Major if not controlled.
Residual Impact Magnitude	Small	Fencing will be used to restrict animal movements onto Mandai Road and Mandai Lake Road, thereby reducing the likelihood of vehicle strikes and to facilitate movement towards safe refugia (such as the *Eco-Link*). Some risk may remain where fauna are trapped within the road verge. Additional mitigations have been specified, including a 40 km/h speed limit on Mandai Lake Road and daily inspections along the road to rescue trapped fauna. On this basis, it is expected that the residual impact magnitude will be Small. The effect is not expected to cause substantial changes in the population of resident species.
Residual Impact Significance	Moderate	It is expected that mitigation will lower the residual impact significance to Moderate. The fencing and inspection management strategy will reduce the risk of collision during operation. However, a minor risk will remain that fauna may become exposed to traffic along Mandai Lake Road. The receptor sensitivity remains High but it is expected that fencing can reduce the chance of vehicle strike and subsequent fauna mortality to Low (Small Magnitude; High Receptor Sensitivity).

9.4.13 Spread of Disease

9.4.13.1 Mitigation

Measures to mitigate the impacts due to the spread of disease within fauna populations are outlined in *Table 9.31.*

Table 9.31: Mitigation Measures for Spread of Disease

Phase / Activity	Specific Actions

General Management & Planning	• The mitigation measures outlined in *Table 9.25, Mitigation Measures for Potential Escape of Species from Enclosures* are relevant for the mitigation for the spread of disease. Additional management measures include:
	  • Quarantine measures, which are to be established in consultation with the relevant regulatory agencies, are to be implemented prior to arrival of all exhibited fauna. During operation, regular monitoring of disease shall be undertaken for all fauna within enclosures. If any disease is identified, specialist advice must be provided by veterinarians and a health management protocol implemented in consultation with the relevant regulatory agencies. Specialist monitoring should be undertaken for diseases such as avian influenza.
	  • If disease outbreak is identified within local or exhibited fauna populations, contact must be made with the Agri-Food and Veterinary Authority of Singapore and NParks. Quarantine and management protocols must be implemented as directed by the regulatory authority.

Monitoring	• The following monitoring measures will be implemented to monitor the spread of disease from enclosures within the Project area: • A disease management protocol must be developed in consultation with the relevant regulatory agencies to manage any outbreak of disease within native populations, and should include provisions for health monitoring of local fauna populations through regular fauna monitoring.

9.4.13.2 Residual Impacts

Impacts from the spread of disease within both exhibited and resident populations may cause impacts to local populations of species. Impacts have been considered in terms of the Project Vicinity as impacts may occur to species within this area.

The magnitude of impact to fauna from the spread of disease within animal populations within enclosures and resident fauna within the Project Vicinity may cause impacts to fauna through the spread of disease and subsequent fauna mortality. The likelihood of the spread of diseases to native populations from exhibited fauna is considered possible. It is possible that the introduction of imported fauna into enclosures may provide a disease pathway to native fauna within the surrounding environment. The magnitude of impact therefore is considered to be **Medium**. As a result of this impact, a sufficient proportion of a species population will be affected such that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.

Mitigation measures have been designed to monitor and implement protocols to manage the risk of disease outbreak. Quarantine measures, to be established in consultation with the relevant regulatory agencies, will be used to reduce the possibility of transmission of disease from exhibited fauna to local populations. Monitoring the health of populations surrounding the Project area is recommended to determine health risks. Where disease is identified, appropriate authorities will be consulted to determine the correct protocols to follow to reduce the risk of further disease outbreaks. With the application of mitigations, the residual impact magnitude is expected to reduce to **Small**. The impact will affect a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself. The impact assessment summary is provided in *Table 9.32*.

Table 9.32 Impact Assessment Summary – Potential Spread of Diseases to Native Populations from Exhibited Fauna

Criterion	Rating	Comment
Potential Spread of Diseases to Native Populations from Exhibited Fauna		
Nature	Negative	Potential spread of diseases to native populations from exhibited fauna may negatively impact on the surrounding ecosystem, including the potential disease spread/mortality of native species.
Type	Direct	Potential spread of diseases to native populations from exhibited fauna may have a serious long-term impact by disrupting natural ecosystem processes.
Likelihood	Possible	The likelihood of the spread of diseases to native populations from exhibited fauna is considered Possible. It is possible that the introduction of imported fauna into enclosures may provide a disease pathway to native fauna within the surrounding environment.
Duration	Long-term	Potential spread of diseases to native populations from exhibited fauna could have a long-term impact to the ecosystem if not managed.
Extent	Local but potentially larger	Impacts of the spread of diseases to native populations from exhibited fauna would likely be local or within the project vicinity however may be larger if the disease spreads within local populations.
Scale	-	The impact to local populations may be small in scale, however may become larger if the disease spreads within wider populations. The scale of impacts is difficult to determine as the impact would be dependent on the species population infected.
Magnitude	Medium	Without adequate controls, the magnitude is considered potentially Medium. The impact may affect a sufficient proportion of a species population such that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and the species of conservation significance are listed as CR on the SRDB and IUCN Red List.
Significance	Major	Without mitigation, the impact significance is considered

Criterion	Rating	Comment
Potential Spread of Diseases to Native Populations from Exhibited Fauna		
		potentially Major arising from the combination of High receptor sensitivity and Medium impact magnitude.
Residual Impact Magnitude	Small	If mitigation strictly controls the risk of disease through the application of quarantine procedures which are to be established in consultation with the relevant regulatory agencies, the residual impact magnitude is considered to be Small. Monitoring of disease within enclosed populations and within the native populations outside of enclosures will alert of any disease risk which can be controlled. A risk of disease transmission from native fauna to enclosed fauna will remain and will be dependent on factors outside of the control of the operators. Although a risk remains that disease may occur, it is considered to be of a low likelihood. The impact will affect a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself.
Residual Impact Significance	Moderate	It is expected that mitigation will lower the residual impact significance to Moderate. The receptor sensitivity remains High but it is expected that adequate controls will reduce the likelihood of disease transmission to Low (Small Magnitude; High Receptor Sensitivity).

9.4.14 Noise Impacts to Fauna during Operation

9.4.14.1 Mitigation

Measures to mitigate impacts due to noise generated from the Project during operation activities are outlined in *Table 9.33.*

Table 9.33: Mitigation Measures for Noise Impacts to Fauna

Phase / Activity	Specific Actions

General Management & Planning	• To mitigate against noise impacts on fauna during operation, the following additional mitigation measures are to be applied:
	  • All equipment that is not necessary to operate after hours will be turned off (such as air conditioners).
	  • Signage will be posted at the following locations to remind visitors of the need to minimise noise due to sensitive wildlife in the area:
	  • East and West Arrival Nodes;
	  • Along nature trails;
	  • Along the Boardwalk; and
	  • Walkways within 100 m of the CCNR.
	  • A real time digital display of measured ambient noise and target noise level of 68 dB(A) will be located immediately outside of the *Eco-Lodge* reception (see *Figure 9.2* for an example). This digital noise display will be accompanied by educational signage explaining the importance of maintaining noise outside the *Eco-Lodge* below a target noise level of 68 dB(A) between the hours of 6pm and 8am. The noise display will also

Phase / Activity	Specific Actions
	be connected to a continuous data logging system which relays data to eco-lodge staff so that they are alerted to investigate exceedances of target noise levels of 68 dB(A). This level has been established in order to maintain night time noise levels at the CCNR at 50 dB(A), which represents measured baseline noise conditions at the CCNR prior to the development. • Public address systems will not be used at outdoor attractions during Project operations, other than for the purpose of emergency communications.
Monitoring	• The following noise monitoring is to occur during operation: • Noise monitoring will be undertaken at two points within the CCNR (subject to approval from NParks), i.e. NL10 and NL11 (see *Figure 6.5*) for a period of one week every three months during Project operation. The acceptable noise threshold for the CCNR is 50 dB(A) based on mean night-time baseline levels logged at NL10 (see *Table 6.6*). Should noise monitoring indicate exceedance of this threshold, the sources of noise will be investigated to identify possible contributions from the Project area and to determine additional mitigation measures required.
Management of Implementation	• The following measures will be applied to manage the implementation of the mitigation measures listed above: • MPH to maintain a complaints procedure to log and track response to complaints received from stakeholders. • MPH to undertake noise monitoring against the night-time threshold value of 50 dB(A) within the CCNR. MPH to implement an adaptive management framework and change procedure to manage changes to mitigation measures.

Figure 9.2 Example of a Digital Noise Display

9.4.14.2 *Residual Impacts*

Impacts from noise may cause disturbance and displacement of resident species during operation. The impact is considered in terms of impacts to resident fauna within the Project Vicinity as these species will be impacted by noise generating sources that may impact their lifecycle.

Without mitigation, the magnitude of impact from operational noise on fauna within the Project Vicinity during operation is considered to be **Medium** and is likely to be of greatest concern during early morning and evening when wildlife are active. Noise impacts will extend over the life of operations, albeit at a much lower level than during construction. Noise impacts on species can cause disturbance and displacement, reducing species utilisation of habitats. This is of particular concern at night when nocturnal wildlife are expected to be active in the area and making use of the *Eco-Link*. If noise is not appropriately controlled, a sufficient proportion of a species population may be affected that may bring about a substantial change in abundance and /or reduction in distribution over one or more generations if not appropriately managed.

Mitigation measures have been designed to reduce the duration and intensity of noise at source during operation. Specific measures used to manage human receptor impacts will be sufficient to reduce noise impacts on fauna. Since no specific standards or guidelines exist for the reduction of noise impacts on fauna, the approach taken has been to adopt the measured baseline noise levels within the CCNR during night time as the target threshold, since this is the most sensitive time for wildlife. With the application of mitigation, the residual impact magnitude is expected to reduce to **Small**. The impacts are likely to affect a small proportion of a population, but do not substantially affect other species dependent on it, or the populations of the species itself.

Table 9.34: Impact Assessment Summary – Impacts on Fauna from Noise during Operation

Criterion	Rating	Comment
Impacts from Noise on Fauna		
Nature	Negative	Impacts from noise to resident species within the Project Vicinity from operational noise sources.
Type	Direct	Operational noise will have a direct impact on resident species within and adjacent to the Project area through disturbance to lifecycle functions.
Duration	Long-term	Noise impacts will extend over the life of operations, albeit at a lower level than during construction.
Extent	Local	Habitats within and immediately adjacent to the Project area.
Scale	Large	The impact scale within and adjacent to the Project area is Medium during the operation phase. Noise sources are likely to occur from equipment and visitors and be limited to areas of higher visitation such as the arrival nodes.
Magnitude	Medium	The impact within the Project Vicinity is considered to be Medium as it will affect a sufficient proportion of a species population such that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.
Receptor	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important

Criterion	Rating	Comment
Impacts from Noise on Fauna		
Sensitivity		Bird Area) and contains threatened species that are listed as CR on the SRDB and IUCN Red List.
Significance	Major	The significance to species within the Project Vicinity is considered to be Major. Sensitive species are located within the Project area and the CCNR. These include species such as the Lesser Mouse Deer (*Tragulus kanchil*), Malayan Colugo (*Cynocephalus variegatus*) and Sunda Pangolin (*Manis javanica*).
Residual Impact Magnitude	Small	Application of mitigation will reduce impacts on species within the Project Vicinity through the use of education and signage to remind visitors to curb noisy behaviour. The impacts will likely affect a Small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself.
Residual Impact Significance	Moderate	The Residual Impact significance is considered to be Moderate (Small Magnitude; High Receptor Sensitivity).

9.4.15 Cumulative Impacts From Committed Developments

9.4.15.1 Sources

Potential impacts on biodiversity from committed developments within the Project Area of Influence have considered the following sources:

- The Mandai depot, a train maintenance depot for the Thomson-East Line;
- Thomson-East Mass Rapid Transit Line (Springleaf Station);
- Thomson-East Mass Rapid Transit Line (Woodlands South Station);
- The Singapore Power Cable Tunnel Project;
- Proposed sewers in Mandai Road area; and
- Demolition of Pumping Installations at Upper Thomson Road.

The activities associated with the operation of these future developments that would likely impact biodiversity have been identified to include:

- General operation of facilities;
- Generation and management of waste and wastewater;
- Use of machinery and equipment;
- Discharge of hazardous substances or pollution;
- Maintenance;
- Replanting and maintenance of vegetation;
- Importing materials;
- Storage of materials on-site; and
- Hours of operation.

9.4.15.2 Receptors

The Project Area of Influence contains significant biodiversity values as outlined in *Chapter 6.* Baseline studies identified a diversity of flora and fauna species, and ecosystems, including species listed on the SRDB and IUCN Red List of threatened species, endemic species and migratory species.

Priority biodiversity values within the broader Area of Influence include:

- Vegetation/habitats located within the CCNR;
- Forests and grasslands on private land (primary, secondary forests; and grasslands);
- Swamp forests and wetlands; and
- Riparian areas (forested freshwater habitat).

9.4.15.3 *Cumulative Impacts*

Management and monitoring outlined in this EIA include measures to undertake surveys to determine species presence in the Project Vicinity. Data from camera trap surveys, transects and community monitoring can be used to measure long term population changes and trends for key species (such as the Sunda Pangolin and Lesser Mouse Deer). If available, monitoring undertaken for other developments may also be used to determine changes in species populations and habitat distribution.

MPH will liaise with NParks to capture any relevant ecological monitoring data that is available from surrounding committed developments to integrate in the long term monitoring and management of the Project. Additional management and mitigation measures should be applied by these other developments to reduce the overall impact on biodiversity. These mitigation measures would need to be applied consistently, monitored and audited to ensure that they are applied.

Table 9.35 provides an impact assessment summary for potential future identified projects within the Area of Influence.

Table 9.35: Impact Assessment Summary – Cumulative Biodiversity Impacts

Criterion	Rating	Comment
Cumulative Biodiversity Impacts		
Nature	Negative	Developments in the surrounding area may have a cumulative adverse impact on the populations of species and the availability of habitats within and around the Project area.
Type	Direct/ Indirect	The type of impacts will vary for each development. The cumulative impact is likely to result in a net reduction in habitat availability within the Project's area of Influence. Populations of species may be impacted through reduction in resource availability, competition for resources and conflict.
Duration	Long-term	It is likely that impacts on habitats and species is likely to be long term. Species populations are likely to reduce over time given the reductions in habitat availability and direct/indirect species impacts.
Extent	Local/ Project Vicinity	The impact with the Mandai Project area is likely to be small as the Projects are located at some distance from the Project area. Proposed sewers upgrade in Mandai Road area is likely to have the greatest impact given its proximity to the Project area. More likely are cumulative effects on competition for resources that may occur in surrounding areas as a result of cumulative displacement of fauna species from the Mandai Project and other nearby projects.
Magnitude	Medium	For species, potential impacts may be Medium. It is expected that impacts may cause a substantial change in abundance and/or reduction in distribution of a population over one, or more generations, but are unlikely to threaten the long term viability/function of a given population. For habitats, the potential impacts are considered to be Medium. It is likely that cumulative effects may affect a portion of certain habitats, but would not threaten the long-term viability/function

Criterion	Rating	Comment
		of the habitat within the Project Vicinity.
Receptor Sensitivity	High	The receptor sensitivity is considered to be High as the Project area is within an internationally designated area (Central Forest Important Bird Area) and the species of conservation significance are listed as CR on the SRDB and IUCN Red List.
Impact Significance	Major	Without appropriate mitigation, the impact significance is considered to be Major. The receptor sensitivity is High. The magnitude is considered to be Medium.
Residual Impact Magnitude	Small	If mitigation is applied to other developments and monitoring is undertaken to manage potential impacts, the magnitude is considered to be Small. MPH will liaise with NParks to capture any relevant ecological monitoring data that is available to integrate in the long term monitoring and management of the Project.
Residual Impact Significance	Moderate	It is expected that with mitigation applied to the other projects, the residual impact significance could be lowered to Moderate. The receptor sensitivity remains High but it is expected that controls would reduce the magnitude of impact to Small (Small Magnitude; High Receptor Sensitivity).

10 ENVIRONMENTAL MANAGEMENT & MONITORING PLAN

This Environmental Management and Monitoring Plan (EMMP) outlines actions that will be undertaken in order to avoid, minimise, mitigate and monitor the potential impacts predicted through the Project's EIA. It outlines the organisational structure that will be put in place by MPH (or its appointed operator, during the operational phase) and assigns responsibility for the actions required during both the construction and operation phases of the work. The focus areas of the EMMP are consistent with the project components outlined in the Project Description (*Chapter 2*). The EMMP does not include regulatory controls (referred to as "*embedded controls*" within the EIA) which the Project and all contractors will need to comply with.

All mitigation measures identified through the impact assessment, along with the responsibilities for implementing and monitoring that will be undertaken to ensure effective implementation of mitigation, are detailed in *Table 10.1*. These will need to be reviewed and updated periodically in order to align the mitigation measures with the detailed design, construction and operation plans for the Project as they evolve.

In addition to the actions identified through this EIA process and the regulatory requirements, MPH have developed a *Wildlife Protection Plan* (included in *Annex 18*) and *Tree Protection Guidelines* (included in *Annex 19*) which will be implemented during the relevant construction and / or operation phases of the works.

10.1 PURPOSE OF THE EMMP

The objectives of this EMMP are:

- To ensure compliance with mitigation measures identified in the EIA; and
- To monitor the Project's actual environmental impacts so that, if necessary, corrective actions can be taken and the necessary modifications can be made to the Project.

10.2 EMMP STRUCTURE

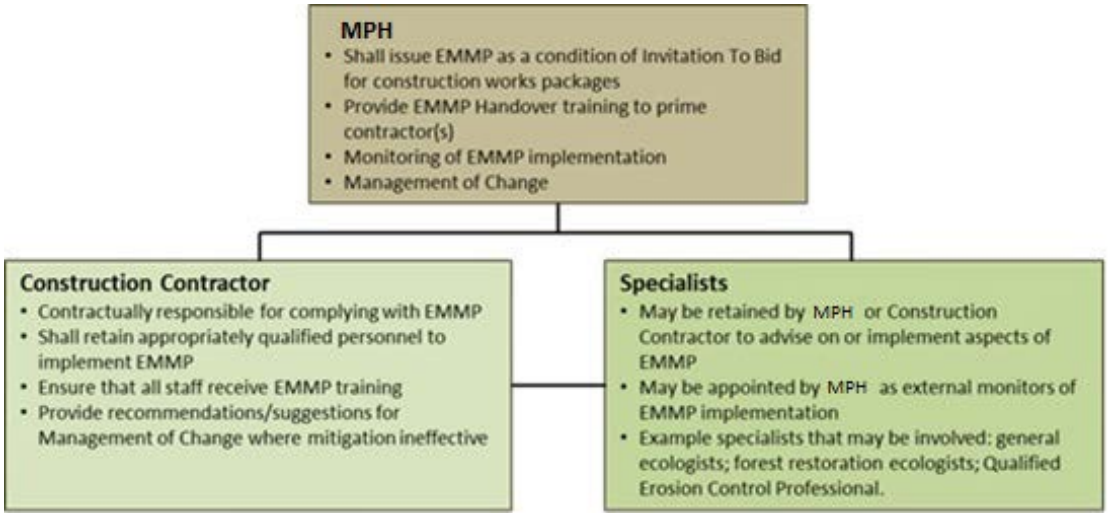
The EMMP planning table is provided in *Table 10.1*. The planning table comprises of the following main elements:

- **Phase**, i.e. at what phase of the Project does the mitigation action apply;
- **Aspect, Potential Impact/Issue** of the works and potential environmental impact/issue;
- **EIA Reference** to the relevant Chapter within the EIA;
- **Required Mitigation**, i.e. mitigation measures that the Project will implement, as identified from the impact assessment process;

- **Responsible person for ensuring action implementation** of the mitigation measure defined;
- **Means of verification that commitment has been met**;
- **Monitoring** measures, where applicable to the **Required Mitigation**; and
- **Related Documents** into which the mitigation measures would need to be incorporated.

10.3 EMMP ROLES AND RESPONSIBILITIES

10.3.1 Overview of Implementation Arrangements



10.3.2 Mandai Park Holdings

MPH (or its appointed operator, during the operational phase) will have overall accountability for the environmental performance during the construction and operation phases of the Project and assume ultimate ownership of Project compliance with relevant legislation, guidelines and best practice. In overseeing implementation of the EMMP, MPH will undertake Environmental, Health and Safety Inspections throughout; routine audits of the EMMP; and, establish and maintain a grievance and corrective action mechanism and lines of communication within the Project organisation to ensure stakeholder concerns are addressed in a timely manner. MPH will also set up an Environmental Advisory Panel (EAP) comprised of external subject matter experts to oversee the environmental aspects of the Project. The EAP will provide a forum for discussion and guidance on decision-making in relation to the overall environmental management of the Project.

10.3.3 Contractor

Contractors will be responsible for establishing an Environmental, Health and Safety team for the duration of the construction phase. The EHS team responsibilities will include implementing mitigation and monitoring measures assigned to them by MPH. The EHS team will be required to implement and check other Health and Safety related matters which are outside the scope of the EMMP presented herein.

MPH intends to issue the construction phase requirements of the EMMP with Invitations to Bid for the construction works packages. Contractors will be required to comply with EMMP provisions as a condition of contract.

It should be noted that Contractors will also be involved periodically during the operation phase of the Project. Specific roles and responsibilities will need to be determined in conjunction with the operations plan when available, and cross checked with the EMMP to ensure mitigation measures are appropriately captured.

10.3.4 Specialists

From time to time throughout the construction and operation phases of the Project, various specialists will be required to provide advice in relation to environmental management. For example, there may be a need to engage specialist ecologists to aid the wildlife relocation process, and Qualified Erosion Control Professional for earth control measures planning and implementation.

10.4 GRIEVANCE

MPH will establish a grievance process to ensure that any complaints received from stakeholders throughout the Project, are appropriately recorded, investigated and resolved where required. The main elements of this grievance process will encompass:

- Prompt acknowledgement and response to stakeholder complaints, keeping them informed of the progress and outcomes;
- Accurate records of complaints, investigations and outcomes are maintained;
- Resolution by MPH within a specified timeframe (four weeks is suggested);
- An escalation mechanism in the event that grievance cannot be resolved by MPH within the nominated timeframe;
- Responsibility and accountability assigned to individual(s) within MPH for administering the grievance procedure; and
- Government authorities are kept informed of complaints, where required.

10.5 TRAINING

MPH shall be responsible for "handover" of the EMMP to construction Contractors and to the operator of the future attractions. In practice, this will require training in the requirements of the EMMP, particularly for the construction Contractors which shall be contractually bound to comply with the EMMP.

Construction Contractors shall be responsible for induction and appropriate training of all workers employed on the construction site so that they are aware of their environmental responsibilities.

MPH will periodically review and update the training programme to align with any Project changes. The training programmes developed will include but not be limited to the following:

- An overview of the roles and responsibilities of MPH/Contractors/Specialists, including reporting requirements, grievance mechanisms, contingency planning etc;
- Basic biodiversity awareness of the Mandai site, including introduction to species of conservation significance;
- Risks and threats to biodiversity in the Mandai area, including poaching and invasive species;
- Management of biodiversity and habitat restoration activities;
- "Do's and Don'ts" when on site, including response in event of animal sighting, waste management etc;
- Emergency responses procedures;
- Management of Change mechanism; and
- Stakeholder grievance process (and the duty to report grievances to the nominated MPH representative with responsibility for administering the grievance procedure).

10.6 REPORTING

Records of training, EHS Inspection reports, EMMP implementation audit reports, meeting minutes etc. throughout both the construction and operation phases will be maintained by MPH with a unique identifier for future reference. It is recommended to develop suitable templates for reports such as the EHS Inspection report and the EMMP implementation audit report prior to commencement of construction. In summary, the documentation generated will comprise the following as a minimum:

- Training attendance records;
- EHS Inspection reports;
- EMMP implementation audit reports;
- Monitoring reports;
- Minutes of Meetings;
- Records of Grievance received and its resolution; and
- MPH EMMP audit reports.

10.7 MANAGEMENT OF CHANGE

The overall aim of the EMMP is to ensure that environmental management is implemented and its performance monitored. This means there must be scope for corrective action to be taken if required. It may be necessary to make modifications to the EMMP over the course of the Project when:

- Unanticipated environmental impacts are identified that require additional mitigation;
- When mitigation proposed proves ineffective or unable to be implemented; and
- When the Project changes in a way that is substantially different to that described in the EIA.

All parties involved in the construction and operation phases, (e.g. MPH, Contractors, and Specialists) have a role to play in suggesting modifications to the EMMP. However, overall responsibility for the Management of Change to the EMMP rests with the MPH Environmental Manager. In addition, the MPH Environmental Manager shall carry out the Management of Change to the EMMP in consultation with the relevant technical agencies. The steps for managing change to the EMMP are as follows:

- Identify and describe unanticipated impacts, ineffective mitigation or changes in the Project construction or operation that require updates to the EMMP;
- Suggest mitigation to manage the identified issues with the MPH Environmental Manager. Concerns/issues could, for example, be highlighted in EHS Inspection reports or progress calls with MPH on an ongoing basis;
- Review and update the EMMP in consultation with the relevant technical agencies; and
- Record recommended corrective action in a Minute of Meeting.

In addition to the steps for managing change outlined above, the MPH Environmental Manager will be responsible for audits of the EMMP throughout the construction phase and at least annually during the operation phase of the Project to ensure effective implementation. Such audits will likely be combined with other elements of the Project implementation, such as health, safety and regulatory compliance. Where audit findings highlight a non-conformance, there will be an immediate investigation and appropriate corrective action taken. All audits will be clearly documented and filed internally.

Table 10.1: Environmental Management and Monitoring Planning Table

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
								Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements
1	Construction & Operation	General Management & Planning	All Environmental Aspects	Chapter 8 & 9	Implement adaptive management measures to review and change (if and where necessary) mitigation measures. All parties involved in the construction and operation phases, (e.g. MPH, Contractors and Specialists) have a role to play in suggesting modifications to the EMMP. However, overall responsibility for the Management of Change to the EMMP will rest with the MPH Environmental Manager. In addition, the MPH Environmental Manager shall carry out the Management of Change to the EMMP in consultation with the relevant technical agencies. The steps for managing change to the EMMP are: 1. Identify and describe unanticipated impacts, ineffective mitigation or changes in the Project construction or operation that require updates to the EMMP. 2. Suggest mitigation to manage the identified issues with the MPH Environmental Manager. Concerns/issues could, for example, be highlighted in EHS Inspection reports or progress calls with MPH on an ongoing basis. 3. Review and update the EMMP in consultation with the relevant technical agencies. 4. Record recommended corrective action in a Minute of Meeting.	MPH Environmental Manager	Quarterly Audit of EMMP Implementation During Construction and Annual Audit During Operations	Ongoing throughout construction and operation	Required mitigation outlined within this EMMP	Required locations as outlined within this EMMP	Quarterly EMMP Implementation Audit Report Minutes of any meetings conducted during construction and operation in relation to EMMP implementation and corrective actions
2	Construction & Operation	General Management & Planning	Stakeholder Engagement	Chapter 10	MPH will establish a grievance process to ensure that any complaints received from stakeholders throughout the Project, are appropriately recorded, investigated and resolved where required. The main elements of this grievance process will encompass: 1. Prompt acknowledgement and response to stakeholder complaints, keeping them informed of the progress and outcomes. 2. Accurate records of complaints, investigations and outcomes are maintained. Resolution by MPH within a specified timeframe (four weeks is suggested). 3. An escalation mechanism in the event that grievance cannot be resolved by MPH within the nominated timeframe. 4. Responsibility and accountability assigned to individual(s) within MPH for administering the grievance procedure. 5. Government authorities are kept informed of complaints, where required.	MPH Environmental Manager	Grievance process in place	Ongoing throughout construction and operation	Grievance complaints received	Not applicable	Grievance records
3	Construction	General Management & Planning	All Environmental Aspects	Chapter 8 & 9	Designate an Environmental Manager with responsibility for implementation of the EMMP, including oversight of the EHS Inspection implementation, corrective action and EMMP implementation auditing.	MPH Environmental Manager	Environmental Manager in place prior to commencement of construction works	Not applicable	Not applicable	Not applicable	Not applicable
4	Construction & Operation	General Management & Planning	Biodiversity / Clearing vegetation / habitats prior to construction	Chapter 8, Section 8.5.4	Maintain the services of a qualified arborist and/or horticulturalist to monitor and provide ongoing advice and management of all retained and planted flora within the Project area throughout the construction and operation period. Where disease outbreaks are identified, the arborist and/or horticulturalist must advise of measures to manage any outbreaks. Measures can include using selected insecticides/fungicides to control outbreaks; reduction of stressors (dust, water etc.). The plant may be removed or quarantined if it poses a threat to surrounding individuals.	MPH Environmental Manager Qualified arborist and/or horticulturalist	Quarterly Audit of EMMP Implementation During Construction Tree/Flora inspections	On appointment of arborist Fortnightly during construction or when trees observed to show signs of stress Monthly for at least the first 2 years of operations with more frequent monitoring during the inter monsoon season	Arborist appointed Vegetation condition and species mix	Not applicable All landscaped areas within project areas adjacent to construction areas	Not applicable Inspection Reports
			Biodiversity / Transition of habitats during operation	Chapter 9, Section 9.4.4							
			Biodiversity / Visitor interaction with flora and fauna	Chapter 9, Section 9.4.7							

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
								Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements
5	Design	General Management & Planning	Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5	Maintain a minimum of 10 m distance between built structures. Forest buffers of up to 45-50 m will be established/retained to maintain connectivity within the Project area with the CCNR. The boundaries of the CCNR as well as the boundaries of the 45-50m wide buffers to the west of the CCNR are to be flagged or otherwise marked in the field prior to construction. MPH will engage NParks on the design of the marking/pegs, as well as when the marking/pegging is carried out on the ground.	MPH	i) Design Review to ensure that building setbacks and buffers are included in design ii) "As built" review of construction to ensure that building setbacks and buffers have been built as per design requirements	Once, prior to start of construction works Once, upon completion of construction of each works package The boundaries are to be checked weekly during clearing and construction works.	Building setbacks and buffers Building setbacks and buffers Markers of CCNR boundaries	As per Project Description (Chapter 2) 'As per Project Description (Chapter 2) CCNR boundaries bordering Project area	Not applicable Not applicable Not applicable
			Biodiversity / Mortality from vehicle / machinery strike	Chapter 8, Section 8.5.7							
			Biodiversity / Restriction to wildlife movement / reductions in connectivity	Chapter 8, Section 8.5.8							
6	Design & Operation	General Management & Planning	Canopy connectivity Biodiversity / Mortality from vehicle / machinery strike Biodiversity / Restriction to wildlife movement / reductions in connectivity	Chapter 8, Section 8.5.7 Chapter 8, Section 8.5.8	Maintain canopy connections where possible between trees to facilitate arboreal movement of fauna, including gliders. Maximum gliding distances for Malayan Colugos and Horsfield's Flying Squirrel are approximately 100 m. For primates, (eg Banded Leaf Monkey), interlocking canopies are preferred Canopy connectivity will occur at the following locations: 1. *Eco-Link* . 2. *Arrival Node* tree canopies. 3. Retained vegetation within Project components adjacent to the CCNR. 4. Vegetation retained outside of enclosures within Project component area. 5. Adjacent to Disturbed Primary forest and the *Planet Explorer* and *Sri Seletar Point* . 6. Vegetation along the *Boardwalk* . 7. Across Mandai Lake Road (the development will seek to avoid the existing Alstonia trees along Mandai Lake Road as a first priority; netting will be considered and rope ladders to facilitate movement across the road verge and to prevent access to the road by fauna). Artificial connectivity elements will be considered where tree canopy growth or vegetation is immature or distances are too great to facilitate fauna movement. Measures such as nets and rope ladders will be used. All habitat connectivity structures will be repaired/replaced as necessary.	MPH Environmental Manager	i) Design Review to ensure canopy level connectivity is maintained ii) Quarterly Audit of EMMP Implementation	Once, prior to start of construction works Quarterly during Operations to determine the effectiveness of canopy level connectivity.	Canopy connectivity Monitoring of entry and exit points for tracks and traces of use to occur on a regular basis	Specified areas in "Required Mitigation column" Specified areas in "Required Mitigation column"	Not applicable EMMP Implementation Audit Report
7	Design & Operation	General Management & Planning	Biodiversity / Mortality from vehicle / machinery strike Biodiversity / Restriction to wildlife movement / reductions in connectivity	Chapter 8, Section 8.5.7 Chapter 8, Section 8.5.8	Maintain fencing around project components. Ensure that perimeter fencing mesh size is a maximum of 50 mm. Different fence mesh size may be used depending on the requirement. All fences will be recessed into the ground surface and anchored to prevent damage from tree fall. Tops of fences will be lined to prevent injury to arboreal species and avifauna. The fencing strategy will: 1. Exclude all resident fauna from fully closed enclosures. 2. Exclude all ground dwelling mammals from all Project components (including Sambar Deer and Wild Boar) (limited to 2.4 m fence height). 3. Exclude all ground dwelling fauna from accessing Mandai Lake Road and Mandai Road adjacent to the Project boundary. 4. Include crush resistant fencing (to withstand tree fall) along the verge of the *Eco-Link* of minimum 2.4 m fence height to prevent fauna from entering the road verge and protect the road verge from falling trees. 5. Include low fences to prevent fauna from entering high human traffic areas within vegetative barriers, such as at the *Arrival Nodes* .	MPH Environmental Manager MPH Environmental Manager	i) Daily inspections in the morning will occur along Mandai Lake Road to determine if fauna have become trapped between the road and the fence or if injury has occurred with any individuals ii) All fencing will be maintained and regularly inspected for damage or breaches.	Daily Once every 3 months during operations and after storm events	Presence of trapped fauna Condition of perimeter fencing and attraction enclosures, including anchoring	Within road reserves All fencing and enclosures	Daily EHS Inspection Reports EMMP Implementation Report
			Biodiversity / Species requiring management	Chapter 8, Section 8.5.12							
			Biodiversity / After hours delivery vehicles colliding with fauna	Chapter 9, Section 9.4.6							
			Biodiversity / Fauna strikes from visitor vehicles	Chapter 9, Section 9.4.12							
			Biodiversity / Potential escape of species from enclosures	Chapter 9, Section 9.4.10							
			Biodiversity / Spread of disease	Chapter 9, Section 9.4.13							

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
								Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements
8	Design & Operation	Landscaping General Management & Planning	Landscaping Strategy Biodiversity/ Edge effects on habitats	Chapter 8, Section 8.5.5	The following components will be integrated into the landscaping of the Project area: 1. Vegetative barriers will be used at ground level to discourage human incursion into vegetated areas consisting of native indigenous flora that are impenetrable to humans. 2. Pathways will be constructed outside the Tree Protection Zone (TPZ) (developed in accordance with NParks TPZ guidelines) of each tree identified for retention, to avoid soil compaction and root damage. Advice will be obtained from the MPH arborist on the requirements for the construction of paths within the vicinity of trees. 3. Connectivity of planted flora within landscaped features will be planted to allow for refuge for fauna. Patches of vegetation will be included that are sufficient size for refuge for ground dwelling fauna. Maximum distances between refuge vegetation patches will not exceed 25 m. Vegetation planted within refuge areas will enable access to ground dwelling fauna at ground level. 4. Movement corridors for wild birds linking adjacent forest habitats and the CCNR will be incorporated within the *Bird Park* through retention of existing trees as well as supplementary planting (see *Figure 2.4b* within the EIA). 5. Ground level habitat will be installed in conjunction with vegetative patches. Ground level habitat can include: logs and branches, rocks, swales, artificial tunnels and low water logged areas. Ground level habitat will be constructed to be contiguous with vegetation (if appropriate). 6. All flora and grasses used for planting will be from native indigenous stock or non-native species that are not listed as weed or invasive species or have a low seeding rate. Grasses planted will consist of a range of heights, included mown and freely sprouting areas.	MPH Environmental Manager	i) "As built" review of construction to ensure that vegetation barriers, habitat connectivity and tree protection zones have been incorporated as per design requirements ii) Inspection of planting stock	Once upon completion of construction When purchasing planting stock	Location of vegetative barriers and corridors, pathways adjacent to TPZ and size of vegetation patches planted Provenance of planted stock and the presence of weed/invasive species	Within landscaped areas Not applicable	Not applicable EMMP Implementation Audit Report
			Biodiversity / Restriction to wildlife movement / reductions in connectivity	Chapter 8, Section 8.5.8							
			Biodiversity / Weed/invasive species introduction and proliferation	Chapter 8, Section 8.5.9							
			Biodiversity / Transition of habitats during operation	Chapter 9, Section 9.4.4							
			Biodiversity / Visitor interaction with flora and fauna	Chapter 9, Section 9.4.7							
9	Design & Construction	General Management & Planning	Biodiversity / Habitat Management and Forest Restoration Biodiversity/ Edge effects on habitats	Chapter 8, Section 8.5.5	All trees transplanted into the Project area will have local provenance or will be from within the Johor region for all SRDB and IUCN listed species. Other species will be obtained within the larger Sunda landscape. Due diligence will be conducted on suppliers to ensure that the trees are obtained by legal means and are able to be exported/imported to Singapore. All imported trees will be inspected and/or undergo quarantine if required to reduce the chance of transmission of weeds and soil pathogens.	MPH Environmental Manager	i) Due diligence check on tree suppliers ii) Inspection of all trees and other planting stock brought onto the site iii) Visual inspections and removal of the presence of weed/invasive species	Due diligence prior to using all suppliers of planting stock Inspections prior to planting on site Fortnightly during construction	Provenance of planted stock Presence of weed/invasive species Presence of weed/invasive species	Not applicable Holding area, prior to planting trees	Quarterly EMMP Implementation Audit Report during Construction
			Biodiversity / Weed/invasive species introduction and proliferation	Chapter 8, Section 8.5.9							
10	Construction	General Management & Planning	Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6	Deploy roadside reflectors along Mandai Lake Road attached to posts 20-50 m apart, and at a height of at least 2 m from the ground surface.	MPH Environmental Manager	i) "As built" review of construction to ensure that reflectors have been installed ii) Routine Inspections of presence and condition of roadside reflectors	Once, upon completion of construction Quarterly, during operations	Presence of reflectors Presence and condition of reflectors	Along Mandai Lake Road Along Mandai Lake Road	Not Applicable Quarterly EMMP Implementation Audit Reports during Operations
			Biodiversity / Mortality from vehicle / machinery strike	Chapter 8, Section 8.5.7							
			Biodiversity / Restriction to wildlife movement / reductions in connectivity	Chapter 8, Section 8.5.8							
			Biodiversity / After hours delivery vehicles colliding with fauna	Chapter 9, Section 9.4.6							
			Biodiversity / Fauna strikes from visitor vehicles	Chapter 9, Section 9.4.12							

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11	Construction	Transportation	Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6	Erect hoarding and barriers progressively to prevent fauna from entering road reserves (Mandai Road and Mandai Lake Road) in accordance with the *Wildlife Protection Plan* in *Annex 18* . The hoarding will be erected along roads first and to encourage fauna movement towards refuge areas. The hoarding will be carefully removed following completion of the construction works to prevent damage to vegetation within development areas, and to prevent exposure of fauna to risks.	MPH Environmental Manager	i) Wildlife shepherding surveys to be undertaken preferably the day and night before closure of the hoarding to identify any remaining individuals. These individuals will be encouraged to move or removed through capture (as a last resort). Hoardings can be closed around each work package once surveys have confirmed that the Project area has been cleared of fauna. ii) Inspection of hoarding to ensure that it follows the agreed hoarding plan, the hoarding is not damaged and that wildlife is not trapped	Prior to closure of hoarding for each work package Daily during construction	Number and type of fauna relocated Hoarding erection and dismantling around each worksite	Work package area to be cleared Around each worksite	Not applicable Not applicable
			Biodiversity / Mortality from vehicle / machinery strike	Chapter 8, Section 8.5.7							
			Biodiversity / Restriction to wildlife movement / reductions in connectivity	Chapter 8, Section 8.5.8							
12	Construction & Operation	General Management & Planning	Biodiversity / Restriction to wildlife movement / reductions in connectivity	Chapter 8, Section 8.5.8	Implement a temporary fauna crossing across Mandai Lake Road at least 30 m in width during construction of the *Bird Park* and *Rainforest Park North* . The location of the temporary fauna crossing is to coincide with existing forested areas either side of Mandai Lake Road, within approximately 100m of the western boundary of the CCNR. Close the temporary fauna crossing only after at least 6 months have passed since construction completion of the *Eco-Link* . Ensure that no direct lighting of the temporary fauna crossing occurs. All lights will be directed away from the fauna crossing, including along the road verge.	MPH Environmental Manager	i) Environmental Manager to ensure that temporary crossing is installed and that no light is directed onto the crossing ii) Wildlife camera trap data / photo records to be collected and analysed fortnightly	Once during construction Wildlife camera traps will be used on a continuous basis	Not applicable Wildlife camera trap data / photo records	Across Mandai Lake Road Deploy camera traps at approximately 50 m intervals parallel to and on both sides of Mandai Lake Road within the temporary ground level crossing; at landing points and along the length of the Eco-Link; and at approximately 100 m intervals along the boundary of the buffers within the Bird Park and Rainforest Park North, facing the CCNR.	Fauna monitoring reports Fauna monitoring reports
13	Construction & Operation	General Management & Planning	Biodiversity / Restriction to wildlife movement / reductions in connectivity	Chapter 8, Section 8.5.8	Implement a speed limit of 40 km/h along Mandai Lake Road. Post the speed limit on signs at regular intervals along Mandai Lake Road. Install speed bumps 50 m before the temporary fauna crossing along Mandai Lake Road. The stretch of Mandai Lake Road where the temporary fauna crossing is shall be a special Low Speed Zone with speed limit of 20 km/h. Ensure that all vehicle strikes are investigated and that gaps in mitigation measures that may have led to the death/injury are identified, and appropriate changes made to the mitigation strategy. Such investigations will make use of information from camera traps to determine whether there are patterns in animal crossings of Mandai Lake Road. Roadkill register and investigation will be maintained and continued during operation. WRS to support in handling injured or trapped fauna.	MPH Environmental Manager	i) Installation of signs and speed bumps as required ii) Speed data statistics via installation of a 'Vehicle-Activated Speed Display' iii) Number of fauna-related road incidents along Mandai Lake Road	Prior to commencement of construction works Installaition prior to commencement of construction works and monitoring throughout construction and operation Quarterly Audit of EMMP Implementation During Construction	Installation of signs and speed bumps Speed data statistics Records/ investigation reports	Mandai Lake Road Mandai Lake Road All locations	Not applicable Not applicable Quarterly EMMP Implementation Audit Report
			Biodiversity / After hours delivery vehicles colliding with fauna	Chapter 9, Section 9.4.6							
			Biodiversity / Fauna strikes from visitor vehicles	Chapter 9, Section 9.4.12							

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14	Construction	General Management & Planning	Biodiversity / Restriction to wildlife movement / reductions in connectivity	Chapter 8, Section 8.5.8	Maintain connectivity along edge of the Upper Seletar Reservoir during construction activities of the *Boardwalk* . Temporary construction rigs/tools may be removed at night, where practical, to reduce opportunities for fauna obstruction.	MPH Environmental Manager	Daily inspection to see if there is disturbance to canopy or ground-level connectivity due to the presence of construction equipment. If this is the case, temporary construction tools will be removed at night.	Daily	Obstruction to connectivity with Upper Seletar Reservoir and *Boardwalk* construction areas	Mandai Lake Road	Daily inspection reports summarised in Quarterly EMMP Implementation Audit Report
15	Design, Construction & Operation	General Management & Planning	Biodiversity /Edge effects on habitats Light reflection from built structures and glazing	Chapter 8, Section 8.5.5	For all built structures, a colour palette will be used that has a Light Reflective Value (LRV) of less than 30%. The LRV Value may be varied where built structures are enclosed or do not directly face or reflect onto vegetated areas (including facing the Upper Seletar Reservoir). All glazed surfaces will be placed at angles that limit direct light reflection into vegetated areas and the Upper Seletar Reservoir). Screens, louvres or shading may be used to limit direct sunlight penetration and reflection from glazed surfaces. Where newly exposed forest edges are exposed following clearing and where impacts to vegetation are evident, e.g. vegetation shows signs of drying out, artificial shading and/or a sprinkler system will be installed to improve moisture differentials around forest edges.	MPH Environmental Manager	i) Review of detailed design prior to construction to ensure that correct colour palette is used and measures incorporated to limit reflection of sunlight ii) Monitor the edges of vegetation exposed to newly constructed buildings, enclosures and other facilities.	Once, prior to construction Minimum monthly during construction and annually during operation	Colour palette and shading measures Condition of vegetation, reflection from built structures	Built structures Forest edges beside project components and built structures	Not applicable EHS Inspection Reports and EMMP Implementation Audit Reports during construction and operations
16	Design, Construction & Operation	-	Biodiversity /Edge effects on habitats Nocturnal lighting	Chapter 8, Section 8.5.5	The following design elements for lighting within the Project area will be implemented: 1. Lighting will be directed away from vegetated areas and habitats. Upward and directional lighting will be avoided. Lighting into unintended areas will be avoided. Where lighting is required to be installed for safety and security purposes, regulatory requirements will be followed. During construction, lights will not be used outside of construction hours. During operations, general lighting usage will be consistent with the operating hours of each Project component. Outside of operating hours, low lux level and downcast lighting will be needed along pathways, paved areas etc. in areas where public access cannot be prevented (such as the arrival nodes and carparks) for public safety. 2. Reduce the duration of nocturnal lighting sources by using a timer or movement based sensor system to turn off lights. 3. Where permanent lights are employed, ensure that darker passages between lights exist for sensitive fauna to pass. Automatic dimming to reduce lighting intensity will also be considered. 4. Avoid using lumination that has a high UV component to reduce impacts on insects. 5. Avoid using broad spectrum lights. 6. Installation of light fittings to reduce nocturnal light impacts on habitats in vegetated areas and habitats outside project area that are close to these night light sources	MPH Environmental Manager	Light monitoring	At night, minimum monthly during construction and operations	Light intensity. Light levels should target to be as close to baseline levels during a moonless night as possible: 0.06 lux for locations along the edge of project components 0.03 lux for vegetated areas further away from project components	Vegetated areas and habitats that are close to these night light sources	Light monitoring records
17	Construction	General Management & Planning	Air Quality / Impacts to human receptors from dust	Chapter 8, Section 8.1.1	Schedule construction activities (such as land clearance, demolition works, earthworks and building construction) to minimise the area of ground exposed and the volume of soil and construction material handled at any one time.	MPH Environmental Manager	Daily inspection for signs of dust and soil erosion, including review of air monitoring data (see S/N 18)	Daily	Dust generation and surface erosion	All worksite areas, in particular where land clearance, demolition, earthworks and building construction are ongoing	EHS Inspection Reports & Quarterly EMMP Implementation Audit Report during construction
			Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1							
			Soil & Groundwater / Impacts to ground quality	Chapter 8, Section 8.3.1							
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6							

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18	Construction	General Management & Planning	Air Quality / Impacts to human receptors from dust	Chapter 8, Section 8.1.1	Ensure availability of fresh water for dust suppression at suitable locations, in particular the excavation sites at the *West* and *East Arrival Nodes* , and the demolition sites for the existing multi-storey carpark and existing structures within the WRS site. Ensure the following measures are undertaken to manage impacts due to dust generated during Project construction: 1. Use water suppression during excavation and earth handling at exposed areas in the event of rainfall of less than 0.25 mm in a 24 hour period and gusting or sustained wind speeds of greater than 19 kph. The use of these thresholds is based on the National Pollutant Inventory (NPI) guidance. The occurrence of low rainfall and windy conditions at these defined thresholds will lead to fugitive emissions due to wind erosion from active stockpiles. 2. Water suppression at the *West and East Arrival Nodes* will be controlled to the minimum necessary to reduce excess water runoff that may enter waterways. The drainage infrastructure for the Project will have zero discharge to Upper Seletar Reservoir, including during the construction phase. 3. Apply water to roads at a rate exceeding 2 litres/m^2/hour prior to and during truck use in dry conditions. 4. Use dust suppression methods such as misting during demolitions works in dry conditions.	MPH Environmental Manager	Ambient air quality monitoring against Singapore ambient air quality target for 24 hour PM10, i.e. 50 µg/m3. If exceeding target level, review of suppression techniques and construction plan will be undertaken and additional measures put in place to alleviate elevated dust levels, e.g., reduce the number of dust generating activities being undertaken	Continuous monitoring against Singapore ambient air quality target	24 hour PM10 concentration of 50 µg/m3	One location upwind and one location downwind of construction worksites as presented in *Figure 10.1*	**Note**: Dust generation from the work area is indicated by low measurements upwind and high measurements downwind of the Project site boundary. If both upwind and downwind measurements are high, it is likely that ambient dust levels are due to contributing sources outside the Project Study Area, e.g. transboundary haze.
			Soil & Groundwater / Impacts to ground quality	Chapter 8, Section 8.3.1							
			Biodiversity / Clearing vegetation / habitats prior to construction	Chapter 8, Section 8.5.4							
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6							
19	Construction	General Management & Planning	Air Quality / Impacts to human receptors from dust	Chapter 8, Section 8.1.1	Ensure that workers clean up any spoil/earth spillage onto the haulage routes immediately and undertake proper housekeeping of the construction site, as well as roadways linked to the entrances of the worksites e.g. Mandai Road, Mandai Lake Road, at the end of each day, to ensure that roadways, vehicle wheels and equipment tracks are clear of dust or mud, and that appropriate barriers, tarpaulin covers/erosion blankets have been repaired and/or reinstated.	MPH Environmental Manager	Daily site walkover to inspect construction site housekeeping	Daily	Spoil, spillage and general housekeeping. Presence of mud or dirt on public road entrances	Mandai Road, Mandai Lake Road, worksites	Daily EHS Inspection Reports
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6							
20	Construction	General Management & Planning	Air Quality / Impacts to human receptors from dust	Chapter 8, Section 8.1.1	Waste management during construction to include: 1. All waste management to be undertaken by licensed third party waste contractors (general, sanitary, hazardous and spoil waste). 2. Locate temporary stockpiles of spoil/excavated earth at areas away from surface water courses and excavations (e.g. carparks), on solid ground and cover with a tarpaulin when not in use and/or raining. 3. Ensure control measures will be put in place to prohibit temporarily stockpiled material being washed into surface water courses, e.g. temporary drainage which is connected to Earth Control Measures facilities with collection sumps around stockpiling area; booms; regular removal and disposal of waste spoil etc. 4. Illegal disposal of construction waste will be strictly prohibited. Waste bins to be provided in dedicated areas for general wastes. 5. Recycling initiatives to be implemented, where possible. 6. Disposal of construction wastes (wastewater and solid wastes) into streams, storm water channels or Upper Seletar Reservoir will be strictly prohibited. 7. Construction waste to be temporarily stored in dedicated areas and removed by a third party licensed contractor at least once every 5 days. 8. All waste disposal areas and containers will be covered to prevent access from fauna (especially the Long Tailed Macaque) 9. All general waste will be cleared at least twice per day. 10. Adequate temporary waste storage facilities will be located a minimum of 100 m away from surface water features and on hardstand.	MPH Environmental Manager	i) Daily site walkover to inspect construction site housekeeping ii) Quarterly Audit of EMMP Implementation During Construction	Daily Quarterly	As detailed in the Required Mitigation -	All worksite areas -	Daily EHS Inspection Reports Quarterly EMMP Implementation Audit Report during Construction
			Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1							
			Soil & Water / Impacts to ground and water quality	Chapter 8, Section 8.3.1							
			Biodiversity / Clearing vegetation / habitats prior to construction	Chapter 8, Section 8.5.4							
			Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6							
			Biodiversity / Species requiring management	Chapter 8, Section 8.5.12							
21	Construction	Soil Investigation Works	Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1	Provide spill kits and secondary containment trays at each SI worksite.	MPH Environmental Manager	Daily site inspections to confirm provision of spill kits and secondary containment trays	Daily	As detailed in the Required Mitigation	All SI worksites	Daily EHS Inspection Reports
			Soil & Water / Impacts to ground and water quality	Chapter 8, Section 8.3.1							

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22	Construction	Soil Investigation Works	Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1	Use hand fuel transfer pump and pipes equipped with flow control valves on for refuelling operations.	MPH Environmental Manager	Daily site inspections to confirm provision of hand fuel transfer pump and pipes equipped with flow control valves	Daily	As detailed in the Required Mitigation	All SI worksites	Daily EHS Inspection Reports
			Soil & Water / Impacts to ground and water quality	Chapter 8, Section 8.3.1							
23	Construction	Earthworks	Air Quality / Impacts to human receptors from dust	Chapter 8, Section 8.1.1	Locate stockpiles and worksite entrances as far as possible from and downwind of the WRS sites and the CCNR. Avoid stockpiling at areas within 100 m north of the WRS sites and CCNR boundary.	MPH Environmental Manager	Daily site walkover to inspect construction site housekeeping including locations of stockpiles and signs of dust	Daily Site Inspection	Stockpile location and visual signs of dust plumes being generated Signs of dust deposition and staining	Worksites north of WRS sites and CCNR boundary (*Eco-Lodge, Planet Explorer/Sri Seletar Point, West Arrival Node, Bird Park*) Office building and entrance atrium at Singapore Zoo, entrance atrium at River Safari, entrance atrium and restaurants at Night Safari, and vegetation located at the boundary of worksites	Daily EHS Inspection Reports
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6							
24	Construction	Earthworks	Air Quality / Impacts to human receptors from dust	Chapter 8, Section 8.1.1	To minimise the mobilisation of dust during windy conditions, cover all stockpiles with well-maintained tarpaulin when not in use or as soon as practicable, in particular during dry periods such as the late NE monsoonal period (late January to early March).	MPH Environmental Manager	Daily site walkover to inspect construction site housekeeping including covering of stockpiles and signs of dust	Daily	Condition and positioning of tarpaulin covers	Stockpiles	Daily EHS Inspection Reports
			Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1							
			Soil & Water / Impacts to ground and water quality	Chapter 8, Section 8.3.1							
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6							
25	Construction	Transportation	Air Quality / Impacts to human receptors from dust	Chapter 8, Section 8.1.1	Vehicles used to transport spoil will have tarpaulin securely covering load.	MPH Environmental Manager	Daily site walkover to inspect construction site including vehicles leaving the construction site	Daily	Loads covered, condition and positioning of tarpaulin covers	Construction site	Not applicable
			Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1							
			Soil & Groundwater / Impacts to ground quality	Chapter 8, Section 8.3.1							
26	Construction	Earthworks	Air Quality / Impacts to human receptors from dust	Chapter 8, Section 8.1.1	To minimise the transport of dust beyond the construction worksites, ensure that stockpiles will be maintained below a maximum height of 2 m so that perimeter hoarding or barriers can serve as an effective shield for surrounding buildings.	MPH Environmental Manager	Daily site walkover to inspect construction site including of height of stockpiles	Daily	Height of stockpile relative to surrounding hoarding	Stockpiles	Not applicable
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6							

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27	Construction	Earthworks	Air Quality / Impacts to human receptors from dust	Chapter 8, Section 8.1.1	To minimise the volume of spoil stockpiled and potential for dust generation and erosion/runoff, schedule removal of spoil from the Project area or waste material by licensed third party at least once every 5 days.	MPH Environmental Manager	Waste transfer manifests will be inspected during Quarterly Audit of EMMP Implementation During Construction	Quarterly	Waste transfer manifest	All worksite areas	Quarterly EMMP Implementation Audit Reports
			Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1							
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6							
28	Construction	Earthworks	Air Quality / Impacts to human receptors from dust	Chapter 8, Section 8.1.1	Wherever reasonable and practicable, cleared vegetation in particular at sloped areas, will be covered with mulch or erosion control blankets to control erosion of exposed soil. Re-vegetate exposed ground as soon as possible to stabilise surfaces and minimise re-entrainment of dust and potential for erosion of waste spoil to watercourses.	MPH Environmental Manager	i) Daily visual inspection to see if erosion control blankets are provided to cleared areas. ii) Quarterly Audit of EMMP Implementation During Construction	Daily Quarterly	Erosion control measures	Cleared areas (flat and sloped)	Daily EHS Inspection Reports Quarterly EMMP Implementation Audit Reports
			Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1							
			Soil & Groundwater / Impacts to ground quality	Chapter 8, Section 8.3.1							
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6							
29	Construction	Demolition	Air Quality / Impacts to human receptors from dust	Chapter 8, Section 8.1.1	Adopt manual or mechanical methods for the demolition of buildings and structures as opposed to blasting so as to reduce volume of dust released.	MPH Environmental Manager	Review of Contractor Plans and daily site inspections	Daily inspections	Not applicable	All demolition sites	Daily EHS Inspection Reports
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6							
30	Construction	Demolition	Air Quality / Impacts to human receptors from dust	Chapter 8, Section 8.1.1	Prior to demolition works, enclose all buildings to be demolished. Deploy demolition chutes and demolition waste receptacles.	MPH Environmental Manager	Daily site inspections to confirm provision of demolition chutes and waste receptacles prior to demolition work	Daily inspections	Not applicable	All demolition sites	Daily EHS Inspection Reports
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6							

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31	Construction	General Management & Planning	Air Quality / Impacts to human receptors from dust	Chapter 8, Section 8.1.1	All vehicles and machinery used for construction purposes will be cleaned prior to use on site to remove any seeds, plant, contaminating material. If vehicles and machinery leave the site, they will be cleaned/washed down prior to re-entry or departure from the Project area. All construction vehicles to pass through a bunded wheel wash upon entry and exit of the construction work areas. To manage water quality impacts and impacts to aquatic habitats, water used in wheel wash to be sourced from mains supply and contained, pumped and periodically removed from site by a licensed wastewater collector or discharged to a surface water drain not connected to the unnamed stream parallel to the western boundary of the *Bird Park* and Upper Seletar Reservoir, in accordance with relevant regulations. Discharge to the unnamed stream along the Project western boundary and Upper Seletar Reservoir will be strictly prohibited.	MPH Environmental Manager	Daily site inspections to ensure provision of bunded wheel wash and that vehicles leaving the site are cleaned	Daily	Vehicle inspections and wheel wash	Entrances of worksites	Daily EHS Inspection Report
			Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1							
			Biodiversity / Clearing vegetation / habitats prior to construction	Chapter 8, Section 8.5.4							
			Biodiversity / Weed/invasive species introduction and proliferation	Chapter 8, Section 8.5.9							
32	Construction	Transportation	Air Quality (Vehicular Emissions)	Chapter 8, Section 8.1.2	Minimise traffic delays caused by movement of construction vehicles by planning transport route and transport period that avoid congested areas and peak hours of road use by visitors to the existing WRS operations.	MPH Environmental Manager	i) Daily visual inspection of construction vehicular traffic movement ii) Quarterly Audit of EMMP Implementation During Construction	Daily Quarterly	Visual observation of construction vehicular traffic movements	Mandai Lake Road and Mandai Road	Daily EHS Inspection Reports Quarterly EMMP Implementation Audit Reports
33	Construction	Transportation	Air Quality (Vehicular Emissions)	Chapter 8, Section 8.1.2	Control queuing or parking of vehicles outside the construction work area, both before the construction work area opens and during work hours.	MPH Environmental Manager	i) Daily visual inspection of construction vehicular traffic movements and parking areas ii) Quarterly Audit of EMMP Implementation During Construction	Daily Quarterly	Visual observation of construction vehicular traffic movements and parking areas, and whether these are obstructing existing traffic flows	Mandai Lake Road and Mandai Road	Daily EHS Inspection Reports Quarterly EMMP Implementation Audit Reports
34	Construction	Transportation	Air Quality (Vehicular Emissions)	Chapter 8, Section 8.1.2	Vehicles and equipment will not be left idling when not in use and will be periodically checked during maintenance and inspection to ensure emissions are within the prescribed exhaust emission and noise limits.	MPH Environmental Manager	Daily visual inspection of operation of vehicles and equipment	Daily	Emissions are within the prescribed exhaust emission and noise limits	All worksite areas	EHS Inspection Reports
			Noise / Impacts to human receptors from construction equipment operations.	Chapter 8, Section 8.4.1							
			Biodiversity / Noise impacts to fauna	Chapter 8, Section 8.5.13							
35	Construction	Transportation	Air Quality (Vehicular Emissions)	Chapter 8, Section 8.1.2	Avoid use of diesel or petrol powered generators by using mains electricity or battery powered equipment where possible, and if safety concerns can be overcome.	MPH Environmental Manager	Quarterly Audit of EMMP Implementation During Construction	Quarterly	Generators and equipment	All worksite areas	Quarterly EMMP Implementation Audit Reports

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36	Construction	Maintenance & Monitoring	Air Quality (Vehicular Emissions)	Chapter 8, Section 8.1.2	All equipment and machinery used at the construction or demolition worksites will be maintained and operated in a manner such that it does not give rise to smoke emissions or leakage of fuel/oil to ground, and will comply with the *Environmental Protection and Management (Vehicular Emissions) Regulations.* Maintenance and mechanical repairs will be undertaken at dedicated designed locations, bunded to capture and control oil, grease and other spills.	MPH Environmental Manager	Daily visual observation of vehicle/ equipment condition Quarterly Audit of EMMP Implementation During Construction	Daily Quarterly	Smoke emissions and leakage of fuel/oil Inspection of tagging of equipment for last inspection/ maintenance date Visual observation of designated maintenance area	All worksite areas Designated maintenance areas	Daily EHS Inspection Reports Quarterly EMMP Implementation Audit Reports
			Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1							
			Soil & Groundwater / Impacts to ground quality	Chapter 8, Section 8.3.1							
37	Construction	Maintenance & Monitoring	Air Quality (Vehicular Emissions)	Chapter 8, Section 8.1.2	If necessary to use large vehicles with power output over 37 kW, ensure vehicles have exhaust after-treatment systems installed.	MPH Environmental Manager	Quarterly Audit of EMMP Implementation During Construction	Quarterly	Construction Equipment List and Vendor Specifications	Not applicable	Quarterly EMMP Implementation Audit Reports
38	Construction	General Management & Planning	Surface Water / Impacts to water quality Biodiversity / Clearing vegetation / habitats prior to construction	Chapter 8, Section 8.2.1 Chapter 8, Section 8.5.4	The Earth Control Measures (ECM) plan will be designed and endorsed by a Qualified Erosion Control Professional (QECP) in accordance with PUB requirements. The following measures will be included within the ECM Plan to manage potential impacts to surface water quality and impacts on aquatic habitats: 1. Wastewater management measures (slurry water, bentonite etc.) due to construction activities such as piling. 2. Erosion and sediment control measures in accordance with PUB requirements. Examples such as silt fences and turbidity curtains will be considered, in particular during earthmoving and excavation activities or *Boardwalk* construction within 250 m of Upper Seletar Reservoir, the unnamed stream along the Project western boundary or other surface water features in the Project area, to prevent sediment from entering streams and other surface waterbodies. The Contractor will submit the ECM proposal duly endorsed by his QECP to PUB and copied to the owner / developer as follows: 1. Before work commences, submit the ECM proposal indicating that: a. exposed surfaces will be minimised according to the construction activities in each phase. b. effective sediment control facilities (including storage and treatment facilities) will be implemented. c. a system of ECM as indicated in (a) and (b) above will be in place before work commences. d. Clearance Certificate (See (b) above) to commence earthworks is obtained. 2. During construction works, revise and resubmit the ECM proposals according to each phase of the construction activities indicating that: a. exposed surfaces will be minimised according to the construction activities in each phase. b. effective sediment control facilities (including storage and treatment facilities) will be implemented c. a system of ECM as indicated in (a) and (b) above will be revised and put in place to control silty discharge for each phase. 3. Upon completion of work, confirm that all the site activities have been completed and the ECM can be removed.	MPH Environmental Manager	i) PUB Approved Earth Control Measures Plan(s) submitted and approved ii) Implementation of actions and monitoring as prescribed within the Earth Control Measures Plan	Prior to the start of construction Continuously during construction	Not applicable As per ECM Plan	Not applicable As per ECM Plan (to be developed)	ECM Plan Weekly submission of ECM inspection report to QECP

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
								Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements
39	Construction	General Management & Planning	Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1	Locate portable sanitary facilities and temporary storage facilities for hazardous materials (e.g. fuel, lubricant, oils, paints) away from surface water courses on hardstand. Portable sanitary facilities will be managed by a licensed third party.	MPH Environmental Manager	i) Daily visual inspection of signs of oil slick ii) Surface water quality sampling	Daily At a frequency agreed with PUB	Visual observations (oil slick etc.) Monitoring against threshold limits specified within the Environmental Protection Management (Controlled Watercourse) regulations: pH: 6 - 9 Temperature: 45 ˚C TDS: 1,000 mg/L TSS: 30 mg/L BOD_5 at 20˚C: 20 mg/L COD: 60 mg/L Oil & Grease (Total): 1 mg/L For parameters where limits are not specified within the regulations, monitoring results should be compared against baseline monitoring results in *Table 6.9* of the EIA report. These parameters include turbidity, Total Phosphorus, Total Nitrogen, *E. coli,* Chlorophyll a and dissolved oxygen. Full suite of parameters and threshold limits as per the baseline study (Due to excessive information, the parameters and threshold limits have not been listed in the EMMP. Details to be found within *Annex 9.2* of the EIA report)	At key outfall points to surface water courses from the Project area Monitoring locations with reference to *Figure 10.1.*	Daily EHS Inspection Reports Quarterly EMMP Implementation Audit Reports
			Soil & Groundwater / Impacts to ground quality	Chapter 8, Section 8.3.1			iii) Groundwater quality sampling	Immediately after excavation works		Suggested borehole locations as indicated in *Figure 10.1.*	
40	Construction	General Management & Planning	Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1	Hazardous materials to be stored in bunded and covered areas in accordance with the manufacturer's safety requirements. Storage of hazardous materials on-site should be limited to the minimum necessary in order to reduce the impact of any spillage or mitigation failure.	MPH Environmental Manager	Surface water quality sampling Daily housekeeping inspections of construction site to ensure proper storage of hazardous materials	Refer to S/N 39 Daily	Refer to S/N 39 Signs of leakage or spills	Refer to S/N 39 Hazardous material storage areas	Refer to S/N 39 Daily EHS Inspection Reports
			Soil & Groundwater / Impacts to ground quality	Chapter 8, Section 8.3.1							
41	Construction	General Management & Planning	Surface Water / Impacts to water quality Soil & Groundwater / Impacts to ground quality	Chapter 8, Section 8.2.1 Chapter 8, Section 8.3.1	Use recharge wells as necessary during excavation of the carparks so as to limit potential groundwater drawdown and subsequent water level impacts to the unnamed stream along the Project western boundary.	MPH Environmental Manager	Inspections of the unnamed stream along the Project western boundary for visible impacts to water level	Daily during construction of west arrive node	Surface water levels Groundwater levels	At the unnamed stream along the Project western boundary Up and down groundwater flow gradient of the excavation areas.	Daily EHS Inspection Reports

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
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42	Construction	General Management & Planning	Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1	Spill control measures (leaks from pipework during decommissioning; from machinery and equipment; spills as a result of accidental damage to other underground structures uncovered during excavation works etc.) throughout construction phase, to include but not be limited to the following: 1. Training for all staff in spill response measures. 2. Spill management kits will be provided at worksites (composition will depend on the type of hazardous materials to be used, but likely include rags, sands, eyewash, protective gloves etc.) in particular at where hazardous materials, equipment and machinery will be stored and used.	MPH Environmental Manager	i) Visual observation of spill management provisions ii) Training records for those workers handling chemicals iii) Spill management kits provided at worksites	Daily Quarterly Quarterly	Signs of leakage Training records Spill management kits	Hazardous materials storage areas	Daily EHS Inspection Reports Quarterly EMMP Implementation Audit Reports Quarterly EMMP Implementation Audit Reports
			Soil & Groundwater / Impacts to ground quality	Chapter 8, Section 8.3.1							
43	Construction	General Management & Planning	Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1	Avoid or minimise downtime of the WRS perimeter cut-off drain. New/upgraded drainage infrastructure will be installed up-gradient of existing cut-off drain. Alternatively, upgrade works may be completed in sections with temporary provisions to avoid surface runoff or leaks to nearby watercourses if further assessment determines that this does not pose an unacceptable risk to surface water quality in Upper Seletar Reservoir.	MPH Environmental Manager	Inspect if new/upgraded drainage infrastructure has been installed. Inspect it there is surface runoff or leaks from drains	Daily	As per Required Mitigation	As per Required Mitigation	Daily EHS Inspection Report
44	Construction	Demolition & Earthworks	Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1	Discharge of pumped dewatered groundwater or other wastewaters from excavations to Upper Seletar Reservoir and the unnamed stream along the Project western boundary (due to ecological sensitivities) will be prohibited. Discharge will either be to temporary storage tanks for removal by third party licensed wastewater collector; or to a temporary treatment system prior to discharge to a discharge point agreed with PUB.	MPH Environmental Manager	i) Visual observation of location of pumped groundwater and all other water discharges during construction ii) Surface water quality sampling iii) Quarterly Audit of EMMP Implementation During Construction	Daily Refer to S/N 39 Quarterly	Signs of contamination Refer to S/N 39 Not applicable	Upper Seletar Reservoir and unnamed stream along the Project western boundary Refer to S/N 39 All discharge points	EHS Inspection Reports Surface water quality sampling reports Quarterly EMMP Implementation Audit Reports
			Soil & Groundwater / Impacts to ground quality	Chapter 8, Section 8.3.1							
45	Design & Operation	General Management	Surface Water / Impacts to water quality	Chapter 8, Section 8.2.1	The design of the WTP will include alarms and standby pumps to protect against equipment failure as well as emergency power provision. Secondary methods for removal of wastewater from the Upper Seletar catchment during emergencies will be considered and incorporated into the design. Examples include equalization storage or bypass pumping to the effluent discharge line.	MPH Environmental Manager	Review of detailed design of WTP	Once, prior to the start of construction, in consultation with PUB	To be defined in agreement with PUB when final design is available.	Discharge points from WTPs	WTP discharge monitoring reports during operations
46	Construction	Soil Investigation Works	Noise / Impacts to human receptors from construction equipment operations.	Chapter 8, Section 8.4.1	Noise generated from Soil Investigation works to be mitigated through: 1. Use acoustic enclosures on rig engines and install a silencer at the exhaust pipe of the engines throughout the drilling operations. 2. Erect portable hoarding around drilling rigs. 3. Erect portable acoustic enclosures around the hammer during Standard Penetration Test (SPT).	MPH Environmental Manager	Noise monitoring	Daily	Noise levels from SI works	1 m from all SI worksites	EHS Inspection Reports
			Biodiversity / Noise impacts to fauna	Chapter 8, Section 8.5.13							

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
								Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements
47	Construction	General Management & Planning	Noise / Impacts to human receptors from construction equipment operations.	Chapter 8, Section 8.4.1	To minimise the noise and vibration impacts to fauna and human receptors, locate construction worksite entrances and haul routes as far as possible from the CCNR and buffer, the entrances and connecting walkways between the entrances of the existing WRS operated areas (i.e. Singapore Zoo, River Safari and Night Safari attractions).	MPH Environmental Manager	Noise monitoring in accordance with *Annex C & D* of the *Singapore Standard SS602:2014* to ensure compliance against limits in the *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations* and guideline values adopted for the Project EIA	Daily (using a Class 1 (Type 1) Sound Level meter) at any of the following frequencies during normal construction works: - 5 min every 1 hr. (± 2.5 dB(A)*; - 20 min every 1 hr. (±1.5 dB(A)*; or - single 1 hr. sample (±3 dB(A)*. *Daily LAeq estimated within 95% confidence	Threshold limits: 85 dB(A) (at any point in time). Where exceedances occur, investigate to ensure proper implementation of recommended mitigation measures and/or identification of additional measures such as portable acoustic screens for noise generating activities.	Monitoring locations as indicated in *Figure 10.1*. 1 m from the nearest façade at the following buildings: - Entrance plaza of Singapore Zoo; - Entrance plaza of River Safari; - Entrance plaza of Night Safari. Within the CCNR at NL10 and NL11 as indicated in *Figure 10.1* . Adjacent to the eastern and western edges of the CCNR, at the closest location to the source (dependent on the work package being constructed)	EHS Inspection Reports (noise monitoring reporting section to include information as defined in *Annex D, Section D.5* of Singapore Standard *SS602:204*)
			Biodiversity / Clearing vegetation / habitats prior to construction	Chapter 8, Section 8.5.4							
			Biodiversity / Noise impacts to fauna	Chapter 8, Section 8.5.13							
48	Construction	General Management & Planning	Noise & Vibration / Impacts to human receptors from construction equipment operations. Biodiversity / Noise impacts to fauna	Chapter 8, Section 8.4.1 and Section 8.4.3 Chapter 8, Section 8.5.13	Liaise with WRS to schedule construction activities (in particular piling and demolition activities) so as to minimise disturbance to visitors and staff during peak visiting periods (such as weekends or public holidays) or during events requiring low noise levels.	MPH Environmental Manager	Noise monitoring in accordance with Annex C & D of the Singapore Standard SS602:2014 to ensure compliance against limits in the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations and guideline values adopted for the Project EIA Grievance process records	Refer to S/N 47	Refer to S/N 47	Refer to S/N 47	Refer to S/N 47
49	Construction	General Management & Planning	Noise & Vibration / Impacts to human receptors from construction equipment operations. Biodiversity / Noise impacts to fauna	Chapter 8, Sections 8.4.1 and 8.4.3 Chapter 8, Section 8.5.13	As far as possible, restrict public access to within 10 m of the Project boundary by providing alternative pathways, and relocating amenities. Coordinate with WRS to provide alternative walkways, where possible, for WRS staff and visitors to transit between the entrance plazas of Singapore Zoo, River Safari and Night Safari, to minimise interface between receptors and piling works near the Project boundary.	MPH Environmental Manager	i) Inspect if alternative pathways and ammenities are located within 10m from Project boundary. ii) Inspect to confirm that alternative walkways have been provided	Quarterly	Visual observation of pedestrian walkways	Along construction worksite boundary	Quarterly EMMP Implementation Audit Report during construction

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
								Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements
50	Construction	General Management & Planning	Noise / Impacts to human receptors from construction equipment operations.	Chapter 8, Section 8.4.1	Source quiet models of construction equipment where possible. Quieter models are defined as those having sound pressure levels at least 5 dB quieter than other models readily available locally, when measured 1 m from the equipment body while the equipment is operating at its rated load. Equipment will be labelled with weatherproof stickers showing clearly its noise specification. Utilise noise attenuation devices to absorb and direct noise away from forested areas/habitats and to avoid a direct line of sight of the construction site.	MPH Environmental Manager	Noise monitoring	Daily (using a Class 1 (Type 1) Sound Level meter)	Leq,20min, for spot checks of equipment during normal construction works	1 m from noise generating portion of an equipment, e.g. motor box, engine exhaust etc.	EHS Inspection Reports (noise monitoring reporting section)
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Noise impacts to fauna	Chapter 8, Section 8.5.13							
51	Construction	Maintenance & Monitoring	Noise / Impacts to human receptors from construction equipment operations.	Chapter 8, Section 8.4.1	Install rubber lining within demolition chutes.	MPH Environmental Manager	EHS inspection to confirm installation of rubber lining and regular follow-ups to inspect condition of rubber lining.	Daily	Visual spot check	Demolition chutes	Daily EHS Inspection Reports
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Noise impacts to fauna	Chapter 8, Section 8.5.13							
52	Construction	Training	Noise / Impacts to human receptors from construction equipment operations.	Chapter 8, Section 8.4.1	Workers to be trained in noise-reduction behaviours such as reducing the drop height of materials, and turning off equipment and vehicle engines when not in use. Daily toolbox briefings should include reminders on the need to implement noise-reduction behaviours, in particular during piling and demolition activities.	MPH Environmental Manager	i) Daily spot check of workers ii) Quarterly Audit of EMMP Implementation During Construction to verify training records	Daily Quarterly	Presence of noisy behaviour Training records	All worksite areas	Daily EHS Inspection Reports Quarterly EMMP Implementation Audit Reports
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Noise impacts to fauna	Chapter 8, Section 8.5.13							
53	Construction	General Management & Planning	Noise / Impacts to human receptors from construction equipment operations.	Chapter 8, Section 8.4.1	Where possible, use hydraulic and electric tools in place of pneumatic equipment such as concrete breakers.	MPH Environmental Manager	i) Daily inspection of construction equipment list ii) Quarterly Audit of EMMP Implementation During Construction	Daily Quarterly	Construction Equipment List	All worksite areas	Daily EHS Inspection Reports Quarterly EMMP Implementation Audit Reports
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Noise impacts to fauna	Chapter 8, Section 8.5.13							

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
								Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements
54	Construction	General Management & Planning	Noise & Vibration / Impacts to human receptors from construction equipment operations.	Chapter 8, Section 8.4.1 and Section 8.4.3	Where technically feasible, use earth retaining and stabilising structures for the proposed underground carparks, such as use of diaphragm walls, contiguous piles or secant bored piles that could eliminate the need for percussive piling, e.g. sheet-piling.	MPH Environmental Manager	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Noise impacts to fauna	Chapter 8, Section 8.5.13							
55	Construction	General Management & Planning	Noise & Vibration / Impacts to human receptors from construction equipment operations.	Chapter 8, Sections 8.4.1 and 8.4.3	Where piling is required, consider the use of quieter piling methods for example: 1. Use hydraulically driven equipment instead of hammers; 2. Use pressed-in piling with low soil displacement piles etc. If not feasible, use acoustic shrouds around the hammer head to reduce noise.	MPH Environmental Manager	Daily Inspections of piling equipment type and noise mitigation measures	Daily	Piling equipment type and noise mitigation measures	Piling worksites	Daily EHS Inspection Reports summarised in Quarterly EMMP Implementation Audit Reports
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Noise impacts to fauna	Chapter 8, Section 8.5.13							
56	Construction	General Management & Planning	Noise / Impacts to human receptors from construction equipment operations	Chapter 8, Section 8.4.2	Acoustic barriers will be installed instead of hoarding along the boundary between the Project construction work area and the WRS site. The acoustic barriers will be a minimum height of 3.5m to block visibility of construction equipment from receptors within the WRS site, and will be designed to achieve a Sound Transmission Class of 20 so as to achieve a minimum reduction of 10 dB(A). Hoardings along the worksite boundary with the CCNR shall be constructed using the same material as acoustic barriers and shall be a maximum height of 2.4 m. With reference to the construction packages, this is the eastern boundary of Packages B and C North and the western boundary of Package C South.	MPH Environmental Manager	Daily EHS Inspections and Quarterly audits to verify the presence, location height and configuration of acoustic barriers	Daily Inspections	Presence and configuration of acoustic barriers	Boundary of Construction Sites and WRS area	Daily EHS Inspection Reports summarised in Quarterly EMMP Implementation Audit Reports
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Noise impacts to fauna	Chapter 8, Section 8.5.13							
57	Construction	General Management & Planning	Noise / Impacts to human receptors from construction equipment operations.	Chapter 8, Section 8.4.1	Locate structures or equipment such as storage silos or temporary site office buildings, between noise generating activities and the nearest NSRs (WRS site, special use area and CCNR) to serve as barriers.	MPH Environmental Manager	i) Daily site inspections to include location of silos and office buildings ii) Quarterly Audit of EMMP Implementation During Construction	When these structures are established	Location of structures near noise generating activities	All worksite areas	EHS Inspection Reports Quarterly EMMP Implementation Audit Reports
			Biodiversity / Impacts to flora & fauna due to clearance of vegetation and habitats	Chapter 8, Section 8.5.4							
			Biodiversity / Noise impacts to fauna	Chapter 8, Section 8.5.13							
58	Construction	General Management & Planning	Noise / Impacts to human receptors from construction equipment operations.	Chapter 8, Section 8.4.1	Undertake the following measures to manage noise levels generated from the worksites: 1. Enclose the facade of the demolition worksite directed towards nearby receptors with acoustic curtains. 2. Erect screens around smaller worksites where noisy activities will be carried out over a short-term period, e.g. concrete or road breaking. 3. Enclose static noisy equipment such as generators and water pumps as fully as possible (allowing openings for access and safety considerations), using sound reduction material with a sheet material mass of at least 10 kg/m^2 and/or which achieve a minimum noise reduction of 15 dB(A) as compared to without the acoustic enclosure, as measured at the same distance from the noise source.	MPH Environmental Manager	i) Daily EHS Inspections to verify the presence of acoustic screens and the direction of noise propagation ii) Noise monitoring in accordance with Annex C & D of the Singapore Standard SS602:2014 to ensure compliance against limits in the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations and guideline values adopted for the Project EIA iii) Quarterly Audit of EMMP Implementation During Construction	Daily Refer to S/N 47 Quarterly	Not applicable Refer to S/N 47	Across construction site Refer to S/N 47 Not applicable	Daily EHS Inspection Reports Refer to S/N 47 Quarterly EMMP Implementation Audit Reports
			Biodiversity / Noise impacts to fauna	Chapter 8, Section 8.5.13							

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
								Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements
59	Construction	General Management & Planning	Noise / Impacts to human receptors from construction equipment operations.	Chapter 8, Section 8.4.1	Investigate and identify the source(s) of noise where measurements exceed limits at the affected receptors. Corrective actions will be undertaken to ensure that mitigation measures listed above are properly implemented. Where mitigation measures have been properly implemented and noise levels still results in exceedance, liaise with MPH to examine feasibility of scaling down construction activities e.g. reduce number of equipment deployed near affected receptor location.	MPH Environmental Manager	i) Noise monitoring in accordance with Annex C & D of the Singapore Standard SS602:2014 to ensure compliance against limits in the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations and guideline values adopted for the Project EIA ii) Records of grievance or complaints	Refer to S/N 47 Upon receipt of any complaints	Refer to S/N 47 Not applicable	Refer to S/N 47 Not applicable	Refer to S/N 47 Not applicable
60	Construction	General Management & Planning	Noise / Impacts to human receptors from construction equipment operations.	Chapter 8, Section 8.4.1	Undertake spot checks of construction equipment to ensure that equipment is operating within its noise specification. In the event of an exceedance, ascertain if exceedance is due to the improper operation of the construction equipment. In the event of repeated and significant exceedances (i.e. more than 3 dB(A)), earmark construction equipment for maintenance.	MPH Environmental Manager	EHS Inspections of noise levels Quarterly Audit of EMMP Implementation During Construction	Daily Quarterly	Leq,20 min levels against noise specifications	1 m from equipment body	Daily EHS Inspection Reports Quarterly EMMP Implementation Audit Reports
61	Construction	General Management & Planning	Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6	Prior to the start of construction at each Project component, ensure that wildlife is shepherded from the Project area into adjacent refuge areas, and that hoarding is erected in accordance with the Wildlife Protection Plan in Annex 18. Identified wildlife refuge areas during pre-construction and construction activities include: 1. CCNR south of Mandai Lake Road. 2. Special use area west of Bird Park. 3. CCNR north of Mandai Lake Road. 4. Habitats along the edge of the Upper Seletar Reservoir. Immediately upon detection of any dead or injured animal, construction activities in that immediate area shall stop and the MPH Environmental Manager shall be notified. No attempt shall be made by construction staff to handle the animal. The MPH Environmental Manager shall promptly arrange for on-call wildlife handlers and veterinarians to attend to the animal as soon as practicable. Construction activities in the immediate area may resume only after notice has been received from the MPH Environmental Manager that it is safe to continue with the work. Construction activities shall also stop in the event that any target terrestrial fauna (i.e. sambar deer, lesser mouse deer, wild boar, sunda pangolin, king cobra, blue malayan coral snake, malayan racer and banded malayan coral snake) are encountered within the construction site construction staff shall stop activities in that immediate area and allow the animal to leave the site. Construction staff shall not be permitted to handle and/or harass the animal, and shall promptly notify the MPH Environmental Manager. The MPH Environmental Manager shall provide notice to resume construction work only after it has been ascertained	MPH Environmental Manager Environmental Manager	i) Visual inspections of hoarding erection ii) Wildlife shepherding surveys iii) Conduct fauna tracking using GPS trackers for Sambar Deer and Wild Boar to determine their movement within the CCNR and refuge areas. Note, permits will be obtained from NParks prior to affixing GPS trackers to individual Sambar Deer and Wild Boar.	Daily following erection of hoardings for each work package Survey in conjunction with shepherding activities Throughout construction and/ or operation (if possible)	Erected hoardings 1. Species requiring relocation within the Project component area. 2. Habitat features such as hollow trees, pangolin dens, nests and roosts. 3. Record all habitat features observed using a GPS. Wild boar and Sambar deer	Work package boundaries Work package area to be cleared CCNR and refuge areas	Daily EHS Inspection Reports Wildlife shepherding records GPS tracker records
			Biodiversity / Competition for resources / conflict	Chapter 8, Section 8.5.10							
62	Construction	General Management & Planning	Biodiversity / Clearing vegetation / habitats prior to construction	Chapter 8, Section 8.5.4	Identify and mark out plants for retention. Particular importance will be placed on CR, EN and VU listed species, significant native individuals (over 1 m girth) and plants for function such as animal food, nesting material etc. Note, any proposal to remove flora of conservation significance (native with girth above 1 m and/or listed as CR, EN and VU on the Singapore Red Data Book) must be subject to approval by NParks.	Specialists	Construction Plan	Field check prior to construction	GPS location of species	Work package to be cleared	Flora monitoring reports
63	Construction	General Management & Planning	Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6	Ensure that experienced wildlife handlers and veterinarians will be on hand during wildlife shepherding activities to oversee and provide expert advice. Wildlife shepherding activities will be undertaken separately for each work package according to the *Wildlife Protection Plan* in *Annex 18* .	MPH Environmental Manager	Quarterly Audit of EMMP Implementation During Construction	Field check prior to construction	Qualifications/ experience of wildlife handlers/ veterinarians	Each work package where clearance activities are being undertaken	Quarterly EMMP Implementation Audit Reports
			Biodiversity / Competition for resources / conflict	Chapter 8, Section 8.5.10							

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
								Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements
64	Construction	Ground Clearance	Biodiversity / Displacement of flora & fauna	Chapter 8, Section 8.5.4	During clearance, a team of qualified personnel will be on hand to capture and manage any injured wildlife. Any injured wildlife will be immediately taken to a veterinary clinic for treatment.	MPH Environmental Manager	Fauna monitoring reports (record of injured wildlife)	Throughout site clearance activities	Record of injured wildlife and location where there were found	Each work package where clearance activities are being undertaken	Fauna monitoring reports
65	Construction	General Management & Planning	Biodiversity / Clearing vegetation / habitats prior to construction	Chapter 8, Section 8.5.4	Hoardings and temporary barriers (limited to 2.4 m in height) will be installed around the edges of the work package area to encourage wildlife movement towards refuge areas, and to protect fauna from risks in the immediate vicinity of the Project area, such as Mandai Lake Road and Mandai Road (see *Wildlife Protection Plan* in *Annex 18* for further details). During wildlife shepherding surveys, habitat features will be marked using a GPS to enable future reference.	MPH Environmental Manager	i) Construction Plan shall be reviewed prior to start of construction ii) Records of wildlife shepherding will be maintained iii) Daily EHS Inspections of hoardings to ensure that they are functioning and that wildlife is not trapped	Once, prior to start of construction at each works package Refer to S/N 61 Daily	Not applicable Refer to S/N 61 Adequacy of hoardings and barriers (signs that barriers have been breached by fauna)	Work package to be cleared Refer to S/N 61	Not applicable Wildlife shepherding survey records Daily EHS Inspection Reports
			Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6							
			Biodiversity / Competition for resources / conflict	Chapter 8, Section 8.5.10							
66	Construction	General Management & Planning	Biodiversity / Disturbance and displacement of fauna	Chapter 8, Section 8.5.6	During wildlife shepherding activities, ensure that all habitat features such as nests, roosts, basal hollows and ground burrows are thoroughly inspected. If any fauna is present, undertake methods to encourage the fauna to relocate. Further details are outlined within the *Wildlife Protection Plan* in *Annex 18.*	MPH Environmental Manager	Wildlife shepherding survey records maintained	Weekly	Number of nests, roosts, basal hollows and ground burrows inspected	Identified habitat resources in the Project area	Wildlife shepherding survey reports
			Biodiversity / Competition for resources / conflict	Chapter 8, Section 8.5.10							
67	Construction	General Management & Planning	Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6	Prior to wildlife shepherding activities, undertake a briefing with all involved personnel so they are aware of their roles and responsibilities; measures to deal with injured wildlife; occupational health and safety requirements; and requirements regarding the prohibition of hunting/catching/taking of fauna and flora. This will include incident reporting measures to the NParks and Agri-Food and Veterinary Authority (AVA), and the reporting of any individual suspected or caught with fauna and flora to the relevant authority. Should an incident contravene the Wild Animals and Birds Act, the incident will be immediately reported to the AVA for further action. Random inspections of personnel arriving and leaving the Project area can be considered. Refresher training is to occur with new employees.	MPH Environmental Manager	Clearance briefing attendance records	Prior to clearance activities	Number of persons briefed	-	Quarterly EMMP Implementation Audit Reports
			Biodiversity / Mortality from hunting and poaching	Chapter 8, Section 8.5.11							
68	Construction	General Management & Planning	Biodiversity / Clearing vegetation / habitats prior to construction	Chapter 8, Section 8.5.4	Clearance activities on site will not occur during rainfall or when storm events are forecast to occur within the vicinity to protect forest edge from wind throw. Where forest edges are exposed to wind, temporary measures will be put in place to protect the forest edge during storm events e.g., additional hoarding.	MPH Environmental Manager	EHS inspection to ensure no clearance activities are carried out during rainfall	Daily	Daily weather forecast	Work package area to be cleared	Daily EHS Inspection Reports
69	Construction & Operation	General Management & Planning	Biodiversity / Clearing vegetation / habitats prior to construction	Chapter 8, Section 8.5.4	A TPZ, developed in accordance with NParks TPZ guidelines, will be installed around each tree identified for retention according to the following distances: - Minimum protection zone of 2.0 m around a tree with girth ≤1.0 m. - Minimum protection zone of 3.0 m around a tree with girth ≥1.0 m but ≤1.5 m. - Minimum protection zone of 4.0 m around a tree with girth ≥1.5 m but ≤2.0 m. - Minimum protection zone of 5.0 m around a tree with girth ≥2.0 m.	MPH Environmental Manager	EHS inspection to ensure TPZ are installed around each tree as per the Required Mitigation	Daily inspections on establishment; weekly thereafter	Presence and size of the TPZ	Project area	Daily EHS Inspection Reports
			Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5							
			Biodiversity / Transition of habitats during operation	Chapter 9, Section 9.4.4							
			Biodiversity / Visitor interaction with flora and fauna	Chapter 9, Section 9.4.7							

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70	Construction	General Management & Planning	Biodiversity / Disturbance & displacement of fauna	Chapter 8, Section 8.5.6	Habitat resources identified for retention will be GPS-marked and monitored. All damaged/destroyed habitat resources will be documented to enable replacement.	MPH Environmental Manager	Habitat Resources Register	During clearance activities	Location of habitat resources identified	Work package to be cleared	Fauna monitoring records
			Biodiversity / Competition for resources / conflict	Chapter 8, Section 8.5.10							
71	Construction	General Management & Planning	Biodiversity / Clearing vegetation / habitats prior to construction	Chapter 8, Section 8.5.4	During site clearance, care will be taken when removing trees in riparian zones to reduce impacts to the bed and banks of waterways.	MPH Environmental Manager	Tree clearance report	During clearance activities	Location of habitat resources identified	Work package to be cleared	Tree clearance report
72	Construction	General Management & Planning	Biodiversity / Clearing vegetation / habitats prior to construction	Chapter 8, Section 8.5.4	Where practicable, saplings, seeds and seed banks will be retained within the soil profiles for use in forest restoration	MPH Environmental Manager	Tree clearance report	During clearance activities	Location of habitat resources identified	Work package to be cleared	Tree clearance report
73	Construction	General Management & Planning	Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5	Establish a site nursery to cultivate native species on site for use in forest restoration activities. Native seed stock and saplings from within the Project area will be used.	MPH Environmental Manager	i) Confirm the presence of site nursery ii) Maintain an inventory of native species cultivated at the nursery.	Establishment of nursery Inventory to be established from inception of site nursery. It should be updated every time a new individual is added and a "stocktake" conducted bi-monthly.	Not applicable Inventory to include date of arrival of individual to nursery, general location where individual was derived from. Location data can range from spatial coordinates to broader descriptions (eg Rainforest Park South) depending on available resources for curation.	Designated nursery area Inventory can be maintained in a spreadsheet format.	Not applicable
74	Construction	General Management & Planning	Biodiversity / Clearing vegetation / habitats prior to construction	Chapter 8, Section 8.5.4	All construction personnel will undertake biodiversity awareness training prior to commencement of construction to raise their awareness of the: (i) ecological sensitivity of the site; (ii) proper protocols to adopt when wildlife is encountered; and (iii) need to be cautious when operating machinery to avoid injury/mortality to fauna. All workers and visitors to be educated to ensure that all work places are kept clean and waste is not left in open areas. All workers will be prohibited from feeding animals. Refresher training will be provided at least every 6 months during the construction phase.	MPH Environmental Manager	Training Records Quarterly Audit of EMMP Implementation During Construction	Prior to commencement of works and for all new workers Monthly	Number of workers trained	Not applicable	Training records maintained
			Biodiversity / Mortality from hunting and poaching	Chapter 8, Section 8.5.11							
			Biodiversity / Species requiring management	Chapter 8, Section 8.5.12							
75	Construction & Operation	Transportation	Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5	Minimise driving machinery within 10 metres of a tree to avoid impacts to root systems through soil compaction. Where machinery is required to be used close to a tree or retained vegetation, it must be a machine that exerts a low pressure on the ground (such as a tracked machine).	MPH Environmental Manager	i) Daily inspection of construction site will include inspections of vegetation exposed to machinery movements	Daily	Distance of machinery tracks from trees	All trees retained on site	Daily EHS Inspection Reports
			Biodiversity / Transition of habitats during operation	Chapter 9, Section 9.4.4							
			Biodiversity / Visitor interaction with flora and fauna	Chapter 9, Section 9.4.7							

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76	Construction & Operation	General Management & Planning	Biodiversity / Clearing vegetation / habitats prior to construction	Chapter 8, Section 8.5.4	Where trees and vegetation are moved or translocated within the Project area, a suitably qualified arborist will advise on the methods and approach necessary to ensure the trees health during translocation. Translocated trees will be managed through adequate watering and monitoring of their health to ensure their long term survival. Advice will be sought from an arborist if the tree exhibit signs of stress e.g. peeling bark, withered leaves.	MPH Environmental Manager	Tree inspection Quarterly Audit of EMMP Implementation During Construction	Weekly or when tree observed to show signs of stress Monthly during construction and annually during operation	Condition of vegetation	All retained trees and translocated trees within project areas adjacent to construction areas	To be recorded in Daily EHS Inspection Reports and summarised in Quarterly EMMP Implementation Audit Reports
			Biodiversity / Transition of habitats during operation	Chapter 9, Section 9.4.4							
			Biodiversity / Visitor interaction with flora and fauna	Chapter 9, Section 9.4.7							
77	Construction	General Management & Planning	Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5	Requirements of the landscaping strategy as per S/N 8 must be implemented to reduce edge effects adjacent to buildings, enclosures and other facilities. The success of planting within landscape features must be monitored. Where a planting strategy is not working, an alternative planting strategy will be developed suitable for the location. Temporary measures will be employed to reduce stress on planted individuals. The removal of sources of stress (such as dust) may also be required. If disease outbreaks are present, methods will be used to control the outbreak or remove the diseased individual. Where a tree exhibits signs of stress, a suitably qualified arborist should inspect the tree and advise on a strategy to reduce further impacts and rehabilitation measures. Where monitoring indicates that drying out or edge impacts are occurring, remediation measures will be undertaken. These measures may be temporary (such as the installation of artificial shading and sprinklers). Long term solutions will be investigated and implemented with the advice of a suitably qualified specialist. Where edge effects occur due to natural events (i.e. storm event or strong wind), the affected areas will be inspected as soon as practicable after the event. Temporary measures will be taken to mitigate impacts if required while long term solutions are investigated and implemented with the advice of a suitably qualified specialist. Mitigation measures undertaken within the CCNR will need to be agreed upon with NParks.	Contractors and Specialists MPH Environmental Manager MPH Environmental Manager	i) Undertake monitoring of habitat edges to determine if edge effects along planted forest areas and the CCNR are adequately managed. 2) Quarterly Audit of EMMP Implementation During Construction 3) Visual Inspection	Fortnightly during construction over the inter-monsoon period (March to May, and October to November); Monthly for at least the first 2 years of operations with more frequent monitoring in the inter monsoon season Quarterly On an "as needed" basis	Condition of vegetation	All retained trees adjacent to construction sites or Project areas, and at selected permanent monitoring plots All landscaped areas within Project areas adjacent to construction areas On an "as needed" basis	Daily EHS Inspection Reports Quarterly EMMP Implementation Audit Reports Incorporated into Daily EHS Inspection Reports
78	Construction & Operation	General Management & Planning	Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5	Contract as necessary, specialist advice on forest restoration activities to ensure that all recommendations outlined in the Forest Restoration Plan will be implemented to adequately establish and restore vegetation within the Project area. Suitable tree recruitment strategies will be put into place for all trees within enclosures.	MPH Environmental Manager	i) Quarterly Audit of EMMP Implementation During Construction ii) Installation of wildlife camera traps within the Project area and along Mandai Lake Road to determine species utilisation of habitat and connectivity of habitats. iii) Conduct transect survey within the Project area. The transect survey will occur at dawn/dusk. All species will be identified and recorded using a field data sheet. The data will be used to inform the movement patterns and dispersal of species identified as requiring management and dispersal into refuge areas by ground dwelling fauna.	On appointment of forest restoration specialist Wildlife camera trap data / photo records to be collected and analysed fortnightly Frequency of transect surveys is to be determined in consultation with the relevant technical agencies	Plantings as required Condition of vegetation Wildlife camera trap data / photo records Species presence	All areas subject to forest restoration activities Project Area and along Mandai Lake Road Within the Project area	Quarterly EMMP Implementation Audit Reports Fauna monitoring reports Fauna monitoring reports
			Biodiversity / Restriction to wildlife movement / reductions in connectivity	Chapter 8, Section 8.5.8							
			Biodiversity / Transition of habitats during operation	Chapter 9, Section 9.4.4							
			Biodiversity / Visitor interaction with flora and fauna	Chapter 9, Section 9.4.7							

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								Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements
79	Construction	General Management & Planning	Stakeholder Engagement	Chapter 8, Section 8.5.11	Training will be prepared for visitors to the construction site to raise their awareness of biodiversity protection and management within Singapore and the Project site. This training will include: 1. Introduction to important biodiversity at Mandai. 2. Threatened species and their conservation. 3. Conservation initiatives developed as part of the Mandai project. 4. Weeds and invasive species management. 5. Community conservation and involvement. Training package will be reviewed and updated at least every 6 months during construction phase.	MPH Environmental Manager	Training Records will be inspected	Quarterly	Number of workers / visitors trained	Construction site office	Quarterly EMMP Implementation Audit Reports
80	Construction & Operation	General Management & Planning	Biodiversity / Weed/invasive species introduction and proliferation Biodiversity / Import of exotic pests and weeds	Chapter 8, Section 8.5.9 Chapter 9, Section 9.4.11	Weed and invasive species will be cleared from the Project area progressively and will be separated and transported to an appropriate disposal location. Transport will occur within a covered vehicle to ensure seed/vegetative matter does not dislodge. All vegetative matter and seeds will be rendered inert at the disposal location through incineration at a licensed waste disposal facility. The Project area will be carefully cleared of all remaining vegetative matter from the weeds/invasive species. Herbicides may be used to render any stumps/root systems inert. The cleared area will be inspected on a monthly basis to detect any seedlings of invasive species. These seedlings will be killed using herbicide or removed by hand weeding. Any seedlings or vegetative matter that may sprout will be disposed of at a licensed waste management facility. Management options will refer to best practice control techniques such as those contained in Koh et al 2012; Chenoweth EPLA et al 2012.	MPH Environmental Manager	i) Invasive species and weed survey ii) Licensed contractor disposal records will be inspected quarterly	Monthly Construction: Quarterly Operations: Annually	Spatial extent of weed or invasive species infestation Records maintained	All landscaped areas within Project areas and vicinity (WRS operated zoo areas, CCNR and forested area to the west of the Project area)	Invasive species and weed survey report (map of Project area, GPS records of locations of new infestations, list of invasive and weed species) Construction: Quarterly EMMP Implementation Audit Reports Operations: Annual EMMP Implementation Audit Reports
81	Construction	General Management & Planning	Biodiversity / Weed/invasive species introduction and proliferation Biodiversity / Import of exotic pests and weeds	Chapter 8, Section 8.5.9	The use of herbicides, pesticide will be minimised. If herbicides or pesticides are used within the Project area, techniques that limit spray or non-target spray drift will be used. These techniques include but are not limited to: cut and paint techniques and drilling injection. All use of herbicides and pesticides will be conducted in accordance with the relevant Material Safety data Sheet (MSDS). Any incidents of off label use, spillage or damage to non-target species will be reported and investigated.	MPH Environmental Manager	Conduct quarterly spot-checks of landscaping maintenance activities within the Project area	Quarterly	Use of herbicides and pesticides Pesticide/herbicide application methods; visual assessment of volumes of herbicides/pesticides used	Within Project area where herbicides are used	Quarterly EMMP Implementation Audit Reports
82	Construction	General Management & Planning	Biodiversity / Weed/invasive species introduction and proliferation	Chapter 8, Section 8.5.9	Specific measures will be undertaken to control and manage flora species within the Project area that have been identified to be invasive (i.e. *Spathodea campanulata* ; *Cecropia pachystachya* ; and *Falcataria moluccana*). Particular care will be exercised in managing *Falcataria moluccana* groves as the species serves as a nesting site for locally endangered species such as the Grey-Headed Fish Eagle (*Icthyophaga ichthyaetus*) and Changeable Hawk Eagle (*Nisaetus cirrhatus*). Particular care will also be exercised for other weed and invasive species which may also provide important foraging resources.	MPH Environmental Manager	i) EHS inspection to identify presence of invasive species ii) Rapid vegetation surveys of Project area and comparison of these results year on year. Active management measures such as weeding and removal of invasive flora species will be carried out if survey documents an expansion of these areas. iii) Quarterly Audit of EMMP Implementation During Construction	Monthly Annually Quarterly	Invasive species, including *Pathodea campanulata; Cecropia pachystachya;* and *Falcataria moluccana* Number of individuals of invasive flora species, height of invasive flora stand (estimated), utilisation of invasive flora species by wildlife, species of wildlife that utilise invasive flora species, presence of active raptor roosts, spatial information on invasive flora stands	Areas where invasive species have been identified A transect to be identified that offers access to areas where invasive species have proliferated and adjacent forest areas	Survey findings (including a comparative section) to be included in Quarterly EMMP Implementation Audit Reports during construction

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
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83	Construction & Operation	General Management & Planning	Biodiversity / Weed/invasive species introduction and proliferation Biodiversity / Import of exotic pests and weeds	Chapter 8, Section 8.5.9 Chapter 9, Section 9.4.11	Ensure material imported into the Project area will be checked for contamination from weed/invasive species seeds/vegetative matter at source (as per S/N 8 and S/N 9). This is particularly important for imported building materials, such as clay and soil. Source site will be inspected to determine presence of weed/invasive species. Where weed or invasive species are identified, alternative supply sources or decontamination will occur before the material is transported to site.	MPH Environmental Manager	i) Source of materials and material transportation and delivery manifests ii) Invasive species and weed survey	Monitor all disturbed soil surfaces on a monthly basis to determine the presence of germination of invasive/weeds Monthly during construction and annually during operations	Presence of invasive species	Areas where invasive species have been identified	Invasive species and weed survey records to be incorporated into Quarterly EMMP Implementation Audit Reports (Construction) and Annual EMMP Implementation Reports (Operations)
84	Upon availability of transportation information	General Management & Planning	Air Quality (Vehicular Emissions)	Chapter 9, Section 9.1.1	Revisit screening assessment to determine if a detailed air impact assessment will be required at the detailed design stage.	MPH Environmental Manager	-	-	-	-	-
85	Design & Operation	General Management & Planning	Biodiversity / Potential escape of species from enclosures	Chapter 9, Section 9.4.10	Walk-in animal enclosures (e.g., aviaries) at the *Bird Park* and *Rainforest Park* will be designed to include a displaced double door system at all entry and exit points. Door mechanisms will be designed to ensure that one door remains shut when the other is open. Visual inspections/sensors will be installed to ensure that animals have not escaped into the entrance corridors before the remaining door is opened. In addition, CCTV and other suitable technologies will be used to monitor possible theft, vandalism and escapees. In the event that animal escapees are discovered, the relevant regulatory and technical agencies including NParks, AVA and PUB will be notified as soon as practicable and engaged on a coordinated effort to recover the escaped animal. In addition, the following key actions will be carried out: <u>Bird escapees:</u> - inspect the transition area between double doors and the immediate vicinity of the aviary for the escaped bird; - illicit conditioned responses from birds (e.g. keepers to use food lures and calls) to draw the escaped bird back; and, - inspect the mesh for any defects and carry out any necessary repair works. <u>(Non-bird) animal escapees:</u> - locate the animal and set traps or use other means (e.g. tranquiliser guns) to recapture the escaped animal. A database of all collection animals will be maintained and all disposition (deaths, transacted out, changing exhibits, and (if any) escapes) have to be accounted for.	MPH Environmental Manager	i) Installation of CCTV at all entrances/exits to enclosures and motion sensors within all entrance corridors. GPS tracking locational devices are to be installed on exhibited species with high flight risk. ii) Undertake regular monitoring of animal inventory within the enclosures. Monitoring will be carried out via daily counts and the installation of sensors at locations such as feeding stations and nests within the enclosures to enable automated detection and tracking of animals (potential technological solutions are under study at the time of writing).	i) Daily review of CCTV footage and real time monitoring of GPS trackers/motion sensors ii) Daily	Number of escapees Animal inventory	*Bird Park* , *Rainforest Park North* and *Rainforest Park South* All enclosures in the Project area	-
86			Biodiversity / Spread of disease	Chapter 9, Section 9.4.13							
87	Design	General Management & Planning	Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5	All enclosures constructed will be subject to a full engineering designing process. The engineering design will: 1. Outline methods to anchor all enclosures into the ground surface to prevent damage from wind and tree throw. 2. Provide sufficient air space above trees to be included within the enclosures, taking into account likely growth rates and future tree replacement. 3. Include failsafe mechanisms to prevent breaches from tree falls from within or outside of enclosures. 4. Outline construction techniques to minimise damage to existing trees and vegetation, including the compaction of the ground surface around the base of trees (suitable advice must be obtained from an arborist on specific measures to prevent ground compaction during construction). 5. Outline suitable mesh/screen sizes to enable suitable light and water penetration into enclosures. 6. Enable access points for future maintenance (such as tree replacement).	MPH Environmental Manager	i) Review of detailed design for enclosures prior to construction ii) Annual inspections of enclosures during operations	Once, prior to start of construction Annual inspections of enclosure anchoring during operation	Design of enclosures to incorporate required mitigation not applicable	All enclosures in the Project area	Not applicable Annual EMMP Implementation Audit Reports during operations

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88	Design & Operation	General Management & Planning	Biodiversity / Edge effects on habitats Biodiversity / Aerial collision of fauna with enclosed structures and netting	Chapter 8, Section 8.5.5 Chapter 9, Section 9.4.9	Mesh size of enclosures will be constructed to be visible for resident fauna and to exclude animals (such as mice, snakes and monitor lizards). A maximum of 25 mm stainless steel wire mesh must be used for all enclosures that house fauna. Polyethylene or polypropylene may be used if suitable for the host species. Smaller size mesh may be used where the species requires additional protection. Larger mesh sizes may be used for large fauna (such as ground dwelling mammals). A concrete skirting of at least 1 m deep will be sunk into the ground to deter ground burrowing animals. The mesh from ground to the height of 2.5 m will be sized to prevent the entry of the ground animals. The mesh from 2.5 m above ground will be sized to prevent ingress of arboreal animals.	MPH Environmental Manager	Installation of mesh at all enclosures Quarterly Audit of EMMP Implementation During Construction	Inspection of mesh for the enclosures during installation Minimum monthly during construction and annually during operation	Mesh size is installed as required by the specification	All enclosures in the Project area	Quarterly EMMP Implementation Audit Reports
			Biodiversity / Species requiring management	Chapter 8, Section 8.5.12							
89	Design & Operation	General Management & Planning	Biodiversity / Potential escape of species from enclosures	Chapter 9, Section 9.4.10	Aviaries will be built with a minimum distance of 10 m away from trees in the CCNR to minimize contact with the aviary structure. Selected trees (depending on height, species and condition) surrounding the aviaries will be secured to prevent enclosures being impacted from tree fall. The periphery of the aviaries will be built with at least 1 m deep concrete skirting to prevent animal ingress/egress. The mesh of aviaries will be made of stainless steel and sized to prevent captive birds from flying through.	MPH Environmental Manager	i) Design Review to ensure that building setbacks and buffers are included in design ii) "As built" review of construction to ensure that aviary setbacks mesh size has been installed as per design requirements Quarterly Audit of EMMP Implementation During Construction	Once, prior to start of construction Once, upon completion of construction	Design and installation of aviaries within required specifications Location and anchoring of trees surrounding the *Bird Park* aviaries	*Bird Park*	Not applicable
			Biodiversity / Spread of disease	Chapter 9, Section 9.4.13							
90	Operation	General Management & Planning	Biodiversity / Transition of habitats during operation	Chapter 9, Section 9.4.4	A horticultural maintenance schedule will be implemented to regularly check and prune trees and plants around enclosures to protect against trees damaging the integrity of the mesh and animals using branches to enter the aviaries.	MPH Environmental Manager	Horticultural maintenance schedule Quarterly Audit of EMMP Implementation During Construction	To be determined based on operational requirements Annually	Aviary mesh integrity, damage to doors, erosion and tree fall	All installations within Project area	To be incorporated into Annual EMMP Implementation Audit Reports
			Biodiversity / Visitor interaction with flora and fauna	Chapter 9, Section 9.4.7							
91	Design & Operation	General Management & Planning	Biodiversity / Species requiring management	Chapter 8, Section 8.5.12	All drainage and effluent points will be covered with fine mesh to prevent ingress of outside fauna. An electronic CCTV system will be installed at critical areas (doors, perimeter fence) within the Project area to prevent vandalism and theft.	MPH Environmental Manager	Inspections of installation of mesh at all drainage points and CCTV system Annual Audit of EMMP Implementation During Construction	Inspections every 6 months during operation Annually	Mesh size is installed as required by the specification CCTVs are installed at critical areas	Drainage and effluent points Within Project area	Not applicable Annual EMMP Implementation Audit Reports during operations
92	Operation	General Management & Planning	Biodiversity / Visitor interaction with flora and fauna	Chapter 9, Section 9.4.7	Keep the following areas out of bounds for visitors at all times: - *Eco-Link;* - *CCNR;* - Buffer zones; and - Area of high value forest adjacent to the *Sri Seletar Point / Planet Explorer* facility. Install CCTVs to monitor visitor interactions with flora and fauna and incursions into the abovementioned locations that are out of bounds for all visitors. Where visitor incursions to there areas are detected or inappropriate visitor interaction occurs, these will be investigated to determine the causal factors. Additional mitigation measures will be designed and implemented to reduce the risk of further negative fauna interaction with visitors.	MPH Environmental Manager	Inspect fencing, barriers, signs and CCTV equipment used to ensure visitors are excluded from these areas	Every 6 months during operation	Not applicable	*Eco-Link* ; Buffer zones; and Area of high value forest adjacent to the *Sri Seletar Point / Planet Explorer* facility.	Incorporate into Annual EMMP Implementation Audit Reports during Operations
93	Operation	General Management & Planning	Biodiversity / Potential escape of species from enclosures	Chapter 9, Section 9.4.10	Develop protocols in case of release and for the capture of any individual fauna from the enclosures / aviaries, which will include but not be limited to: methods to attract bird(s) and recapture using attractants / feed, and the fixing of GPS tracking location devices to birds of high flight risk.	MPH Environmental Manager	i) Protocols for recapturing escapees developed and training records maintained ii) GPS tracking devices used on birds of high escape risk	Not applicable Not applicable	Not applicable Not applicable	Not applicable Not applicable	Not applicable Not applicable
			Biodiversity / Spread of disease	Chapter 9, Section 9.4.13							

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94	Operation	General Management & Planning	Biodiversity / Mortality from hunting and poaching Biodiversity / Noise impacts to fauna	Chapter 8, Section 8.5.11 Chapter 8, Section 8.5.13	Conduct a visitor awareness program to provide information on the impacts on hunting on local flora and fauna during operation, and educate visitors to keep noise to a minimum when visiting the attractions.	MPH Environmental Manager	Development of a visitor awareness program and number and records of implementation	Review implementation of Visitor Awareness Program on a 6 monthly basis	Number of sessions run	Not applicable	Not applicable
95	Operation	General Management & Planning	Biodiversity / Noise impacts to fauna	Chapter 8, Section 8.5.13	Install signs along nature trails and the *Boardwalk* , and within 100 m of the CCNR to request visitors to keep quiet and not make excessive noise.	MPH Environmental Manager	Installation of signs along nature trails and Boardwalk	Not applicable	Not applicable	Boardwalk	Not applicable
96	Operation	General Management & Planning	Biodiversity / Transition of habitats during operation	Chapter 9, Section 9.4.4	Training will be prepared for visitors to the attractions to raise their awareness of biodiversity protection and management within Singapore and the Project site. This training will include: 1. Introduction to important biodiversity at Mandai. 2. Threatened species and their conservation. 3. Conservation initiatives developed as part of the Mandai project. 4. Weeds and invasive species management. 5. Community conservation and involvement.	MPH Environmental Manager	Training package developed for visitors and implemented	Review visitor training on a six monthly basis	Number of training sessions provided	Not applicable	Incorporate into Annual EMMP Implementation Audit Reports during Operations
			Biodiversity / Visitor interaction with flora and fauna	Chapter 9, Section 9.4.7							
			Biodiversity / Import of Exotic Pests and Weeds	Chapter 9, Section 9.4.11							
97	Operation	General Management & Planning	Biodiversity / Accidental Proliferation of Feed Species	Chapter 9, Section 9.4.8	Undertake the following mitigation measures to minimise impacts from the accidental proliferation of feed species: 1. Locate the fodder area away from the CCNR and buffer areas. The fodder area will be fenced and measures taken to control any seeds within fodder placed within enclosures. 2. Manage fodder species within the Project area by monitoring. 3. Where fodder/feed species are detected outside of designated areas, control these species using appropriate means. 4. Undertake investigations to identify the pathway for fodder/weed species which have moved from designated areas to enclosures. Remedial measures subsequently identified will be implemented and monitoring further to prevent re-occurrence. 5. The fodder area will be fenced to restrict access by native fauna. The fencing will be maintained at a maximum height of 2.4m and be fully enclosed (using a smooth, non-mesh material) to reduce the risk of seed escape.	MPH Environmental Manager	i) Daily EHS inspections will include the identification of fodder/weed species ii) Rapid vegetation surveys of areas within a 50 m radius of designated fodder area	Daily Annually	All fodder species that have germinated outside of designated areas Presence of fodder species outside of designated area, stage of growth of fodder species, spatial information on fodder species presence outside of designated area, number of individuals of fodder species outside designated area	Within Project area Within an area of radius 50 m from designated fodder area	Daily EHS Inspection Reports Incorporate into annual EMMP Implementation Audit Reports
98	Operation	General Management & Planning	Biodiversity / Transition of habitats during operation	Chapter 9, Section 9.4.4	A community based forest restoration project may be developed to engage local community members to participate in forest restoration activities activities. The community forest restoration activities will not be ad-hoc based on visitor demand but will follow the recommendations within the Forest Restoration Plan in Annex 15. This project will work with local community groups to undertake weeding and planting strategies; public awareness activities and workshops. The community based project may also participate in the establishment and maintenance of the Project's nursery, including seedling propagation.	MPH Environmental Manager	I(i) implementation of the community based forest restoration project (ii) Audit of EMMP Implementation	To be established within 6 months of commencement of Project operation and reviewed on a 12 monthly basis Annual	Number of community members engaged	Within Project area Within Project vicinity (subject to permission from NParks)	- Annual EMMP Implementation Audit Reports
			Biodiversity / Visitor interaction with flora and fauna	Chapter 9, Section 9.4.7							
99	Operation	General Management & Planning	Biodiversity / Visitor interaction with flora and fauna	Chapter 9, Section 9.4.7	A community based education program may be established to enable volunteers to provide education services to visitors during operation. This program will develop education materials and standard presentations to enable community members to participate in educational programs.	MPH Environmental Manager	i) Implementation of community based education project	To be established within 6 months of commencement of Project operation and reviewed at a 12 monthly basis	Number of community members engaged	Within Project area	Not applicable

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100	Operation	General Management & Planning	Biodiversity / Transition of habitats during operation	Chapter 9, Section 9.4.4	A community based flora and fauna monitoring project may be developed to engage the community in flora and fauna monitoring within the Project area. This project will include workshops on monitoring techniques; data collection and reporting. Monitoring equipment (including permanent camera traps) will be established within the Project area to assist in the community monitoring program.	MPH Environmental Manager	i) Implementation of the community based flora and fauna monitoring project (ii) Audit of EMMP Implementation	To be established within 6 months of commencement of Project operation and reviewed at a 12 monthly basis Annually	Number of community members engaged	Within Project area	Not applicable
			Biodiversity / Visitor interaction with flora and fauna	Chapter 9, Section 9.4.7							
101	Operation	General Management & Planning	Biodiversity / Transition of habitats during operation	Chapter 9, Section 9.4.4	Resources will be supplemented to sustain displaced fauna. Habitat resources such as artificial nesting boxes, ground habitats, refugia, and other necessary micro habitat components will be installed. Habitat resources that may be required to be supplemented are outlined in the following: - Ground and arboreal forage (native food plants) for ground dwelling herbivorous mammals e.g. Lesser Mouse Deer and for arboreal browsing species e.g.Banded Leaf Monkey; Horsfield's Flying Squirrel - Artificial nests and roosts for hollow reliant nesting/roosting bird and arboreal species. e.g. White-rumped Shama; Blue-crowned Hanging Parrot - Artificial dens for den dependent nursery species. e.g. Sunda Pangolin - Ground habitat (fallen logs and undergrowth)for all herpetofauna The compensatory habitat installed within the Project area and identified refuge areas will consist of a replacement ratio sufficient to compensate for the habitat resources lost. Monitoring will continue for replaced habitat resources to determine their effectiveness. Where required, habitat resources will be modified or replaced if they are deemed not suitable or effective. The location of all habitat resources installed will be recorded and mapped for future monitoring and review.	MPH Environmental Manager	i) Environmental Manager to ensure installations of artificial nesting boxes, ground habitats, refugia, and other necessary micro habitat components are provided based on monitoring results	Monitor the habitat values (nests, dens, roosts, hollow trees, ground habitat, feed trees etc.) which have been marked using GPS throughout construction and operation phases. Supplement habitat resources if required within identified refuge areas if monitoring indicates a reduction in available resources. Monthly within the first six months; 3 monthly for the next 6 months and then six monthly for 5 years. Following this, frequency of monitoring habitat resources installed can be reviewed and adjusted accordingly	Wildlife camera trap data/ photo records Resources identified in Project area	Project area and vicinity	A register of Habitat Resources to be incorporated in the Annual EMMP Implementation Audit Reports
			Biodiversity / Visitor interaction with flora and fauna	Chapter 9, Section 9.4.7							
102	Operation	General Management & Monitoring	Biodiversity / Transition of habitats during operation	Chapter 9, Section 9.4.4	Undertake monitoring of major species groups and habitat utilisation within the Project area. Monitoring will commence prior to the start of any works. The method statements relating to the monitoring will be developed in consultation with the relevant technical agencies. Where monitoring indicates that impacts to species groups/individuals are occurring due to the operation or maintenance of the Project, advice will be sought from suitably qualified specialists and an appropriate action plan developed and implemented. Action plan could include passive measures to encourage species to return to the Project area, such as the provision of habitat resources.	MPH Environmental Manager	(i) Fauna monitoring records (wildlife camera traps and field surveys)	Continuously 5 years using camera traps and visual inspections (fortnightly checks of traps to determine that these are still working) Nocturnal and diurnal surveys will also occur to identify species not easily detected by cameras. The frequency of these surveys will be determined in consultation with the relevant technical agencies.	Major species groups; species of particular focus include: Banded Leaf Monkey (*Presbytis femoralis*), Sunda Pangolin (*Manis javanica*), Lesser Mouse Deer (*Tragulus kanchil*) and Malayan Colugo (*Cynocephalus variegatus*)	Project area	Fauna monitoring reports

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
								Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements
103	Construction & Operation	General Management & Planning	Biodiversity / Edge effects on habitats	Chapter 8, Section 8.5.5	All trees susceptible to wind throw along forest verges, the *Eco-Link* , Mandai Road, Mandai Lake Road and within enclosures will be anchored to prevent wind throw during storm events (including microburst events). Advice on anchoring techniques will be provided by a suitably qualified arborist. Anchoring will be placed using a scarf around the tree to prevent damage. Anchoring will be fixed to structures or anchorage points set into the ground surface. Anchoring will be placed via at least 4 ties to the tree. All anchoring wires will be of suitable strength to hold the weight of the tree.	MPH Environmental Manager	i) EHS inspections of anchor points and condition of anchor devices. ii) Audit of EMMP Implementation	6 monthly basis and following storm events during construction & operation Annually	Trees requiring anchoring	All trees retained on site	Incorporate unto Annual EMMP Implementation Audit Reports
			Biodiversity / Potential escape of species from enclosures	Chapter 9, Section 9.4.10							
104	Operation	General Management & Planning	Biodiversity / Spread of disease	Chapter 9, Section 9.4.13	Quarantine measures, which are to be established in consultation with the relevant regulatory agencies, will be implemented prior to arrival of all exhibited fauna. Regular monitoring of disease will be undertaken for all fauna within enclosures. If any disease is identified, specialist advice will be provided by veterinarians and a health management protocol implemented that will include making contact and seeking direction from the Agri-Food and Veterinary Authority of Singapore and NParks. Specialist monitoring will also be undertaken for diseases such as avian influenza.	MPH Environmental Manager	To be determined based on operational requirements	Ongoing throughout operation	Health of fauna	Within all enclosures in the Project area	Annual EMMP Implementation Audit Reports
105	Operation	Monitoring	Biodiversity / Spread of disease	Chapter 9, Section 9.4.13	Health monitoring of local populations should occur through regular fauna monitoring. A disease management protocol must be developed in consultation with the relevant regulatory agencies to manage any outbreaks of disease within native populations.	MPH Environmental Manager	i) Environmental Manager to ensure development of protocol in consultation with the relevant regulatory agencies to manage outbreaks of disease within native populations ii) Audit of EMMP Implementation	Weekly fauna monitoring records (field surveys) Annually	Health of native fauna	Within all enclosures in the Project area	Fauna monitoring reports Annual EMMP Implementation Audit Reports
106	Operation	Operation & Maintenance	Biodiversity / After hours delivery vehicles colliding with fauna	Chapter 9, Section 9.4.6	Develop protocols for the management of injured wildlife, which will include: 1. Immediate assessment of injured wildlife by suitably qualified veterinary professionals. 2. Investigative measures into the cause of injuries or mortality to wildlife within the Project area. 3. Recording procedures for injured wildlife/ investigations. 4. Identification of management of change measures necessary to reduce the risk of future events.	MPH Environmental Manager	(i) Environmental Manager to ensure development of protocol for handling injured wildlife (ii) Audit of EMMP Implementation	Monitor all enclosures to determine collisions by fauna. Where recurrent patterns in collisions occur, investigations will be undertaken to identify the risks/threats associated with injury/mortality. Further advice will be sought from suitably qualified professionals on potential remedial measures to reduce injury/mortality. Daily for a period of 3 months. Weekly monitoring will occur thereafter for 6 months then monthly thereafter for 12 months using video and visual inspections. Annually	Health of fauna	Within all enclosures in the Project area	Fauna monitoring reports Annual EMMP Implementation Audit Reports
			Biodiversity / Aerial collision of fauna with enclosed structure and netting	Chapter 9, Section 9.4.9							
			Biodiversity / Fauna strikes from visitor vehicles	Chapter 9, Section 9.4.12							

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
								Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements
107	Operation	General Management & Monitoring	Biodiversity / Transition of habitats during operation	Chapter 9, Section 9.4.4	Restore/enhance aquatic habitat features where this is identified to be required during habitat and fauna monitoring surveys. Restoration activities will include but are not limited to: 1. Establishment of habitat features (in-stream debris etc.). 2. Removal of weeds. 3. Targeted control of exotic species.	MPH Environmental Manager	Environmental Manager to ensure establishment of habitat features, removal of weeds and control of exotic species	Frequency of field surveys is to be determined in consultation with the relevant technical agencies.	Species diversity/species mix (exotic/native); mapping of habitat features (in-stream debris; riffles and pools etc.)	Identified aquatic habitats within the Project areas	Fauna monitoring reports to be incorporated into Annual EMMP Implementation Audit Reports
			Biodiversity / Visitor interaction with flora and fauna	Chapter 9, Section 9.4.7	Where monitoring indicates that impacts to species groups/individuals are occurring due to the operation or maintenance of the Project, advice will be sought from suitably qualified specialists and an appropriate action plan developed and implemented.						
108	Construction & Operation	General Management & Planning	Biodiversity / Species requiring management	Chapter 8, Section 8.5.12	Undertake the following domestic waste management measures to reduce the availability of food for animals and species requiring management: 1. Provide litter bins with a closed design, which is fire and animal proof, and ensure these are inspected and emptied twice daily. The frequency of clearing waste may need to be greater during periods of high visitation. 2. Ensure daily housekeeping on *Boardwalk* and trails. 3. Adopt recycling initiatives where possible to minimise the volume of waste generated. 4. All waste from food and beverage outlets will be managed using licensed waste contractors. Advise all food and beverage outlets of their obligations to manage waste to reduce the risk of animal feeding. 5. Storage of waste on site shall be within closed and locked storage facilities that are animal proof. 6. Place signage at the entrance points and near waste disposal areas to discourage littering and feeding of animals. 7. Place signage at prominent locations within the Project area and along the *Boardwalk* highlighting that disposal of waste into streams, stormwater channels or Upper Seletar Reservoir is strictly prohibited. 8. Educate visitors of the need to dispose of waste in waste bins during site introductions.	MPH Environmental Manager	(i) Inspections of waste management procedures to ensure implementation as per the 'Required Mitigation' (ii) Real time CCTV footage	Ongoing throughout operations Ongoing throughout operations	Waste management facilities Real time CCTV footage and/or visual observations of fauna access to waste disposal / storage facilities/areas and negative fauna /flora interaction with visitors	All Project areas, in particular, centralised waste disposal and storage areas	Daily EHS Inspection Reports -
			Biodiversity / Domestic waste and litter from facilities	Chapter 9, Section 9.4.5	Where species are determined to be active around waste management areas, employ measures to reduce the source of the attractant.		(iii) Population counts of target species such as Sambar Deer (Rusa unicolor), Wild Boar (Sus scrofa), and Long-tailed Macaque (Macaca fascicularis). MPH will work with the relevant authorities on the management of these animals should it become a public nuisance (iii) Audit of EMMP Implementation	Annually Annually	Sambar Deer (Rusa unicolor), Wild Boar (Sus scrofa), and Long-tailed Macaque (Macaca fascicularis).		- Annual EMMP Implementation Audit Reports
109	Operation	General Management	Surface Water / Impacts to water quality	Chapter 9, Section 9.2.1	Undertake a risk assessment of the drainage design to determine appropriate containment systems.	MPH Environmental Manager	Drainage design risk assessment	Not applicable	Not applicable	Not applicable	Not applicable
110	Operation	General Management	Surface Water / Impacts to water quality	Chapter 9, Section 9.2.1	Protect surface water sources during operation by ensuring functioning and management of sanitary facilities for workers and visitors. Ensure that sanitary facilities are adequately manned and frequently inspected, in particular during periods of high visitation.	MPH Environmental Manager	(i) EHS inspections of sanitary facilities to ensure functioning (ii) Audit of EMMP Implementation	Throughout operation Annually	Sanitary facilities	All Project areas	- Annual EMMP Implementation Audit Reports
111	Operation	General Management & Planning	Biodiversity / Visitor interaction with flora and fauna	Chapter 9, Section 9.4.7	Place signage at the entrance points and other visually prominent locations within the Project area, to request visitors not to feed or interact with fauna and pick/take flora from within the Project area. Where inappropriate visitor interaction occurs, these will be investigated to determine the causal factors. Additional mitigation measures will be designed and implemented to reduce the risk of further negative fauna interaction with visitors.	MPH Environmental Manager	(i) EHS inspection to confirm provision of signage and regular follow up to inspect the condition of the signage (ii) Audit of EMMP Implementation	Once, prior to start of operation Annually	Signage outlining prohibition of negative fauna / flora interaction with visitors	All Project areas	Not applicable Annual EMMP Implementation Audit Reports

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
								Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements
112	Operation	General Management & Planning	Biodiversity / Import of Exotic Pests and Weeds	Chapter 9, Section 9.4.11	Place visually prominent signage at the entrance to the new attractions explaining that exotic pests and weeds are prohibited from being taken into the Project area.	MPH Environmental Manager	EHS inspection to confirm provision of signage and regular follow up to inspect the condition of the signage	Once, prior to start of operation Annually	Signage outlining prohibition of exotic pests and weeds	All Project areas	Not applicable Annual EMMP
113	Operation	General Management	Ground & Water Resources / Impact to soil, surface water and groundwater during operations	Chapter 9, Sections 9.2.1 & 9.3.1	Re-vegetate exposed ground as soon as possible to stabilise surfaces and minimise re-entrainment of dust and potential for erosion of waste spoil to watercourses.	MPH Environmental Manager	(i) Inspection of exposed ground to confirm revegetation and visual inspection of water quality	Daily before the exposed ground is revegetated	Visual observations of exposed ground for signs of erosion and turbidity of water features at the surrounding	Exposed ground within the Project site and surface water features at the surrounding	Not applicable
114	Operation	General Management	Ground & Water Resources / Impact to soil, surface water and groundwater during operations	Chapter 9, Sections 9.2.1 & 9.3.1	Properly store and manage hazardous materials in accordance with manufacturer and legislative requirements i.e. *Environmental Protection and Management (Hazardous Substances) Regulations,* during operation activities. Locate areas for storage of hazardous materials away from surface water resources. Chemicals and fuels must be properly labelled and stored in bunded areas on pallets. Spill management procedures to include but not be limited to: - Training protocol for all staff in spill response measures; - Provision of spill management kits (composition will depend on the type of hazardous materials to be used, but likely include rags, sands, eyewash, protective gloves etc.) in particular at where hazardous materials, equipment and machinery will be stored and used. Maintenance and mechanical repairs will be undertaken at dedicated designed locations, bunded to capture and control oil, grease and other spills.	MPH Environmental Manager	i) Spot check of hazardous materials management and storage areas for signs of foam, oil film or any other indication of spills	6 monthly surface water quality sampling	Refer to S/N 39	Water channels or bodies downstream of storage/ handling area	Incorporate into Annual EMMP Implementation Audit Reports during Operations
115	Operation	General Management	Ground & Water Resources / Impact to soil, surface water and groundwater during operations	Chapter 9, Sections 9.2.1 & 9.3.1	Spill management procedures as identified in S/N 42 will be reviewed and updated to be specific to operational activities and implemented.	MPH Environmental Manager	i) Review of spill management procedure and provisions ii) Audit of EMMP Implementation	Once, prior to start of operation Annually	Spill management procedure and provisions	-	Not applicable Quarterly EMMP Implementation Audit Reports
116	Operation	General Management	Ground & Water Resources / Impact to soil, surface water and groundwater during operations	Chapter 9, Sections 9.2.1 & 9.3.1	Locate stockpiles (e.g. associated with operational landscaping; cleaning of attractions etc.) as far as possible from surface water features. For example, avoid stockpiling next to the unnamed stream and Upper Seletar Reservoir. Cover stockpiles with tarpaulin when not in use.	MPH Environmental Manager	i) Visual observations of any stockpiles to ensure that they are not located near surface water features and are properly covered ii) Audit of EMMP Implementation	Daily when stockpiling within Project site Annually	Location of stockpiles and provision of tarpaulin	Stockpiles	EHS Inspection Reports Annual EMMP Implementation Audit Reports
117	Operation	General Management	Soil & Groundwater / Impacts to ground quality	Chapter 9, Section 9.3.1	Discharge of pumped dewatered groundwater from excavations to Upper Seletar Reservoir and the unnamed stream along the Project western boundary (due to ecological sensitivities) will be strictly prohibited.	MPH Environmental Manager	Annual inspections and surface water sampling (ii) Audit of EMMP Implementation	Bi annual surface water quality sampling Annually	Refer to S/N 39	Upper Seletar Reservoir and unnamed stream along the Project western boundary	Incorporate inspection and sampling results into Annual EMMP Implementation Audit Reports

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
								Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements
118	Operation	General Management	Biodiversity / Noise impacts to fauna	Chapter 9, Section 9.4.14	All equipment that is not necessary to operate after hours must be turned off (such as air conditioners).	MPH Environmental Manager	EHS inspection of operation of equipment	Daily	Verification against checklist of noise-generating equipment that are not necessary to operate after hours	Within Project area	Incorporate into Annual EMMP Implementation Audit Reports during Operations
119	Operation	General Management	Biodiversity / Noise impacts to fauna	Chapter 9, Section 9.4.14	Signage will be posted at the following locations to remind visitors of the need to minimise noise due to sensitive wildlife in the area.	MPH Environmental Manager	EHS inspection to confirm provision of signage and regular follow up to inspect the condition of the signage EMMP Implementation Audit	Once, prior to start of operation, and weekly during Project operations Annually	Signage highlighting the sensitive wildlife in the area and the need to minimise noise from activities such as shouting, speaking loudly, running along the Boardwalk etc.	• East and West Arrival Nodes; • Along nature trails; • Along the Boardwalk; and • Walkways within 100 m of the CCNR.	Not applicable Annual EMMP Implementation Audit Reports
120	Operation	General Management	Biodiversity / Noise impacts to fauna	Chapter 9, Section 9.4.14	A real time digital display of measured ambient noise and target noise level of 68 dB(A) will be located immediately outside of the *Eco-Lodge* reception area. This digital noise display will be accompanied by educational signage explaining the importance of maintaining noise outside the *Eco-lodge* below a target noise level of 68 dB(A) between the hours of 6pm and 8am. The noise display will also be connected to a continuous data logging system which relays data to eco-lodge staff so that they can be activated to investigate any prolonged exceedance of target noise levels of 68 dB(A). This level has been established in order to maintain night time noise levels at the CCNR at 50 dB(A), which represents measured baseline noise conditions at the CCNR prior to the development.	MPH Environmental Manager	EHS inspection to confirm provision of real time dislay and regular follow up to inspect the condition of the display/measurement equipment EMMP Implementation Audit	Once, prior to start of operation, and weekly during Project operations Annually	Operating condition of real time measurement and display equipment	Outside *Eco-Lodge* reception area	Not applicable Annual EMMP Implementation Audit Reports
121	Operation	General Management	Biodiversity / Noise impacts to fauna	Chapter 9, Section 9.4.14	Public address systems will not be used at outdoor attractions during Project operations, other than for the purpose of emergency communications.	MPH Environmental Manager	i) Event review to ensure that programmes will not involve the use of noise amplifying equipment ii) Audit of EMMP Implementation	Not applicable	Not applicable	All areas withn the Project's operational control	N/A ii) Annual EMMP Implementation Audit Reports
122	Operation	Monitoring & Management of Implementation	Biodiversity / Noise impacts to fauna	Chapter 9, Section 9.4.14	Undertake quarterly noise monitoring to ensure compliance with the night-time threshold value of 50 dB(A) within the CCNR. In the event where exceedances of noise measurements are linked to Project operation activities, remedial actions will be undertaken as soon as practicable. An adaptive management framework and change procedure will be developed to ensure resources and guidance for remedial actions that could be taken.	MPH Environmental Manager	Noise monitoring to ensure compliance against threshold value of 50 dB(A) at night time within the CCNR.	Continuous monitoring for a period of one week, every three months during Project operation	Three manned measurements of Leq,5min levels after equipment set up, during equipment checks and equipment demobilisation, along with observations on sources of noise contributing to observed peaks Continuous one week monitoring of noise levels in Leq,5min intervals in the night-time, 8pm - 8am	NL10 (as shown in *Figure 6.5* within the EIA) within CCNR, south of Mandai Lake Road (approximately mid-way between Rainforest Park South and Bird Park) NL11 (as shown in *Figure 6.5* within the EIA) within CCNR, north of Mandai Lake Road (approximately 50 m from Mandai Lake Road).	Monitoring Records, and reporting of any noise generating source associated with Project operations that was audibly perceptible by personnel undertaking manned noise measurements at NL10/NL11. Noise monitoring results shall be incorproated into into Annual EMMP Implementation Audit Reports during Operations

S/N	Phase		Aspect, Potential Impact /Issue	EIA Reference	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring			
								Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements
123	Operation	General Management	Cumulative Impacts during operations	Chapter 9	Data from camera trap surveys, transects and community monitoring to be used to measure long term population changes and trends for key species (such as the Sunda Pangolin and Lesser Mouse Deer). If available, monitoring undertaken for other developments to also be used to determine changes in species populations and habitat distribution. MPH will liaise with NParks to provide any relevant ecological monitoring data to integrate in the long term monitoring and management of the broader area and with the other surrounding developments.	MPH Environmental Manager	Review of long term monitoring records	Annually	Ecological monitoring data for key species such as Sunda Pangolin and Lesser Mouse Deer	Project Area and surrounding committed developments as identified in the Project EIA	Monitoring Records and Minutes of Meetings

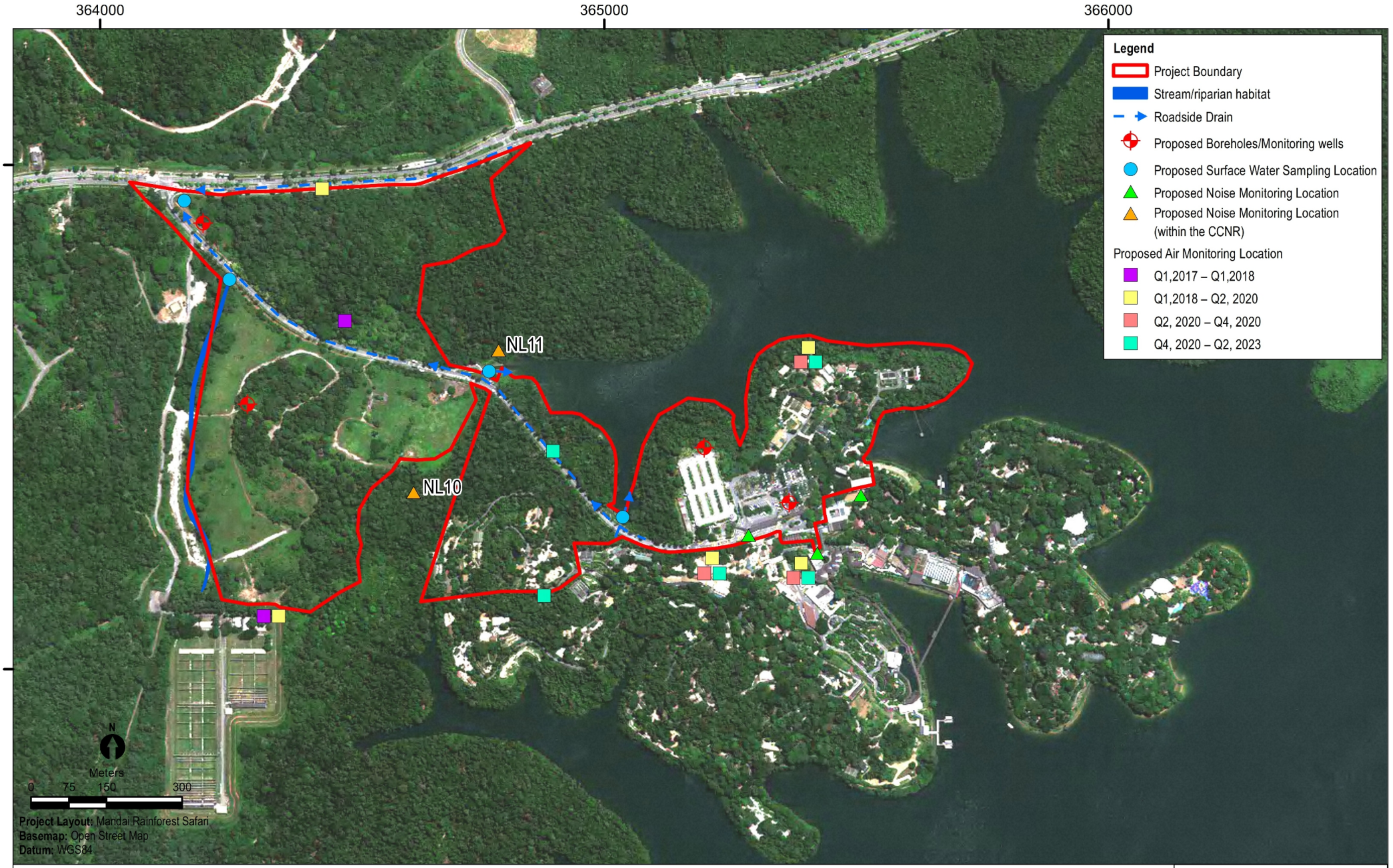

Figure 10.1 Proposed Physical Monitoring Locations for Construction Phase

Note: The monitoring locations are tentative and were proposed based on information available at the time of writing. It is advised for the monitoring locations to be refined upon finalization of construction details

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11 IMPACT ASSESSMENT SUMMARY

The sensitivity of most receptors within the Project area is classified as "High" according to the impact assessment methodology (*Chapter 4*) by virtue of the nearby Upper Seletar Reservoir and CCNR; the presence of internationally listed Critically Endangered species; and its location within an internationally recognised conservation area (being the Central Forest Important Bird Area).

Mitigation measures proposed through the EMMP are designed to reduce the *Magnitude* of impacts such that the residual impact significance is As Low As Reasonably Practical (ALARP). *Table 11.1* summarises the assessed *Magnitude* of impacts prior to and after the application of mitigation measures detailed in the EMMP.

Table 11.1: Summary of the Magnitude of Environmental Impacts Prior to and After Mitigation

Impact Assessed	Magnitude Prior to Mitigation	Residual Impact Magnitude
Construction Phase		
Impact on air quality from elevated dust levels due to construction activities	Medium	Small
Impact on human receptors due to vehicular emission	Insignificant	Insignificant
Impact on human receptors from cumulative air quality impacts	Negligible	Negligible
Impact on surface water quality	Large	Small
Impact on groundwater quality and water table levels	Medium (West) Small (East)	Medium (West) [(1)] Small (East) [(1)]
Impact on human receptors from noise emissions	Negligible to Large	Negligible to Small
Impact on human receptors from cumulative noise emissions	Negligible	Negligible
Impact on human receptors due to vibration	Negligible to Medium	Negligible to Small
Impact on ecological resources due to clearing of vegetation/habitats	Medium	Small
Impact on ecological resources from edge effects on habitats	Medium	Small
Impact on ecological resources due to disturbance and displacement of fauna	Large	Small
Impact on ecological resources due to fauna mortality as a result of vehicle / machinery strike	Medium	Small
Impact on ecological resources from restrictions to wildlife movement	Medium	Small
Impact on ecological resources due to introduction / proliferation of weed / invasive species	Medium	Small
Impact on ecological resources due to competition for resources / conflict	Large	Small

Impact Assessed	Magnitude Prior to Mitigation	Residual Impact Magnitude
Impact on ecological resources due to fauna mortality from hunting / poaching	Medium	Small
Impact on ecological resources due to habitat creation for species requiring management	Medium	Small
Impact on ecological resources due to noise pollution	Medium	Small
Operation Phase		
Impact on human receptors due to vehicular emission	Potentially Significant	Potentially Significant
Impact on surface water quality	Small	Small
Impact on groundwater quality and water table levels	Medium (West) Small (East)	Medium (West) [(1)] Small (East) [(1)]
Impact on ecological resources due to transition of habitats / habitat loss	Medium	Small
Impact on ecological resources from domestic waste generation	Medium	Small
Impact on ecological resources due to after hours delivery vehicles colliding with fauna	Medium	Small
Impact on ecological resources due to interactions between visitors and fauna / flora	Medium	Small
Impact on ecological resources due to accidental proliferation of feed species	Medium	Small
Impact on ecological resources due to aerial collision with enclosure structures and netting	Medium	Small
Impact on ecological resources due to potential escape of species from enclosures	Medium	Small
Impact on ecological resources from import of exotic pests and weeds within feed or introduced by visitors	Medium	Small
Impact on ecological resources from increase in visitor vehicles and subsequent fauna collision risk	Medium	Small
Impact on ecological resources from potential spread of diseases to native populations from exhibited fauna	Medium	Small
Impact on ecological resources from cumulative biodiversity impacts	Medium	Small

Note:

(1) While mitigations do not change the residual impact magnitude, the implementation of a groundwater quality monitoring programme and best practices related to protection of groundwater quality provides additional warning of impacts and allows the opportunity to apply additional corrective actions.

It should be noted that the environmental impact assessment has been undertaken at the master plan/conceptual design stage. Wherever possible, mitigation has been incorporated into the design of the project in order to avoid or minimise impacts through spatial planning and conceptual design. Owing to the level of detail available at the master planning stage, the EIA consultants have made a number of (generally conservative) assumptions in assessing environmental impacts from the Project. It is considered that further assessment is required in

a number of areas once additional engineering, design or construction details become available. These include:

1. Assessment of dewatering requirements during both the construction and operational phases, if required: Further assessment is required to determine location of interceptor drains and dewatering rates. Treatment and disposal methods for this water will need to be agreed with PUB.

2. Assessment of air quality impacts due to vehicular emissions during the operational phase: The screening assessment on air quality impact was based on conservative assumptions which led to the conclusion that impact from vehicular emissions may be significant. The screening assessment should be revisited once further details of the transportation plan for the Project are available. Where the screening assessment using the updated information concludes the same outcome (i.e. Potentially Significant), a detailed assessment is necessary to understand the extent of the impact.

3. A quantitative risk assessment will be carried out to inform the design requirements for the perimeter drainage system, which will prevent pollutive discharge from entering the Upper Seletar Reservoir and avoid impacts to the Upper Seletar Reservoir water quality.

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Annex 1.0

Legislation, Standards and Administrative Framework

A1 LEGISLATION, STANDARDS AND ADMINISTRATIVE FRAMEWORK

This annex presents the requirements from legal acts, standards and guidelines in Singapore that are applicable to the environmental aspects of the Project. The discharge limits of emissions to air, trade effluent, and noise are also presented. These can be found in *Table A1.1*.

Table A1.1: Environmental Discharge Limits and Specific Requirements for Surface Water Protection

Applicable Acts, Regulations & Guidelines	Relevant Requirements/ Discharge Limits

• *Public Utilities Act, 2002 (Chapter 261)*
  • *Public Utilities Act (Reservoirs and Catchment Areas) Regulations, 2006*
• *Sewerage and Drainage Act, 2001 (Chapter 294)*
  • *Sewerage and Drainage Act (Surface Water Drainage) Regulations, 2007*
• *Environmental Protection and Management Act, 2002 (Chapter 94A)*
  • *Environmental Protection and Management (Trade Effluent) Regulations, 2008*
• *Guidebook on Erosion and Sediment Control at Construction Sites* (PUB, 2006)
• *Code of Practice on Surface Water Drainage, 6th Edition* (PUB, 2011)
• *SS 593: 2013 Code of Practice for Pollution Control* (SPRING, 2014)
• *Managing Urban Runoff – Drainage Handbook 1st Edition* (PUB, 2013)
	Trade Effluent Discharge Limits to Sewers and Watercourses are as follows:

Parameter	Limits for Discharge into Public Sewer (Units in mg/l or otherwise stated)	Limits for Discharge into a Watercourse [(1)] (Units in mg/l or otherwise stated)	Limits for Discharge into Controlled Watercourse (Units in mg/l or otherwise stated)
Temperature of discharge	45 ºC	45 ºC	45 ºC
Color	-	7 Lovibond Units	7 Lovibond Units
pH	6 – 9	6 – 9	6 – 9
BOD_5	400	50	20
COD	600	100	60
Total Suspended Solids (TSS)	400	50	30
Total Dissolved Solids (TDS)	3,000	-	1,000
Chloride (as chloride ion)	1,000	-	250
Sulphate (as SO_4)	1,000	-	200
Sulphide (as sulphur)	1	0.2	0.2
Cyanide (as CN)	2	0.1	0.1
Detergents (linear alkylate sulphonate as MBAS)	30	15	5
Grease and Oil (Total)	-	10	1
Grease and Oil (Hydrocarbon)	60	10	-
Grease and Oil (Non-hydrocarbon)	100	-	-
Arsenic	5	0.1	0.01
Barium	10	2	1
Tin	10	-	5
Iron (as Fe)	50	10	1
Beryllium	5	-	0.5
Boron	5	5	0.5
Manganese	10	5	0.5

Parameter	Limits for Discharge into Public Sewer (Units in mg/l or otherwise stated)	Limits for Discharge into a Watercourse [1] (Units in mg/l or otherwise stated)	Limits for Discharge into Controlled Watercourse (Units in mg/l or otherwise stated)
Phenolic compounds (expressed as phenol)	0.5	0.2	-
*Cadmium	1	0.1	0.003
*Chromium (trivalent and hexavalent)	5	1	0.05
*Copper	5	0.1	0.1
*Lead	5	0.1	0.1
*Mercury	0.5	0.05	0.001
*Nickel	10	1	0.1
*Selenium	10	0.5	0.01
*Silver	5	0.1	0.1
*Zinc	10	1	0.5
*Metals in total	10	1	0.5
Chlorine (Free)	-	1	1
Phosphate (as PO_4)	-	5	2
Calcium (as Ca)	-	-	150
Magnesium (as Mg)	-	-	150
Nitrate (NO_3)	-	-	20

Notes:

* The concentration of Toxic Metal shall not exceed the limits as shown, individually or in total.

[1]: Coastal waters are categorised as a watercourse, as defined by the *Environmental Protection and Management Act 2002*.

[2]: Based on the general guidance of the *COPPC2009*, "*diluting trade effluent with portable water, rain water and industrial water to comply with the allowable limits is not permitted*". This is in the event that trade effluent is treated in a WWTP prior to discharge to sewer.

Based on the *Environmental Protection and Management Act (Trade Effluent) Regulations 2008*, the trade effluent discharged must not include:

- Radioactive material;
- Any pesticide, fungicide, herbicide, insecticide, rodenticide or fumigant;
- Refuse, garbage, sawdust, timber, human or animal waste or solid matter;
- Petroleum spirit or other inflammable solvent; or

- A substance that either by itself or in combination or by reaction with other waste or refuse may give rise to any gas, fume, or odor or substance which is or is likely to be a hazard to human life, a public nuisance, injurious or otherwise objectionable.

In addition, based on the *Sewerage and Drainage (Trade Effluent) Regulations 2007,* the trade effluent discharged to sewers must not include:

- Any toxic industrial waste specified in the first column of the Schedule to the Environmental Public Health (Toxic Industrial Waste) Regulations (Chapter 95, Regulation 11);
- Calcium carbide;
- Any organic compound (VOCs/ SVOCs) specified in the First Schedule;
- Yeast, spent or unspent molasses, crude tar, tar oil, carbon disulphide, hydro-sulphide and poly-sulphide;
- Any waste or refuse liable to form a viscous or solid coating or deposit;
- Any excessively discoloring substance;
- Blood waste;
- Infectious waste; and
- Any substance of a nature or quantity which can cause a fire in, damage to or interfere with the public sewer or system.

The trade effluent shall be analyzed in accordance with the latest edition of *Standard Methods for the Examination of Water and Wastewater* (American Public Health Association, the American Water Works Association and the Water Environment Federation of the United States).

Source: Environmental Protection and Management (Trade Effluent) Regulations 2008 and Sewerage and Drainage (Trade Effluent) Regulations 2007

Earth Control Measures

Construction sites are required to adopt an Earth Control Measures plan that has been designed by a Qualified Erosion Control Professional (QECP). The contractor should at all times implement adequate earth control measures and operate these properly at construction sites to prevent muddy discharge into waterways.

Table A1.2: Environmental Discharge Limits and Specific Requirements for Air Quality Protection

<table>
<tr><th>Applicable Acts, Regulations & Guidelines</th><th>Relevant Requirements/ Discharge Limits</th></tr>
<tr><td>

- *Environmental Protection and Management Act, 2002 (Chapter 94A)*
  - *Environmental Protection and Management (Vehicular Emissions) Regulations, 2008*
  - *Environmental Protection and Management (Air Impurities) Regulations, 2008*
  - *Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations, 2012*
- *Singapore Air Quality Targets (NEA)*
- *SS 593: 2013 Code of Practice for Pollution Control* (SPRING, 2014)
- *World Health Organisation Guidelines*

</td><td>

Vehicular Emissions (Motor Vehicles)

<table>
<tr><th>Class of Vehicle</th><th>Date of Registration</th><th>Exhaust Emission Standards</th></tr>
<tr><td>Petrol driven motor vehicles</td><td>On or after 1 April 2014</td><td>i) EC Directive 98/69/EC-B (2005) [1]; or
ii) Paragraphs 102 and 121 of Article 28 of the Japanese Ministry of Land, Infrastructure and Transport Announcement No. 1318 dated 26 September 2003</td></tr>
<tr><td colspan="3">Diesel driven motor vehicles</td></tr>
<tr><td>Passenger car</td><td rowspan="3">On or after 1 January 2014</td><td>i) Regulation (EC) No. 715/2007 [2], Table 1, Annex I; or
ii) JPN 2009 [3]</td></tr>
<tr><td>Motor vehicle with gross vehicle weight not exceeding 3.5 tons</td><td>i) Regulation (EC) No. 715/2007, Table 1, Annex I; or
ii) JPN 2009</td></tr>
<tr><td>Motor vehicle with gross vehicle weight exceeding 3.5 tons</td><td>i) EC Directive 2005/55/EC-B2 (2008) [4]; or
ii) JPN 2009</td></tr>
<tr><td colspan="3">Motor cycles and scooters</td></tr>
<tr><td></td><td>1 July 2013 - Before 1 October 2014</td><td>Directive 97/24/EC</td></tr>
<tr><td>Two-wheeled</td><td rowspan="2">On or after 1 October 2014</td><td>Row B of table referred to in paragraph 2.2.1.1.5 of Annex II of Chapter 5 of Directive 97/24/EC</td></tr>
<tr><td>Three-wheeled</td><td>Row A of the table referred to in paragraph 2.2.1.1.5 of Annex II of Chapter 5 of Directive 97/24/EC</td></tr>
</table>

Notes:

(1) Refers to the Euro IV Emissions Standards.

(2) Refers to the Euro V Emissions Standards for the vehicle class stated above.

(3) JPN2009 refers to Article 41 of the Japanese Ministry of Land, Infrastructure and Transport Announcement No. 619 dated 15 July 2002.

(4) Refers to the Euro V Emissions Standards for the vehicle class stated above.

Source: First, Second and Third Schedules of the Environmental Protection and Management (Vehicular Emissions) Regulations, 2008

</td></tr>
</table>

Vehicular Emissions (In-Use Motor Vehicles)

Class of Vehicle	Date of Registration	Emission Limits for Carbon Monoxide [1]
Petrol driven motor vehicle (apart from motor cycle)	On or after 1 July 1992	3.5% by volume
	1 October 1986 - Before 1 July 1992	4.5% by volume
Motor cycle	On or after 1 October 1986	4.5% by volume
	Before 1 October 1986	6% by volume

Notes:

(1) Taken as a percentage of total volume of exhaust emissions.

(2) Additional requirements:

- Every in-use diesel driven motor vehicle must not emit smoke of opacity greater than 40 Hartridge Smoke Units (HSU)
- Every in-use motor vehicle must not emit any visible smoke or vapor.
- Every in-use petrol driven motor vehicle must be equipped with a silencer, expansion chamber or contrivance to reduce the noise caused by the escape of exhaust gases from the engine
- All parts of the exhaust system of any petrol driven motor vehicle must be in good condition and comply with exhaust requirements.

Fuel Standards

All petrol driven motor vehicles registered on or after 1 July 1999 and utilized for Project activities are to run on unleaded petrol.

Off-Road Diesel Engines

Net Power (P) (kW)	Emission Standards
$8 \leq P < 19$	Japan Tier I, EU Stage II, US Tier II
$19 \leq P < 560$	Japan Tier I, EU Stage II
$P > 560$	US Tier II

Source: Schedule of *Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations 2012*

Standards for Exhaust Emission for Off-Road Diesel Engines

(a) US Tier II

Net Power (P) (kW)	CO (g/kWh)	NMHC + NOx (g/kWh)	PM (g/kWh)
P > 560	3.5	6.4	0.2
450 ≤ P < 560	3.5	6.4	0.2
225 ≤ P < 450	3.5	6.4	0.2
130 ≤ P < 225	3.5	6.6	0.2
75 ≤ P < 130	5.0	6.6	0.3
37 ≤ P < 75	5.0	7.5	0.4
19 ≤ P < 37	5.5	7.5	0.6
8 ≤ P < 19	6.6	7.5	0.8
P < 8	8.0	7.5	0.8

(b) EU Stage II

Net Power (P) (kW)	HC (g/kWh)	CO (g/kWh)	NO_x (g/kWh)	PM (g/kWh)
130 ≤ P < 560	1.0	3.5	6.0	0.2
75 ≤ P < 130	1.0	5.0	6.0	0.3
37 ≤ P < 75	1.3	5.0	7.0	0.4
18 ≤ P < 37	1.5	5.5	8.0	0.8

(c) Japan Tier I

Net Power (P) (kW)	HC (g/kWh)	CO (g/kWh)	NO_x (g/kWh)	PM (g/kWh)	Smoke opacity (%)
130 ≤ P < 560	1.0	3.5	6.0	0.2	40
75 ≤ P < 130	1.0	5.0	6.0	0.3	40
37 ≤ P < 75	1.3	5.0	7.0	0.4	40
19 ≤ P < 37	1.5	5.0	8.0	0.8	40
8 ≤ P < 19	1.5	5.0	9.0	0.8	—

Table A1.3: Environmental Discharge Limits and Specific Requirements for Noise

Applicable Acts, Regulations & Guidelines	Relevant Requirements/ Discharge Limits

• *Environmental Protection and Management Act, 2002 (Chapter 94A)*
  • *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008*
  • *Environmental Protection and Management (Vehicular Emissions) Regulations, 2008*
• *SS 593: 2013 Code of Practice for Pollution Control* (SPRING, 2014)
• *SS602:2014 Code of Practice for Noise Control on Construction and Demolition Sites*
• *World Health Organisation Guidelines*
	Noise from Construction Sites
	
	The authorities may call for the measurement and submission of noise levels from Project sites during construction. Therefore, the Project may be required to undertake noise monitoring over this duration. The noise levels that the Project must adhere to during construction are listed below.

Types of Affected Buildings	Maximum Permissible Noise Levels for Construction Sites in Decibels (A) [1][2]							
	Over 12 hours		Over 1 hours [3]			Over 5 minutes		
	7am-7pm	7pm-7am	7am-7pm	7pm-10pm	10pm-7am	7am-7pm	7pm-10pm	10pm-7am
Hospitals, schools, institutions of higher learning, homes for the aged sick, *etc*.	60	50	-	-	-	75	55	55
Residential buildings located less than 150m from the construction site where the noise is being emitted	75	-	-	65	55	Mondays - Saturdays		
						90	70	55
						Sundays and Public Holidays		
						75	55	55
Buildings apart from those listed above	75	65	-	-	-	90	70	70

Notes:

(1) For construction work commenced on or after 1 October 2007.

(2) The Fourth Schedule states that all works are prohibited from 10pm every Saturday to 7am the following Monday, and from 10pm on the eve of a public holiday to 7am the following day.

(3) For construction work occurring from Mondays to Saturdays

Source: Second Schedule of the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008

Maximum permissible noise levels details in table above may be adjusted if other sources of noise affecting the measurement of noise emissions from a construction site are present. This will involve gathering of baseline noise level data to assess the necessity for an adjustment. The noise correction factors which may be applied to maximum permissible noise levels are outlined as follows:

Difference in decibels (A) [1]	Correction Factor in decibels (A) [2]
Below 2	3
2 to less than 4	2
4 to less than 10	1
10 and above	0

Notes:

(1) Denotes the difference between the background noise level and the applicable maximum permissible noise levels listed in *Table A1.6*.

(2) The addition of the correction factor to the higher of the two noise levels, i.e. the background noise level or the relevant maximum permissible noise level will constitute the new maximum permissible noise level applicable to the Project.

Source: Third Schedule of the Environmental Protection and Management (Control of Nosie at Construction Sites) Regulations, 2008

Vehicular Noise

Class of Vehicle	Permissible Exhaust Noise Emission Levels in Decibels (A) [1]		
	New Vehicles (Registered on/after 1 October 2010)	In-Use Vehicles (Registered on/after 1 July 1999)	In-Use Vehicles (Registered before 1 July 1999)
Motor cycle (with or without a side car), scooter or trivan	94	99	106
Motor car, taxi or station wagon (whether for passengers only or for goods and passengers)	96 or 100 [2]	103	105
Goods vehicle or bus with gross vehicle weight not exceeding 3.5 tons	97	103	-
Goods vehicle or bus with gross vehicle weight exceeding 3.5 tons	99	107	-
Light goods vehicle [3]	-	-	109

Class of Vehicle	Permissible Exhaust Noise Emission Levels in Decibels (A) [1]		
Goods vehicle or bus with engine capacity not exceeding 10,000cm^3	-	-	113
Goods vehicle or bus with engine capacity exceeding 10,000cm^3	-	-	115

Notes:

(1) Measured 0.5 m from the open end of the exhaust pipe of the vehicle

(2) If engine is at rear end

(3) Refers to a goods vehicle with maximum laden weight not exceeding 3 metric tons registered in Singapore before, on or after 1 July 1999. This does not include to any construction equipment, vehicles used for specific purposes or a mobile canteen and recovery vehicles.

Source: Fourth, Sixth and Seventh Schedule of the Environmental Protection and Management (Vehicular Emissions) Regulations, 2008.

Table A1.4: Specific Requirements for Fire Safety

Applicable Acts, Regulations & Guidelines	Relevant Requirements/ Discharge Limits
• *Fire Safety (Petroleum and Flammable Materials – Exemption) Order, 2008* • *Fire Safety (Petroleum and Flammable Materials) Regulations, 2008* • *CP 5: 1998 Code of Practice for Electrical Installations* (SPRING, nd)	<u>Main stipulations (All)</u> • States that release of petroleum and flammable materials into public drains is prohibited; • Provisions for the storage, dispense and transport of petroleum and flammable materials; • Requirements for electrical wiring of equipment and vehicles to be checked by qualified electrician and certified prior to operation to minimize risk of circuit shortage and fire.

Table A1.5: Specific Requirements for Habitat Protection/ Conservation of Protected Areas

Applicable Acts, Regulations & Guidelines	Relevant Requirements/ Discharge Limits

• *Parks and Trees Act, 2006 (Chapter 216)*
  • *Parks and Trees Regulations, 2006*
  • *Parks and Trees (Preservation of Trees) Order, revised 1998*
• *Handbook on Tree Conservation & Tree Planting Provision for Development Projects (NParks)*
• *International Union for Conservation of Nature (IUCN) World Commission on Protected Areas (WCPA) Guidelines*
• *International Finance Corporation (IFC) Performance Standards and Guidelines*
	<u>Main stipulations (Local Regulations)</u>
	• All species of flora and fauna found in NParks' managed areas are protected;
	• Activities that may result in damage to the flora, fauna or any object of "zoological, botanical, geological, ethnological, scientific or aesthetic interest" are prohibited in areas designated as Catchment Area Parks, National Parks and Nature Reserves;
	• Activities subject to approval from NParks are listed in Clauses 8(1) and 9(1) in the *Parks and Trees Act*;
	• NParks may call for the complete cessation of the activity and restoration of affected parts of the national park or nature reserve if adverse impacts from approved activities are observed;
	• Mature trees (i.e. diameter at breast height of more than 1 m) are protected;
	• Felling of mature trees in Tree Conservation Areas and on vacant land outside a TCA is prohibited unless prior approval has been obtained; and
	• The maintenance and protection of mature trees must be considered prior to and during construction works that are conducted in close proximity.
	<u>Main stipulations (International Guidelines)</u>
	• IUCN WCPA provides best practice guidelines for protected area management, including transboundary conservation approaches, concepts for urban protected areas, guidance on governance approaches, ecological restoration and marine protected area management.
	• The IFC's Performance Standards and Guidelines are internationally recognized with respect to the management of environmental and social risk. The guidelines cover eight focal areas: Assessment and management of environmental and social risks and impacts; labour and working conditions; resource efficiency and pollution prevention; community health, safety and security; land acquisition and involuntary resettlement; biodiversity conservation and sustainable management of living resources; indigenous peoples; and cultural heritage.

Table A1.6: Specific Requirements for Wildlife Protection and Welfare

Applicable Acts, Regulations & Guidelines	Relevant Requirements/ Discharge Limits
• *Wild Animals and Birds Act, 2000 (Chapter 351)* • *Wild Animals and Birds (Bird Sanctuaries) Order, 1992* • *Animals and Birds Act, 2002, (Chapter 7)* • *Singapore Red Data Book, Second Edition, 2008*	<u>Wild Animals and Birds Act</u> • Activities causing harm to, the killing, trapping and illegal trade of wild birds and animals will be penalized; • Six birds in Singapore are not protected under this act, i.e. the house crow (*Corvus splendens*), feral pigeon (*Columba livia*), purple-backed starling (*Sturnus sturninus*), Philippine glossy starling (*Aplonis panayensis*), common myna (*Acridotheres tristis*) and the white-vented myna (*Acridotheres javanicus*). The Singapore Red Data Book provides species conservation status subject to the context of Singapore and information on the main threats the species faces locally. It is viewed as a local guideline, complementing the IUCN Red List of Threatened Species, in evaluating species conservation status and determining their sensitivity in a local context.

Table A1.7: Specific Requirements for Import of Animals and Plants

Applicable Acts, Regulations & Guidelines	Relevant Requirements/ Discharge Limits
• *Endangered Species (Import and Export) Act, 2008 (Chapter 92A)* • *Animals and Birds Act, 2002, (Chapter 7)* • *Control of Plants Act, 1993, Chapter 18* • *Control of Plants (Plant Importation) Rules*	<u>Animals and Birds Act</u> • Stipulations on the import and export of animals and birds, including requirements for pre- and post-arrival quarantine and treatment of animals and birds • Stipulations on the prevention of spread of disease from infected animals and birds, including requirements for the destruction of the organism, disinfection and destruction of articles that have come into contact with the organism, and proper disposal of the carcass; • Stipulations on the prevention of cruelty to animals and animals welfare • Stipulations on veterinary centres and breeding of animals. <u>Endangered Species (Import and Export) Act</u> • Species listed in the Schedule (CITES Appendices I, II and III) are subject to strict regulation in order not to endanger their survival. <u>Control of Plants (Plant Importation) Rules</u> • Imported plants must be free of non-quarantine pests; • If found to be infested with a pest, the import may be prohibited, quarantined or destroyed. • List of regulated pests can be found in the First Schedule, Part I (Quarantine Pests) and the First Schedule, Part II (Non-quarantine Pests). • List of plants that are imported under permit can be found in the Second Schedule.

Table A1.8: Specific Requirements for Waste and Hazardous Substances Management

Applicable Acts, Regulations & Guidelines	Relevant Requirements/ Discharge Limits

• *Environmental Protection and Management (Hazardous Substances) Regulations, 2008*
• *Environmental Public Health Act, 2002 (Chapter 95)*
  • *Environmental Public Health (General Waste Collection) Regulations, 2000*
  • *Environmental Public Health (Toxic Industrial Waste) Regulations, 2000*
• *SS 593: 2013 Code of Practice for Pollution Control* (SPRING, 2014)
• *Sewerage and Drainage Act, 2001, Chapter 294*
  • *Sewerage and Drainage (Trade Effluent) Regulations, 2007*
• *Hazardous Waste (Control of Export, Import and Transit) Act, 1998*
• *Radiation Protection Act, 2008*	

Waste Category	Definition	Management Requirement	Source
General Waste	Refuse waste; waste from sewerage systems; waste from sanitary conveniences that are not part of a sewerage system; and toxic industrial waste that has been treated, rendered harmless and determined to be safe for disposal	Waste generators are responsible for arranging for the safe disposal of general waste and are prohibited from dumping waste in a public space	*Environmental Public Health Act*
Toxic Industrial Waste	Any industrial waste which owing to its nature, composition or quantity constitutes a danger to human health of the environment or which contains or may produce pathogens of transmissible disease. A list of toxic industrial waste is provided in the Schedule.	A licensed toxic industrial waste collector must be engaged to undertake waste removal, transport and disposal. Generators of toxic industrial waste must adhere to the quantities for generation and transport prescribed within the Schedule.	*Environmental Public Health (Toxic Industrial Waste) Regulations 2000*
Hazardous Substances	Schedule of the *Environmental Protection and Management (Hazardous Substances) Regulations 2008*	Regulations prescribe mandatory actions that contractors should undertake surrounding the transport, import, storage and supply of hazardous substances Emergency action plans should also be established to deal with accidental spills and leaks	*Environmental Protection and Management (Hazardous Substances) Regulations 2008*

Trade Effluent	Any liquid, including particles of matter and other substances in suspension in the liquid, which is the outflow from any trade, business or manufacture or of any works of engineering or building construction.	If required by authorities, trade effluent must be treated in a pre-treatment plant prior to discharge to the sewerage system; Trade effluent must be analyzed prior to release to the sewerage system; Trade effluent released to the sewerage system must be free of blood waste and infectious waste.	*Sewerage and Drainage (Trade Effluent) Regulations, Sections 72* and *74*
Nuclear Material	As defined in the First Schedule of the Radiation Protection Act	Approval from governing agencies must be sought before transport and disposal of radioactive waste. Records must be maintained documenting the management of radioactive waste.	*Radiation Protection Act, 2008*

Table A1.9: Specific Requirements for Vectors and Pesticides Management

Applicable Acts, Regulations & Guidelines	Relevant Requirements/ Discharge Limits
• *Control of Vectors and Pesticides Act, 2002 (Chapter 59)*	Main stipulations (All) • Creation of conditions favourable to the propagation or harbouring of vectors is prohibited; • Clearing of undergrowth or other vegetation which provide shade to any stream, seepage, running or standing water is prohibited within 6 m of the waterbody without prior approval.

Table A1.10: Specific Requirements for Energy Conservation

Applicable Acts, Regulations & Guidelines	Relevant Requirements/ Discharge Limits
• *Energy Conservation Act, 2014* • *Energy Conservation (Energy Management Practices) Regulations, 2013*	<u>Main stipulations (All)</u> • Registered corporations must report their energy use by 30th June of each year to NEA; • The report must contain the information specified in the *Energy Conservation (Energy Management Practices) Regulations, 2013*, Part III, Clause 4; and • Registered corporations must submit and implement and energy efficiency improvement plan.

Table A1.11: Specific Requirements during Building Construction

Applicable Acts, Regulations & Guidelines	Relevant Requirements/ Discharge Limits
• *Building Control Act, 1999* • *Building Control Regulations, 2003*	<u>Main stipulations</u> • Builders must apply for approval from the Ministry of National Development before commencing with building work; • Builders must produce an impact assessment report to assess potential settlement or other movement which may impair the stability of or cause damage to premises in close proximity to the building work; and • Builders must implement measures to protect foundations and excavations and conduct tests to assess if the structures are sound.

Annex 2.0

IA Methodology and Scoping

Annex 2.1

IA Criteria

A2.1 RECEPTOR/RESOURCE SPECIFIC IMPACT ASSESSMENT CRITERIA

This annex presents the criteria used for assessing each environmental aspect. Where relevant, Singaporean emission limits and standards are incorporated into the assessment criteria. The assessment criteria for air, noise, soil and groundwater, surface water and biodiversity are detailed in the following subsections.

A2.1.1 Air

Table A2.1.1: Magnitude Criteria for Assessment of Dust Impacts

Magnitude Criteria	Definitions

Negligible	• No demolition or building construction works; or
	• Earthworks:
	  • Total site area < 500 m^2; and
	  • Soil type with large grain size (e.g. sand).

Small	• Demolition:
	  • Total building volume < 20,000 m^3;
	  • Construction material with low potential for dust release (e.g. metal cladding, timber); and/or
	  • Demolition activities undertaken < 10 m above ground level.
	• Construction:
	  • Total building volume < 25,000 m^3; and/or
	  • Construction material with low potential for dust release, e.g. metal cladding, timber.
	• Earthworks:
	  • Total site area 500 m^2 to 2,500 m^2; and
	  • Soil type with large grain size (e.g. sand).

Medium	• Demolition:
	  • Total building volume 20,000 – 50,000 m^3;
	  • Construction material with potential for dust release; and/or
	  • Demolition activities undertaken 10 - 20 m above ground level.
	• Construction:
	  • Total building volume 25,000 – 100,000 m^3;
	  • Potentially dusty construction material e.g. concrete; and/or
	  • On site concrete batching.
	• Earthworks:
	  • Total site area 2,500 m^2 to 10,000 m^2;
	  • Moderately dusty soil type (e.g. silt).

Large	• Demolition:
	  • Total building volume > 50,000 m^3;
	  • Potentially dusty construction material e.g. concrete;
	  • On site crushing and screening; and/or
	  • Demolition activities undertaken > 20 m above ground level.
	• Construction:
	  • Total building volume > 100,000 m^3;
	  • Potentially dusty construction material e.g. concrete; and/or
	  • On site concrete batching and sandblasting.
	• Earthworks:
	  • Total site area > 10,000 m^2; and
	  • Potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size).

Table A2.1.2: Sensitivity Criteria for Air Quality Related to Dust Impacts

Sensitivity Criteria	Description
Low	• Locations where human exposure is transient [(1)].
Medium	• Locations where the people exposed are workers [(2)], and exposure is over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day) [(3)].
High	• Locations where members of the public are exposed over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day) [(3)].

Notes:

(1) In accordance with the IAQM guidance, there are no standards that apply to short-term exposure, e.g. one or two hours, but there is still a risk of health impacts, albeit less certain.

(2) Notwithstanding the fact that the air quality objectives and limit values do not apply to people in the workplace, such people can be affected to exposure of PM_{10}. However, they are considered to be less sensitive than the general public as a whole because those most sensitive to the effects of air pollution, such as young children are not normally workers. For this reason workers are included in the medium sensitivity category.

(3) This follows Department for Environment Food and Rural Affairs (DEFRA) guidance as set out in Local Air Quality Management –Technical Guidance published in 2009.

Table A2.1.3: Magnitude Criteria for Screening Assessment of Vehicular Emissions

Magnitude Criteria	Definitions

Insignificant	• A change of:
	  • Light Duty Vehicle flows of less than 500 AADT; and
	  • Heavy Duty Vehicle flows of less than 100 AADT.

Potentially Significant	• A change of:
	  • Light Duty Vehicle flows of more than 500 AADT; and
	  • Heavy Duty Vehicle flows of less than 100 AADT.

A2.1.2 Noise

Table A2.1.4: Magnitude Criteria for Assessment of Noise Nuisance

Magnitude Criteria	Definitions
Negligible	Noise levels are predicted to be 3 dB(A) or more below the limits outlined in Table A2.1.5/ the following guideline values [(1)]: • Ecological receptors outside the zoo: The measured minimum baseline noise levels ($L_{Aeq,T}$) in accordance with WHO guidelines for community noise in 'parkland and conservation areas'. • Zoo animals: 70 dB(A) in accordance with an empirical study on zoo-housed mammals. • Outdoor zoo visitors and workers: 85 dB(A) in accordance with Health and Safety Executive (HSE) UK guidance on speech intelligibility impacts.
Small	Noise levels are predicted to be < 3 dB(A) below the limits / guideline values and to not exceed them.
Medium	Noise levels are predicted to be above the limits/guideline values by less than or equal to 3 dB(A).
Large	Noise levels are predicted to exceed the limits/guidelines values by more than 3 dB(A).

Notes:
(1) Sources: WHO, 1999; Quadros S et al, 2015; HSE UK, nd

Table A2.1.5: Environmental Protection and Management (Control of Noise at Construction Sites) Regulations 2008

Types of Affected Buildings	Maximum Permissible Noise Levels for Construction Sites in Decibels (A)							
	Over 12 hours		Over 1 hours			Over 5 minutes		
	7am-7pm	7pm-7am	7am-7pm	7pm-10pm	10pm-7am	7am-7pm	7pm-10pm	10pm-7am
Hospitals, schools, institutions of higher learning, homes for the aged sick, *etc.*	60	50	-	-	-	75	55	55
Residential buildings located less than 150m from the construction site where the noise is being emitted	75	-	-	65	55	Mondays - Saturdays		
						90	70	55
						Sundays and Public Holidays		
						75	55	55
Buildings apart from those listed above	75	65	-	-	-	90	70	70

Notes:
(1) For construction work commenced on or after 1 October 2007
(2) The Fourth Schedule states that all works are prohibited from 10pm every Saturday to 7am the following Monday, and from 10 pm on the eve of a public holiday to 7am the following day.
(3) For construction work occurring from Mondays to Saturdays

As the noise limits and guidance values have been established through empirical studies and implicitly take into account the receptor sensitivity to noise and vibration, separate criteria for the sensitivity of receptors will not be required. Based on this, noise levels classified as being of **Medium** impact magnitude will correspond to **Moderate** impact significance, while any levels exceeding the standards can cause impacts of **Major** significance to human receptors.

Another significance factor that will be taken into account in determining the magnitude of noise impact will be the duration of the noise generating activity. Impact to a receptor due to a construction activity with **Medium** impact magnitude over a short term operating period, may be downgraded from **Moderate** to **Minor** significance on the basis of its short duration. For the purposes of this study, the durations of impact exposure are defined as follows.

Table A2.1.5: Definition for Duration of Exposure

Duration	Operating Period
Short term exposure	< 1 month
Medium term exposure	1 to 6 months
Long term exposure	> 6 months

Based on the above, the impact significance criteria for the noise assessment are defined as follows.

Table A2.1.6: Impact Significance Criteria for Noise

Impact Magnitude	Duration		
	< 1 month	1 to 6 months	> 6 months
Negligible	Negligible	Negligible	Negligible
Small	Minor	Minor	Moderate
Medium	Minor	Moderate	Moderate
Large	Moderate	Major	Major

Table A2.1.7: Magnitude Criteria for Assessment of Vibration

Magnitude	Vibration Criterion (PPV) mm/s [(1)]
Negligible	< 0.14
Small	0.14 to <1
Medium	1 to <10
Large	≥ 10

Note:
(1) As per guideline values in *Table B.1* of BS 5228-1:2009.

As the guidance values have been established through empirical studies and implicitly take into account the receptor sensitivity to vibration, separate criteria for the sensitivity of receptors will not be required. Based on this, vibration levels classified as being of **Medium** impact magnitude will correspond to **Moderate** impact significance, while any levels corresponding to **Large** impact magnitude can cause impacts of **Major** significance to human receptors, and of **Critical** significance to ecological receptors.

A2.1.3 Soil and Groundwater

Table A2.1.8: Magnitude Criteria for Assessment of Soil and Groundwater Impacts

Magnitude Criteria	Definitions
Negligible	***Groundwater Quality Related*** • Groundwater quality impacts are likely to be well within ambient ranges or allowable criteria and isolated in extent (e.g. <1 ha). • Short-term localized effects on groundwater quality but likely to be highly transitory (e.g. lasting a matter of hours) and well within natural fluctuations. • There are no known/expected other downgradient groundwater users within the watershed that could be affected by the Project. ***Groundwater Quantity Related*** • Impacts to groundwater levels are likely to be well within ambient ranges. • Short-term localized effects on groundwater levels but likely to be highly transitory (e.g. lasting a matter of hours) and well within natural fluctuations. • There are no known/expected groundwater users within the watershed that could be affected by the Project.
Small	***Groundwater Quality Related*** • Groundwater quality impacts are likely to be within ambient ranges or allowable criteria and localized in extent (e.g. 1 to 10 ha). • Short-term localized effects on groundwater quality but which are likely to return to equilibrium conditions within a short timeframe (e.g. hours or days at most). • There are known/expected downgradient groundwater users within the watershed, but their supplies are not expected to not be compromised by the Project. ***Groundwater Quantity Related*** • Impacts to groundwater levels are likely to be within ambient ranges. • Short-term localized effects on groundwater levels but likely to return to equilibrium conditions within a short timeframe (e.g. hours or days at most). • There are known/expected groundwater users within the watershed, but their supplies are not expected to be compromised by the Project.
Medium	***Groundwater Quality Related*** • Groundwater quality impacts are likely to result in occasional exceedances of ambient ranges or allowable criteria and extend area-wide (e.g. 10 to 100 ha). • Localized effects on groundwater quality that are likely to be fairly long lasting (e.g. weeks or months) and/or give rise to indirect ecological and/or socioeconomic impacts. • There are known/expected downgradient groundwater users within the watershed, and their supplies are not expected to be compromised by the Project under certain (e.g. drought or seasonal low flow) conditions. ***Groundwater Quantity Related*** • Impacts to groundwater levels are likely to result in occasional exceedances of ambient ranges. • Localized effects on groundwater levels are likely to be fairly long lasting (e.g. weeks or months) and/or give rise to indirect ecological and/or socio-economic impacts. • There are known/expected groundwater users within the watershed and their supplies are not expected to be compromised by the Project under certain conditions (e.g. drought or seasonal low flow).

Magnitude Criteria	Definitions
Large	***Groundwater Quality Related*** • Groundwater quality impacts are likely to routinely or permanently exceed ambient ranges or allowable criteria over large areas (e.g. >100 ha). • Severe effects on groundwater quality that are likely to be long lasting (e.g., months or more) or permanent and/or give rise to indirect ecological and/or socioeconomic impacts. • There are known/expected downgradient water users within the watershed and their supplies are likely to be compromised by the Project at most times. ***Groundwater Quantity Related*** • Impacts to groundwater levels are likely to routinely or permanently exceed ambient ranges. • Severe effects on groundwater levels are likely to be long-lasting (e.g., months or more) or permanent and/or give rise to indirect ecological and/or socioeconomic impacts. • There are known/expected groundwater users within the watershed, and their supplies are likely to be compromised by the Project at most times.

Table A2.1.9: Sensitivity Criteria for Soil and Groundwater Resource

Sensitivity Criteria	Contributing Criteria	
	Groundwater	
	Groundwater related criteria—The extent to which the groundwater resource provides a use (ie potable and other domestic, agricultural or industrial) to the local communities and businesses, or is important in terms of national resource protection objectives, targets and legislation.	Geologic/subsidence related criteria—The extent to which the geologic resource (i.e., land integrity) provides a platform upon which ecologic and socioeconomic processes are allowed to operate freely without disruption or devastation.
Negligible	The groundwater resource has no role in terms of supply services for the local community.	The geologic resource is located in an area with no socioeconomic activity or sensitive ecological processes.
Low	The groundwater resource has very little or no role in terms of supply services for the local community.	The geologic resource is located in an area with very little socioeconomic activity or sensitive ecological processes.
Medium	The groundwater resource has local importance in terms of supply but there is ample capacity and/or adequate opportunity for alternative sources of comparable quality.	The geologic resource is located in an area with local importance in terms of socioeconomic activity or moderately sensitive ecological processes.
High	The groundwater resource is wholly relied upon locally, with no suitable technically or economically feasible alternatives, or is important at a regional or transboundary watershed level for supply.	The geologic resource is located in an area with significant socioeconomic activity or highly sensitive ecological processes.

A2.1.4 Surface Water

Table A2.1.10: Magnitude Criteria for Assessment of Surface Water Impacts

Magnitude Criteria	Negligible	Small	Medium	Large
Water Quality				
Water Quality parameters for which EPM have not established limits of discharge into controlled watercourses	Less than 10% increase over baseline in any parameter	10% to 50% increase in any parameter	50 to 100% increase in any parameter	>100% increase in any parameter
Water Quality parameters for which EPM have established limits of discharge into controlled watercourses (such as pH, TSS, TDS, BOD, COD, oil and grease)	Less than 10% increase over baseline in any parameter and meeting EPM regulation limit	10% to 50% increase over baseline in any parameter and meeting EPM regulation limit	50% to 100% increase over baseline in any parameter and meeting EPM regulation limit	> 100% increase over baseline in any parameter or exceeding EPM regulation limit
Environmental Protection and Management (Trade Effluent) Regulations, 2008, for discharge into controlled watercourses				
Hydrology				
Watershed conversion	<1% change in watershed characteristics	1 to 5% change in watershed characteristics	5 to 20% change in watershed characteristics	>20% change in watershed characteristics
Flow change	<1% change in mean annual flow	1 to 5% change in mean annual flow	5 to 20% change in mean annual flow	>20% change in mean annual flow
Upper Seletar Reservoir				
Trophic status	No change to existing trophic status	Change of one trophic status indicator by one level towards eutrophic	Change of two trophic status indicators by one level towards eutrophic	Change of three or more trophic status indicator by one level towards eutrophic

Table A2.1.11: Sensitivity Criteria for Surface Water Resource

Sensitivity Criteria	Contributing Criteria		
	Water Quality Related		Hydrologic Regime Related
	The extent to which the water resource plays an ecosystem or amenity role in terms of supporting flora and fauna. This includes its role as a migration route or in supporting a lifecycle stage.	The extent to which the water resource provides a use (drinking water, washing and other domestic or industrial uses) to the local communities and businesses, or is important in terms of national resource protection objectives, targets and legislation.	The extent to which the water resource provides a physical regulating service in the hydrology cycle e.g. in terms of flood protection (via flood plains or flood storage), recession agriculture, navigation, or assimilation of pollution
Low	The water resource does not support diverse aquatic habitat or populations, or supports aquatic habitat or population that is of low quality.	The water resource has little or no role in terms of provisioning or services[1] for the local community.	The water resource has little or no role as a physical regulating service in the hydrologic cycle, and/or the role is highly localised.
Medium	The water resource supports diverse populations of flora and/ or fauna.	The water resource has local importance in terms of provisioning services but there is ample capacity and/ or adequate opportunity for alternative sources of comparable quality.	The water resource plays a local or sub-regional regulating role in the hydrologic cycle in terms of storage, flows and flood alleviation.
High	The water resource supports economically important or biologically unique aquatic species of provides essential habitat for such species.	The water resource is wholly relied upon locally, with no suitable technically or economically feasible alternatives, or is important at a regional or transboundary watershed level for provisioning services or contribution to groundwater dependent ecosystems (e.g. transboundary rivers).	The water resources plays a regional regulating role in the hydrologic cycle in terms of storage, flows and flood alleviation, and one which may have transboundary (international) influences.

[1] Provisioning services are the material/energy products of ecosystems such as food and water.

A2.1.5 Biodiversity

Table A2.1.12: Magnitude Criteria for Effect on Habitats

Magnitude Criteria	Definitions
Positive	• The effect brings beneficial outcomes to ecological functions within the project area.
Negligible	• Effect is within the normal range of natural variation.
Small	• Affects only a small area of habitat, such that there is no loss of viability / function of the habitat.
Medium	• Affects part of the habitat, but does not threaten the long-term viability / function of the habitat.
Large	• Affects the entire habitat, or a significant proportion of it, and the long-term viability / function of the habitat is threatened.

Table A2.1.13: Magnitude Criteria for Effect on Flora and Fauna Species

Magnitude Criteria	Definitions
Positive	• The effect brings beneficial outcomes to flora or fauna taxa.
Negligible	• Effect is within the normal range of variation for the population of the species.
Small	• Effect does not cause a substantial change in the population of the species, or other species dependent on it.
Medium	• Effect causes a substantial change in abundance and / or reduction in distribution of a population over one, or more generations, but does not threaten the long term viability / function of that population, or any population dependent on it.
Large	• Affects entire population, or a significant part of it causing a substantial decline in abundance and / or change in and recovery of the population (or another dependent on it) is not possible either at all, or within several generations due to natural recruitment reproduction, immigration from unaffected areas).

Table A2.1.14: Sensitivity Criteria for Habitats

Magnitude Criteria	Definitions
Negligible	• Habitats with negligible biodiversity values
Low	• Habitats of significance for species listed as of Least Concern (LC) on IUCN Red List of Threatened Species (IUCN Red List) or the Singapore Red Data Book 2008 (SRDB); habitats which are common and widespread within the region; or habitats with low conservation interest based on expert opinion.
Medium	• Habitats within nationally designated or recognized areas; habitats of significant importance to species which are Vulnerable (VU), Near Threatened (NT), or Data Deficient (DD) on the IUCN Red List or the RDB; habitats of significant importance for nationally restricted range species; habitats supporting nationally significant concentrations of migratory species; and low value habitats used by species of medium value.

Magnitude Criteria	Definitions
High	• Habitats within internationally designated or recognized areas; habitats of significant importance to species which are globally Critically Endangered (CR) or Endangered (EN) on the IUCN Red List or the SRDB; habitats of significant importance to endemic and/ or globally restricted-range species; habitats supporting globally significant concentrations of migratory species; highly threatened and/or unique ecosystems; and low or medium value habitats used by high value species.

Table A2.1.15: Sensitivity Criteria for Species

Sensitivity Criteria	Definitions
Negligible	• Species with no specific value or importance attached to them.

Low	• Species:
	  • of LC on the IUCN Red List;
	  • of LC in the Singapore Red Data Book 2008 (RDB 2008); or
	  • not meeting criteria for medium or high value.

Medium	• Species:
	  • on the IUCN Red List as VU, NT, or DD;
	  • listed on RDB 2008 as VU, NT or DD;
	  • are nationally restricted range species, nationally important numbers of migratory species;
	  • do not meet criteria for high value; and/or
	  • vital to the survival of a medium value species.

High	• Species that:
	  • are listed on IUCN Red list as CR or EN;
	  • are listed on RDB 2008 as CR or EN;
	  • have a globally restricted range (ie plants endemic to a site, or found globally at fewer than 10 sites, fauna having a distribution range (or globally breeding range for bird species) less than 50,000 km^2); and/or
	  • constitute internationally important numbers of migratory, or congregatory species;
	  • are key evolutionary species.

Annex 2.2

Final Scoping Report











Environmental Impact Assessment for Mandai Development

Final Scoping Report

February 2015

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Environmental Impact Assessment for Mandai Development

Scoping Report

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Client	Project No
Mandai Park Holdings	0272180
Project Summary Environmental Resources Management (S) Pte Ltd (ERM) was commissioned by Mandai Park Holdings to prepare an Impact Assessment Scoping Report for the proposed development at Mandai ('the Project'). This document presents a high-level project description, regulatory context, preliminary environmental baseline and summarises the findings of the IA scoping study.	Date 17 February 2015 Approved by **Piers Touzel** *Partner, Asia Pacific*

Revision	Description	By	Checked	Approved	Date
1	Final IA Scoping Report	AJ	PT	PT	17.02.15
0	Final IA Scoping Report	AJ/DL	PT	PT	16.02.15
-	Draft IA Scoping Report	AJ/ EY/ DL	DN	PT	23.01.15

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CONTENTS

1 INTRODUCTION

1.1 BACKGROUND

The Singapore Tourism Board (STB) intends to develop a nature-themed attraction at Mandai (hereafter referred to as "the Project") to complement the existing attractions in the area that are operated by Wildlife Reserves Singapore (WRS). Temasek Holdings was invited in 2010 to submit a concept proposal for the Project and subsequently Mandai Park Holdings ("the Client") was established.

The Project will comprise the development of a Rainforest-themed Safari Park, an educational center and an eco-lodge as well as shifting the Jurong Bird Park to Mandai from its current location. Modifications to existing facilities and utilities such as parking areas and the perimeter drain of the Zoo will also form part of the Project.

Environmental Resources Management (S) Pte Ltd (ERM) was commissioned by the Client to carry out an Impact Assessment (IA) Scoping Study for the Project.

1.2 OBJECTIVES

The main objectives of the Scoping Study are to:

- Facilitate an understanding of the elements of the existing baseline conditions that are relevant to resources/receptors that could be significantly impacted by the Project, and to identify where baseline data gaps exist;
- Identify features or activities that may result in significant impacts to resources/receptors; and
- Establish a scope of work for the Environmental Impact Assessment (EIA) for the Project.

1.3 STRUCTURE OF THE REPORT

The structure of the remainder of this report is as follows:

- *Section 2* presents the Project Description which has been used as the basis for this Scoping Study;
- *Section 3* summarizes the Administrative Framework within which the Project is required to comply;
- *Section 4* describes the environmental and social baseline relevant to the Project and its Area of Influence based on currently available information;

- *Section 5* presents the methodology and results of the Scoping phase;
- *Section 6* summarises the data gaps and proposed surveys to address these gaps; and
- *Section 7* concludes the report.

Annex A contains a list of terrestrial and aquatic species identified to date within the Project sites and *Annex B* presents the Scoping Matrix for the Project.

2 PROJECT DESCRIPTION

2.1 INTRODUCTION

The Project involves the development of approximately 35.4 hectares (ha) of land adjacent to the Singapore Zoo along Mandai Lake Road that was designated for tourism development in 2005. In addition to two plots of land to the north and south of Mandai Lake Road, there will also be redevelopment of the 'back-of-house' area within the Singapore Zoo. The main elements of the Project are:

- Rainforest Safari Park;
- Bird Park;
- Eco-Lodge;
- Planet Explorer; and
- Sri Seletar Point.

Existing facilities and utilities such as parking areas and the perimeter drain around the Zoo will be upgraded as part of the Project. A new arrival plaza for the Singapore Zoo and the new attractions will form part of the Project.

In addition, the Project is exploring the feasibility of developing the following:

- An eco-link across Mandai Lake Road to provide connectivity between the two fragmented sections of the Central Catchment Nature Reserve (CCNR) that are currently separated by the road; and

- Approximately 10 km of nature trails within the Project sites and a boardwalk around the perimeter of the Zoo.

The expansion of the Zoo will increase the total land area of the attractions to 110.7 ha. Of this, approximately 18 ha will be recreational areas that will be freely accessible by members of the public.

2.2 LOCATION

The proposed site to the south of Mandai Lake Road between Mandai Camp II and the nature reserve is a 21 ha plot, a part of which was formerly the site of an orchid farm. This land will be used to develop the Rainforest Safari Park attraction. The proposed site of the relocated Bird Park is a 14 ha plot between Mandai Lake Road and Mandai Road. The other elements of the Project will be located within the current 'back-of-house' areas within the Singapore Zoo. The location of the Project is shown in *Figure 2.1*. The two areas outlined in red show the sites to the north and south of Mandai Lake Road that are proposed to be developed. The area outlined in blue is the existing boundary of the Singapore Zoo.

Figure 2.1 Project Location

Map: Google Earth

2.3 SCHEDULE

The current schedule is for completion of the Bird Park and Rainforest Safari areas by 2020, with completion of the arrival plaza, Planet Explorer, Sri Seletar Point and Eco-Lodges to follow by 2023. Construction is planned to commence in the first half of 2017. As the Project is at the concept stage, a detailed construction programme is not yet available.

2.4 PROJECT FACILITIES, COMPONENTS AND ACTIVITIES

2.4.1 Components

2.4.1.1 Bird Park

The existing Jurong Bird Park is located at Jurong Hill along the Ayer Rajah Expressway (AYE). The intention of relocating the Bird Park to the Mandai area is to improve the experience of visitors who visit Singapore and wish to visit nature-themed attractions.

The new Singapore Bird Park will contain netted enclosures, each with a different themed habitat. Its location adjacent to the nature reserve was considered an opportunity for future conservation efforts within the Bird Park to support conservation within the nature reserve..

2.4.1.2 Rainforest Safari

A part of the proposed site of the Rainforest Safari Park was formerly the location of the Mandai Orchid Garden. The orchid farm operated for 60 years until its closure in 2011. The Rainforest Safari will include the construction of a cavern, which will follow the natural contours of the site where certain portions are around eight storeys lower than the surroundings. Water features that will be developed as part of the caverns include an artificial stream, cavern lake and waterfall.

The concept design for the Rainforest Safari Park also includes the 'Zoo in the Air', consisting of a series of boardwalks, aerial sports and treetop dining.

An artificial lake will be created to act as a watering hole for fauna inhabiting the nearby reserve. During operation, guided nature trails will be provided at ground level to allow visitors to explore the area.

2.4.1.3 Planet Explorer

Planet Explorer will be an educational attraction aimed primarily at children, located inside a series of domes along the Seletar Reservoir waterfront. The central themes of Planet Explorer are Conservation and Sustainability, and these will be conveyed through a series of interactive features and activities.

2.4.1.4 Sri Seletar Point

Sri Seletar Point, to be located adjacent to Planet Explorer and also along the waterfront, will be built in the form of canopies. The main attraction will be the Living Green Museum, which will showcase the natural habitats of Singapore. Supporting the central attraction will be an auditorium, an exhibition hall, a library and a café as well as a 'Conservation Centre' that will display information on conservation programs and contain a seed bank and other facilities. The intention is for the facility to act as an area where research and conservation activities and nature-themed programs can be hosted.

2.4.1.5 Eco-Lodge

The proposed Eco-Lodge will be constructed along the Reservoir within the current 'back-of-house' area within the Singapore Zoo currently utilized as staff quarters. At the time of writing the Scoping Report, it is understood that the planned capacity of the Eco-Lodge is 300 rooms within a family hotel and 200 villas.

2.4.1.6 Proposed Eco-Link

The Project includes a proposal to build an Eco-Link in order to enhance connectivity of the two partially fragmented sections of the Central Catchment Nature Reserve on either side of Mandai Lake Road. The form and location

of the Eco-Link are under study at the time of writing and the EIA will provide recommendations for these aspects.

2.4.1.7 Associated Infrastructure

A number of associated elements of infrastructure will be developed to support the Project. This will include a large Arrival Plaza near the existing aboveground parking area. The Arrival Plaza will consist of three parts (Central, East and West), that in addition to a submerged arrival court will house dining and retail amenities designed to mirror the layout of a rice terrace. The East Plaza will serve the existing Zoo facilities, the Eco-lodge, Planet Explorer and Sri Seletar Point. The West Plaza gates will serve as an entry point to the Rainforest Safari and the Bird Park.

Expanded parking will be provided to cater to the additional visitors. At present, the concept plan includes a three-level parking lot to house 3,350 cars near the Central Arrival Plaza and a separate coach parking area near the Rainforest Safari Park.

The concept plan for the Project includes approximately 10 km of nature trails and a waterfront boardwalk along the periphery of the Zoo. It is planned that the nature trails will link with the Park Connector Network.

Modifications to existing infrastructure including Mandai Lake Road and the perimeter drain around the boundary of the Zoo will be subject to further study in 2015. Although not confirmed at this stage, the Project is considering the use of vegetated swales or other similar green infrastructure that will mimic the natural environment while reducing the discharge of pollutants to the Upper Seletar Reservoir.

The staff quarters and quarantine area will all need to be relocated to other areas to accommodate the Sri Seletar Point, Planet Explorer and Eco-Lodge developments. The existing wastewater treatment plant will be decommissioned and a pipeline constructed to link the site with the municipal sewerage system.

2.4.2 Activities

This section describes the activities that will occur during the different phases of the Project. A description of the emissions and/ or interactions with the environment that are likely to occur as a result of the activities is also provided.

2.4.2.1 Pre-Construction

The pre-construction phase of the Project will include geotechnical investigation works to understand the geology in locations where aboveground and underground structures will be built; clearance and

excavation of the land; and diversion of roads and utilities. A site office and possibly workers' quarters will be established.

Geotechnical investigation will involve mobilization of trucks and rigs, drilling of boreholes, and demobilisation of equipment. At certain locations, clearance of land may be needed to accommodate the rigs. This activity will generate noise and vibration.

The key activity in the pre-construction phase will be the clearance, excavation and grading of land for the Project footprint, equipment laydown areas and the site office. Traffic diversions and temporary drainage works will be required at this stage. The operation of equipment and lighting will involve temporary power generation, most likely using diesel generators.

Following the geotechnical investigation, the contractors will need to establish a site office. It is understood that workers' quarters may also need to be built, though the possible location of this is not currently known. Materials, equipment and manpower will need to be moved to and from the site through the phase.

2.4.2.2 Construction

Following the completion of land preparation and establishment of the site office, the Project will move into the construction phase. Key activities during this stage include:

- Provision of slope protection along the existing Mandai Lake Road, along the periphery of the Upper Seletar Reservoir adjacent to the Arrival Plaza and potentially near an unnamed road along the Project western boundary;
- Demolition of existing back-of-house facilities within WRS land;
- Construction of aboveground and underground structures (eg Eco-link, cavern within Rainforest Safari, Arrival Plaza, new quarantine area and nursery, surface and underground car parks);
- Modifications to Mandai Lake Road;
- Modifications to existing surface water drain at the Zoo;
- Construction of boardwalk around the perimeter of Zoo facing the Upper Seletar Reservoir;
- Planting of vegetation in Rainforest Safari site, Bird Park and other areas;
- Establishing water features (fountains, lakes) within the Rainforest Safari and Arrival Plaza;

- Installation of features to enhance thermal comfort; and

- Connection of new sewer system to the existing public sewer line. This last activity will be carried out by the PUB but will be considered as part of the Project EIA.

2.4.2.3 Operation

Normal operation of the Project will involve the following activities:

- Transportation and presence of additional personnel and visitors in the Mandai area;

- Maintenance activities such as fumigation, waste disposal, storage and handling of pesticides and other chemicals;

- Lighting of facilities; and

- Supply of power and water.

The Project site will need to be fenced in such a way as to allow movement of species between the Nature Reserve and the sites while also ensuring visitor safety is preserved.

2.5 *PROJECT ALTERNATIVES*

As the Project is currently at the concept stage, a number of aspects are currently not fully defined. This includes, for example, the access and transportation to the site; the proposed Eco-Link; fencing of the site; and modifications to the perimeter drain around the Zoo. It is worth noting that feedback on the initial concept design has been sought from green groups and changes to certain elements of project design are to be expected.

The Project team intends to consider the design of the abovementioned elements such that it will enhance the existing environment. Specifically, the intention of the Eco-Link is to provide a link between currently partially fragmented portions of the Nature Reserve. Similarly, the aim of the modifications to the drainage is to provide more natural edge conditions along the border of the Upper Seletar Reservoir with the Zoo.

In a 'no-project' scenario, the environmental impacts associated with the development of the Project would not materialise; however, the benefits associated with increased connectivity between the Nature Reserves, reforestation with native species and enhanced edge conditions along the Upper Seletar Reservoir would also be lost.

3 LEGISLATIVE FRAMEWORK

3.1 INTRODUCTION

This section of the report details the Administrative Framework for the Project, covering national requirements as well as applicable international treaties and conventions. A summary of requirements provided by the Singapore Government agencies specifically for the Project during prior interactions is also included. The intent of this section is to lay out the regulatory and non-regulatory performance requirements for all stages of the Project.

3.2 NATIONAL ADMINISTRATIVE REQUIREMENTS

3.2.1 Policies

The Ministry of the Environment and Water Resources (MEWR) formulates and implements policies that promote the overall environmental quality in Singapore.

3.2.1.1 Clean Air Policy

The objective is to protect the public health by maintaining good air quality in Singapore. The plans are to set emission standards for main sources of air pollution such as industries, power stations, and motor vehicles. Key targets set under the Clean Air Policy are:

- Pollutant Standards Index (PSI) for ambient air to be maintained within the 'good' range (ie 0 to 50) for 85% of the year and within the 'moderate' range (ie 51 to 100) for remaining 15%;
- Reduce the annual mean of $PM_{2.5}$ from its current level to 12 µg/ m^3 by 2020 and maintain it at the level till 2030;
- Sulphur dioxide (SO_2) annual mean to be maintained at 15 µg/ m^3 till 2030; and
- Air quality targets in Singapore to be benchmarked to World Health Organization's Air Quality Guideline.

3.2.1.2 Clean Land Policy

Clean Land Policy aims to keep the land clean through comprehensive waste management that encourages reducing and recycling of domestic waste and safely disposal of hazardous waste. Under this policy, a 70% recycling target

is to be achieved by 2030 and the lifespan of Semakau landfill is to be extended.

3.2.1.3 Clean Water Policy

Clean Water Policy is set to secure a stable and sustainable water supply for Singapore. The policy intends to promote the portable water quality through research and developments of better technologies and to encourage the awareness of water conservation through community activities and educations. The policy targets to rely on non-conventional water sources such as desalination and water recycling for supply of 30% to 50% water in Singapore by 2060; and work closely with people, public and private sectors to generate greater awareness of water conservation.

3.2.2 Plans

The Urban Redevelopment Authority (URA) prepared a Leisure Plan as part of the 2008 Master Plan for Singapore. The Leisure Plan was developed based on the 2003 Parks and Waterbodies Plan and Identities Plans. It proposes the Mandai development as one of Asia's future must-see nature destinations.

3.3 RELEVANT LEGISLATION

The Project must comply with national environmental regulations and standards for the protection of the biotic and physical environment throughout all its phases. The key legislation and regulations applicable to the Project for the aspects studied in this report are presented in *Table 3.1* below.

The agencies responsible for the implementation and enforcement of these legislation are the National Parks Board (NParks); PUB; National Environmental Agency (NEA); URA; Building and Construction Authority (BCA); and the National Heritage Board (NHB).

Table 3.1 Summary of Key Relevant Legislation

Subject	Legislation/ Regulations/ Guidebooks	Responsible Agency
Physical Environment		
Management of air emissions	• Environmental Protection and Management Act (Chapter 94A) 2002 • Environmental Protection and Management (Air Impurities) Regulations, 2008 • Environmental Protection and Management (Vehicular Emissions) Regulations, 2008 • Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations, 2012	NEA
Management of trade effluent, water resources	• Sewerage and Drainage Act (Chapter 294) 1999 • Sewerage and Drainage (Surface Water	PUB

Subject	Legislation/ Regulations/ Guidebooks	Responsible Agency
and the prevention of water pollution	Drainage) Regulations, 2007 • Sewerage and Drainage (Trade Effluent) (Amendment) Regulations, 2014 • Environmental Protection and Management (Trade Effluent) Regulations, 2008 • Guidebook on Erosion and Sediment Control at Construction Sites, 4th Edition September 2014 • Code of Practice on Surface Water Drainage, 6th Edition December 2011 • Code of Practice on Sewerage and Sanitary Works, 1st Edition March 2000	
Waste Management	• Environmental Public Health Act (Chapter 95), 2002 • Environmental Public Health (General Waste Collection) (Amendment) Regulations, 2014 • Environmental Public Health (Toxic Industrial Waste) (Amendment) Regulations, 2014 • Environmental Protection and Management Act (Chapter 94A) 2002 • Environmental Protection and Management (Hazardous Substances) (Amendment No.2) Regulations, 2014	NEA
Vector control	• Control of Vectors and Pesticides Act (Chapter 59), 2002	NEA
Management of noise pollution	• Environmental Protection and Management Act (Chapter 94A) 2002 • Environmental Protection and Management Act (Control of Noise at Construction Site) Regulations, 2009 • Guidelines on Boundary Noise Limits for Air Conditioning and Ventilation Systems in Non-Industrial Buildings • SS 553 Code of Practice Air-conditioning and Mechanical Ventilation in Buildings, 2009	NEA
Biotic Environment		
Restrictions surrounding activities in a Tree Conservation Area, Nature Reserve/Park, and Public Park	• Parks and Trees Act (Chapter 216), 2006 • Parks and Trees Regulations (Chapter 216) 2006 • Parks and Trees (Preservation of Trees) Order, 1998	NParks
Prohibitions on certain activities in Catchment area parks	• Public Utilities Act (Chapter 261) 2002 • Public Utilities (Reservoirs, Catchment Areas and Waterway) Regulations, 2006	PUB
States that vegetation at reservoirs should be saved and conserved if possible	• URA Development Control Handbook Design Guidelines for Developments Adjacent to Reservoirs and Stormwater Collection Ponds, 2011	URA
Preventions of introduction and spread of diseases associated with animals, birds or fish; control of import and export of animals, birds or fish; and prevention of cruelty to animals, birds or fish.	• Animals and Birds Act (Chapter 7), 2002 • Animals and Birds (Pet Shop and Exhibition) Rules, 2004 • Animals and Birds (Licensing of Farms) Rules, 2004 • Animals and Birds (Care and Use of Animals for Scientific Purposes) Rules, 2007 • Animals and Birds (Disease) Notification, 2004 • Animals and Birds (Importation) Order, 2009	AVA

Subject	Legislation/ Regulations/ Guidebooks	Responsible Agency
	• Animals and Birds (Live Fish) Rules, 2011 • Endangered Species (Import and Export) Act (Chapter 92A), 2008	
Protection of plants and plant products against pests and diseases; and control of activities related to import and export of plants and plant products	• Control of Plants Act (Chapter 57A), 2000 • Control of Plants (Import and Transhipment of Fresh Fruits and Vegetables) Rules, 2006 • Control of Plants (Cultivation of Plants) (Licensing and Certification) Rules, 2000 • Control of Plants (Plant Importation) Rules, 2000	AVA
Conserved/Heritage Structures		
Works carried out in conservation areas	• Planning Act (Chapter 232) 1998	URA
Requirement of a pre-construction survey to establish the condition of existing buildings and structures in close proximity to any piling/ foundation/ excavation works	• Building Control Regulations Part IV (Chapter 29) 2003	BCA

3.4 PROJECT SPECIFIC REQUIREMENTS

Since its inception in 2007, the Project has gathered feedback from government agencies and other stakeholders on requirements to be incorporated into the Project design and to be covered in the Environmental Impact Assessment. The feedback reviewed by ERM in development of this Scoping Report was primarily in the form of responses to previous Form A/B submission by STB.

Key environmental concerns raised by the government agencies to-date include:

- Connectivity between partially fragmented segments of the CCNR as a result of the Project;
- Loss of buffer provided by existing vegetation in the sites to be developed;
- Escapees from the Bird Park and Rainforest Safari (both flora and fauna);
- Noise and light impacts from construction and operation;
- Potential pollution of the Upper Seletar Reservoir and its water catchment area;
- Potential impacts from the proposed Eco-Lodge, due to its location and density of accommodation;
- The potential for transmission of zoonotic diseases;

- The impacts of any future transportation network leading to and catering for the future development on the Mandai forest (along Mandai Road), within the wider context of the Nature Reserve and the existing roadside trees, planting verges and park connectors;

- The potential impacts arising from supporting infrastructure development (sewerage, water, power, other transport infrastructure such as widening of existing Mandai Lake Road, etc.) in and beyond the site;

- Hydrology, groundwater, surface water and reservoir water quality impacts; and

- Impacts to ambient air quality.

To address these concerns, the Singapore Government agencies outlined a number of considerations to be accounted for in the design and execution of the Project. These include:

- Low impact activities within 50 m of the nature reserves (with low volume visitation). Low density accommodation may be incorporated within the 50 m to 100 m buffer zone from the nature reserves;

- Provision of overhead and underpass connections between the nature reserves;

- All planting within 100 m of nature reserves should be native species. It was further recommended that new planting is primarily native trees and plant species attractive to native wildlife. A list of any non-native species to be planted is submitted to NParks for review and approval.

- Roadside trees should not be affected by the Project. Permission from NParks is needed prior to removal of trees of girth larger than 1m;

- Measures to prevent disturbance to visitors by monkeys should be designed in such a way that other species are free to move in and out of the development;

- Inclusion of pedestrian connectivity or a people mover system between the proposed sites across Mandai Lake Road;

- Configuration of developments to utilise existing open areas and consider lower impact developments where there has not been previous land disturbance;

- Existing drainage system should be not altered without PUB approval. Captive exotic animals have the potential to pollute stormwater; appropriate water treatment methods are therefore to be provided.

- Sewage from the site shall be conveyed to the 1.8 m diameter sewer on Woodlands Road. Surface runoff/ rainwater shall not be discharged to the public sewer;

- Provision of bio-filtration swales and/or storm water detention ponds to reduce surface runoff from hard surfaces and therefore not change the catchment yield;

- Worker's quarters or other accommodation should be built outside of the health and safety buffer zone that will be agreed with NEA;

- Structures should not overlook the army training grounds. Earthbunds to be constructed along the boundary, with signs warning visitors not to enter the training area to be placed at intervals of 50 m;

- No impact to monsoon drain on north side of Mandai Lake Road unless acceptable alternative is provided; and

- Consideration of noise from military activities and provision of mitigation measures if necessary. Lighting should not interfere with the activities of the Republic of Singapore Air Force (RSAF), and should be shielded and/or pointed downwards to avoid affecting pilots.

Further, the EIA for the Project must assess the impact to not just Upper Seletar Reservoir but also wider Sungei Mandai Water Catchment Area. The cumulative assessment within the EIA should consider known existing or future projects within 2 km of the Project site.

With regard to baseline studies, in addition to the Project site, they should cover the forest within Nature Reserves; the Upper Seletar Reservoir and associated drains and streams; the unnamed road along the Project western boundary and stream alongside; and nearby significant biodiversity areas. As per the requirements of the PUB, the Project must establish at least six water quality stations to be within Upper Seletar Reservoir, its catchment area and the Sungei Mandai Water Catchment Area, from which samples are to be taken at various times of the day from the surface, mid-depth and bottom.

3.5 INTERNATIONAL STANDARDS, GUIDELINES AND TREATIES/CONVENTIONS

International conventions and regional agreements to which Singapore has acceded or has ratified of relevance to the project are listed in *Table 3.3*.

Table 3.2 International Conventions and Regional Agreements Relevant to the Project

Subject	Convention/ Agreement
Biodiversity	• The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1975 • Convention on Biological Diversity, 1992

Subject	Convention/ Agreement
	• ASEAN Declaration on Heritage Parks and Reserves, 1984 • ASEAN Agreement on the Conservation of Nature and Natural Resources, 1985 • ASEAN Peatland Management Initiative, 2003 • International Plant Protection Convention, 1951 • International Union for the Protection of New Varieties of Plants, 1991
Climate Change and Air Pollution	• Vienna Convention on the Protection of the Ozone Layer, 1985 (Vienna Convention) • Montreal Protocol on Substances that Depletes the Ozone Layer, 1987 (Montreal Protocol) • Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1997 (Kyoto Protocol) • ASEAN Agreement on Transboundary Haze Pollution • Statute of the International Renewable Energy Agency, 2009
Waste Disposal	• Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and Their Disposal, 1989

3.6 INTERNAL SUSTAINABILITY OBJECTIVES

In addition to regulatory requirements, the Project will be designed and executed in line with the following sustainability principles developed by the Client:

- Enhancing resource efficiency by reducing water use, water and energy consumption;
- Enhancing the environment through the use of sustainable materials, minimising the carbon emissions from the Project and by implementing user-friendly solutions with minimal impact on the environment;
- Building capabilities by pioneering solutions to enhance outdoor comfort in the tropical environment; and
- Fostering community action by creating a unique educational experience for visitors.

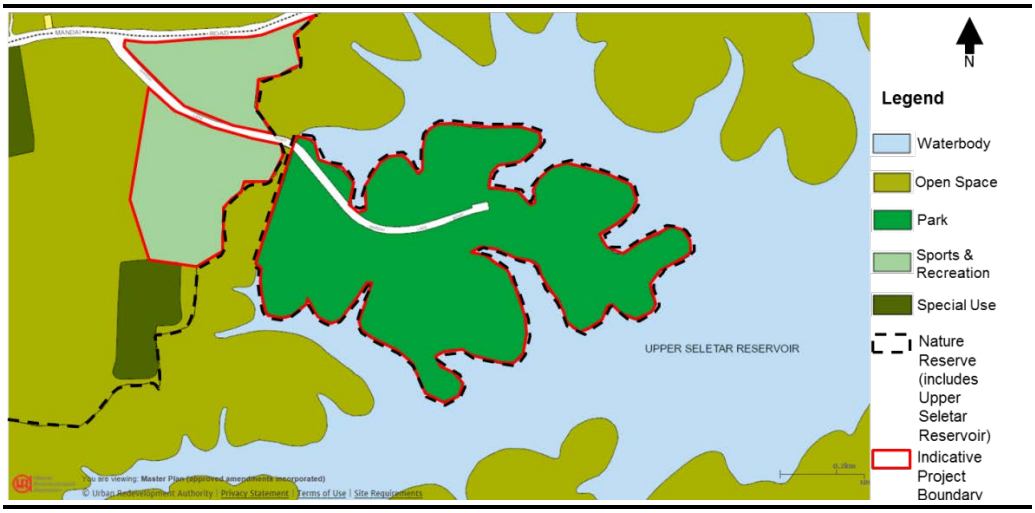
4.1 SURROUNDING LAND USE

The Master Plan published by the URA is a statutory land use plan that provides guidance on the medium-term (ie 5 to 10 years) development of land and property in Singapore. The Project sites on either side of the Mandai Lake Road are currently undeveloped and partially forested. The land use of both plots is classified as *Sports & Recreation* under the Master Plan published in 2014. The Zoo is classified as *Park*, and other designated land uses of the surrounding areas include:

- Open space;
- Special use;
- Nature Reserve; and
- Waterbodies.

Figure 4.1 gives an overview of the land uses of the Project sites and the surrounding areas.

Figure 4.1 Land use Overview



Source: URA, 2014

4.2 CLIMATE AND METEOROLOGY

4.2.1 Prevailing Climatic Conditions

Singapore is located 1 degree north of the equator where the climate is uniformly hot and humid with abundant rainfall. The typical daily temperatures vary between 23 ˚C and 34 ˚C, with the extremes ranging from 19.4 ˚C to 36.0 ˚C *(NEA, 2014a)*.

The country has no true seasons, but is affected by the Northeast (NE) and Southwest (SW) monsoon winds that occur from December to early March and from June to September, respectively. In between the two monsoon seasons are the two inter-monsoon periods which occur from late March to May and from October to November.

4.2.2 Rainfall

The average annual rainfall in Singapore is approximately 2,344 mm *(NEA, 2014 b)*. The wet season usually occurs from October to January, and December normally contributes the most rainfall in the year due to the monsoon rain-belt. Based on data reported by the NEA from 1869 to 2013, December is the month with the highest monthly mean rainfall of 288.4 mm while July, with 158.6 mm, has the lowest monthly mean. The mean number of days with thunderstorms in December and July over the 32 year period from 1982 to 2013 were 19 and 13, respectively.

According to the most recent Annual Weather Review published by the NEA, the northeastern portion of Singapore, near Seletar, typically received the most rainfall across the different monsoon periods in 2013 *(NEA, 2013a)*.

4.2.3 Wind Direction

Northerly to northeasterly winds are the prevailing winds of the NE monsoon from December to March, with speeds ranging from 6 to 10 km/hr. Wind speeds can reach 30 to 40 km/hr in the months of January and February *(NEA, 2014a)*.

During the SW monsoon, from June to September, the prevailing winds are from south or southeast, with speeds between 6 and 10 km/hr. The SW monsoon is occasionally accompanied by Sumatra Squalls, with wind gusts of 40 to 80 km/hr occurring between the predawn hours and mid-day *(NEA, 2009)*. The winds during the inter-monsoon periods are usually light and blow in variable directions.

4.2.4 Extreme Weather Events

4.2.4.1 Haze

Smoke haze originating from forest fires in Indonesia is occasionally encountered in Singapore.

Based on the NEA monitoring data, the overall air quality was "Good" and "Moderate" in 2012 and 2013 respectively. However there were 8 days in 2013 in which the air quality was deemed "Unhealthy" and "Very Unhealthy" as presented in *Table 4.1.* This was related to a severe haze event that occurred in June 2013.

Table 4.1 Summary of 24-hour PSI in 2012 and 2013

Year	Days	No. of Days (% of time) in which PSI was classified as			
		Good (0 – 50)	Moderate (51 – 100)	Unhealthy (101 – 200)	Very Unhealthy (201 - 300)
2012	366	342 (93%)	24 (7%)	0 (0%)	0 (0%)
2013	365	341 (94%)	16 (4%)	5 (1%)	3 (1%)

Source: NEA, 2013b

4.2.4.2 Hail

Hail is uncommon in Singapore. In the afternoon of 25 June 2013, a hailstorm of short duration occurred in the western parts of Singapore (Jurong, Bukit Batok and Clementi). The previous event was reported in March 2008 *(NEA, 2008)*.

4.3 GREENHOUSE GAS EMISSIONS AND CLIMATE CHANGE

Singapore contributes less than 0.2% of global greenhouse gas (GHG) emissions *(NCCS, 2013a)*. The emissions of carbon dioxide (CO_2) associated with the use of energy for development and human needs are the major contribution to national GHG emissions, and the total CO_2 emitted in 2012 was approximately 41, 540 kt *(MEWR, 2014a)*.

Singapore is projected to produce 77.2 million tonnes (MT) of GHG in 2020 based on the emission data obtained in 2005. Industry is predicted to be the major contributor that will account for approximately 60.3% of the total projected emission, followed by the transportation, 14.5% and buildings, 13.8% *(NCCS, 2013a)*.

Singapore is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) as a non-Annex I party since 1997 and acceded to the Kyoto Protocol in 2006. Although there are no mandatory reduction targets for non-Annex I countries, Singapore has embarked on policies and measures to reduce the projected 2020 emissions (ie 77.2 MT) by 7 -11% *(NCCS, 2013b)*.

4.4 AIR QUALITY

The NEA carries out routine monitoring of ambient air quality through the Telemetric Air Quality Monitoring and Management System (TAQMMS). This system comprises remote monitoring stations around Singapore, which monitor ambient air quality and roadside air quality. The NEA air quality monitoring stations monitor both ambient and roadside air quality.

At the air monitoring stations, automatic analysers continuously monitor common urban air pollutants such as SO_2, oxides of nitrogen (NO_x), carbon monoxide (CO), ozone and particulate matter (PM_{10} and $PM_{2.5}$). At selected

stations, meteorological parameters including wind speed and direction, temperature and relative humidity are also monitored.

4.4.1 Ambient Air Quality

The range of ambient concentrations measured across Singapore reported over the last three years is presented in *Table 4.2* alongside the relevant ambient air quality targets. This data does not reflect spatial variations in ambient air quality in different parts of Singapore. Ambient air quality data from individual stations that are in closer proximity to the alignment options is not typically available in the public domain, though it may be provided by the NEA on a case-by-case basis.

Table 4.2 Nationwide Average Ambient Air Quality for Singapore, 2011- 2013

Measured Species	Averaging Period	Range of Concentrations in Ambient Air (2011-2013) ($\mu g/m^3$)	2020 Air Quality Targets ($\mu g/m^3$) (2)	Long-Term Air Quality Targets ($\mu g/m^3$) (2)
SO_2	24-hour	**75 – 98**	50	20
	Annual	10 -14	15	15
$PM_{2.5}$	24-hour	**41- 176**	37.5	25
	Annual	**17- 20**	12	10
PM_{10}	24-hour	50 **-215**	50	50
	Annual	20 - **31**	20	20
Ozone	8-hour	**122- 139**	100	100
NO_2	1-hour	132 - 189	200	200
	Annual	25	40	40
CO	1-hour	7,500	30,000	30,000
	8-hour	5,500	10,000	10,000

Notes:

(1) Numbers in bold denote exceedance of the 2020 and long-term ambient air quality targets.

(2) Singapore has adopted the World Health Organization Air Quality Guidelines (WHO AQG) for PM10, NO_2, CO, and the WHO AQG Interim Targets for PM2.5 and SO_2 as air quality target for 2020.

(3) 24-hour particulate matter (ie PM_{10} and $PM_{2.5}$) concentrations are 99th percentile while short-term concentrations of other species are maximum values.

Source: MEWR, 2014b

While concentrations of NO_2 and CO are within the air quality targets for Singapore, levels of SO_2 , particulate matter and ozone are observed to exceed the 2020 and long-term targets in most of the recent years.

4.4.2 Air Sensitive Receptors

The surrounding areas, as discussed in *Section 4.1,* are predominantly comprised of forested land and military areas. Potential Air Sensitive Receptors (ASRs) include residential areas; areas where the elderly, sick or children are likely to be present (hospitals, homes for the aged, schools); ecological areas; and recreational areas where groups of people may congregate for extended periods of time. A preliminary list of potential ASRs is presented in *Table 4.3*. The nearest residential areas and schools are included, though it is noted that these are at least 1.7 km from the nearest site

boundary. Military camps are considered residential in this context as members of the armed forces reside there.

Table 4.3 Potential ASRs

Name	Landuse Type	Approximate Distance
Upper Seletar Reservoir	Ecological	0 m (adjacent)
Nature Reserve	Ecological	0 m (adjacent)
Visitors and personnel within the Singapore Zoo	Recreational	0 m (adjacent)
Mandai Camp II (Military)	Residential	100 m
Mandai Camp	Residential	1 km
Segar Grove, Segar Garden	Residential	1.8 km
HDBs, Woodlands St 41	Residential	2 km
Century Grove	Residential	2 km
Singapore Turf Club	Recreational	1.7 km
Singapore American School	Educational	1.9 km
Singapore Sports School	Educational	1.9 km

Source: Google Earth, One Map

4.5 ENVIRONMENTAL NOISE

4.5.1 Noise Sources

In the existing environment, the main noise sources in the vicinity of the site are:

- Road traffic along Mandai Lake Road and Mandai Road and to a lesser extent the Bukit Timah Expressway;
- Military movements and activities at the nearby military areas;
- Overhead air traffic from nearby military airbases (such as Sembawang airbase); and
- Movement of people within the Zoo, using trams, boats etc.

Other natural phenomena such as thunder and heavy rain also contribute towards existing noise levels in the environment.

4.5.2 Noise Sensitive Receptors

The noise sensitive receptors (NSRs) identified in the area through a desktop review are similar to the ASRs outlined in *Table 4.3*.

4.6 GEOLOGY, HYDROGEOLOGY, HYDROLOGY

4.6.1 Topography

Topographical surveys were conducted in September 2007 and October 2009 for the two plots of land to the north and south of Mandai Lake Road and the

Zoo, respectively. Review of the topographical maps indicates that the Project sites are located at areas of higher elevation in Singapore and are characterised by gently undulating terrain.

The land parcel to the north of Mandai Lake Road is flat along Mandai Lake Road and Mandai Road with elevations measured at approximately 20 m above mean sea level (msl) and rising to 45 m above msl towards the edge near the CCNR. The topography of the plot of land to the south of Mandai Lake Road is generally flat at the perimeter and elevated to 53 m above msl at the area adjacent to the CCNR (ie the former location of the orchid farm). The elevation of the terrain at the Zoo varies from 24 m to 40 m above msl, with elevations of 40 m at the current location of the Night Safari.

4.6.2 Geology

A review of the *Geology of Singapore, 2nd Edition* (DSTA, 2009) revealed that the Project sites are largely underlain by Bukit Timah Granite. A small section of Alluvial member is noted at the junction of Mandai Lake Road and Mandai Road and along the unnamed road along Project western boundary.

4.6.3 Hydrogeology

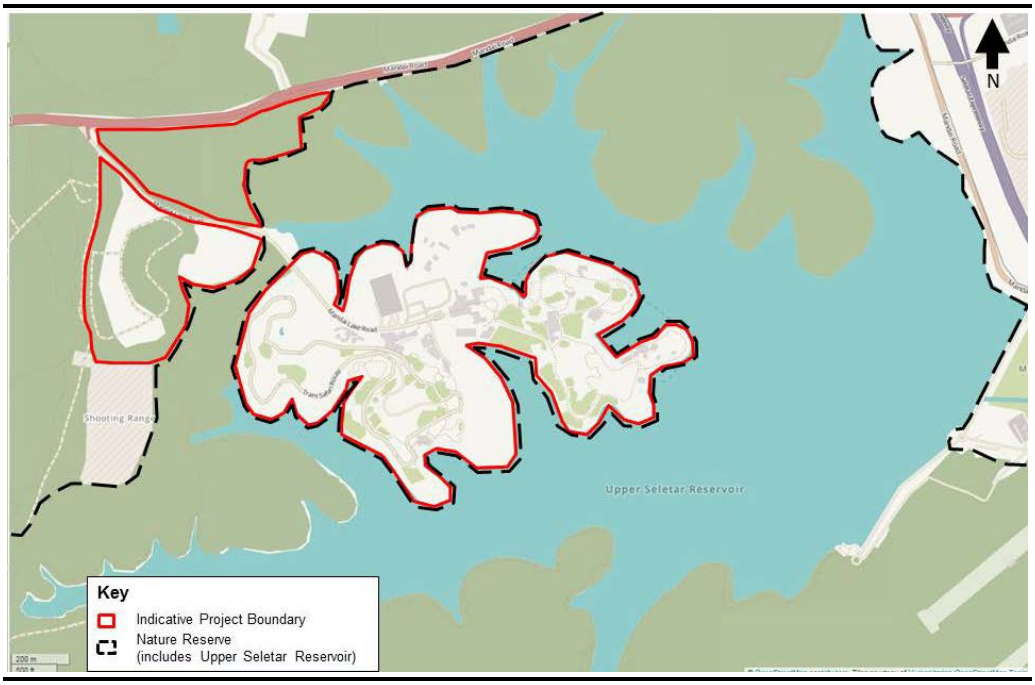
At the time of writing, no information on the hydrogeology of the site was available. However, given the close proximity to Upper Seletar Reservoir, the groundwater level is likely to be shallow and flowing towards the reservoir. It was noted during the Scoping Workshop that there may be two watersheds in the area. This will be further investigated during the baseline surveys.

4.7 TERRESTRIAL ENVIRONMENT

4.7.1 Protected Areas

The Project area is located directly adjacent to the CCNR which it borders on the western side as presented in *Figure 4.2*. The CCNR is one of the main protected areas managed by NParks in Singapore and it supports abundant biodiversity. While not directly part of the CCNR, buffer habitat within 100 m surrounding the CCNR is also present within the surrounding areas including the Mandai military training areas bordering the south and west of project site and the existing Zoo, particularly the Night Safari, and is also of biodiversity value.

Figure 4.2 CCNR Relative to Project Sites



Source: OpenSteertMap, 2014

4.7.2 Habitat

Habitat within the CCNR is generally dominated by (old and young) secondary forests, while the proposed project sites comprise abandoned land, secondary forest, scrub, open grassland and orchards where regeneration of native and exotic trees, herbs, shrubs and climbers has begun.

All habitats within the Project area show some level of disturbance. While freshwater forest swamps and primary lowland dipterocarp forests are still present in some parts of the CCNR, neither are present in the Project area or directly adjacent to it. These are likely to be areas of ecologically significant habitat within the Project's Area of Influence.

4.7.2.1 Terrestrial Flora

Flora and habitat surveys were conducted across the Project site and its Area of Influence (including some parts of the CCNR) during June to July 2014. Results showed that the floral diversity was greater within the CCNR, however, there were a number of national critically endangered species identified within the Project Footprint. The estimated total number of species identified was 144 species; 13 species were categorised as Critically Endangered (CR), 14 species to be Endangered (EN) while 20 species were listed as Vulnerable (VU). These categories were derived from the Singapore Red Data Book *(Davison et al, 2008)*. Some of the CR species include *Aporosa lucida* (tree), *Connarus semidecandrus* (climber), *Dasymaschalon dasymaschalum* (shrub) and *Centotheca lappacea* (herb).

Significant numbers of exotic flora are also existant on the site, including *Cecropia pachystachya* (tree), *Christella dentata* (herb), Ficus benjamina (climber), *Acacia mangium* (tree) and *Mimosa diplotricha* (shrub).

4.7.2.2 Terrestrial Fauna

The Project's Area of Influence includes areas within the CCNR with mature secondary forests and also areas adjacent to the CCNR dominated by regenerative young forests. In studies undertaken to date, wildlife was identified in both reserve and non-reserve areas due to the habitat connectivity between the reserve areas and areas adjacent to it. This connectivity enables wildlife to move freely across both habitats, to the extent that forest dwelling specialists were not only found in reserves, but also in non-reserves.

Based on data obtained from the survey, 20 mammals, 112 birds, 17 reptiles, 13 amphibians were found in the study area. The number of animals encountered is expected to rise with continuing survey effort in the Project area. A total number of 42 species identified can be categorised as Nationally Threatened *(Rajathurai, 2014)*. Of these 42 species, 3 species are Globally Threatened based on the International Union for Conservation of Nature (IUCN) Red List Database *(IUCN, 2012)*. These species include the Sunda Pangolin *(Manis javanica)* (CR), Masked Finfoot *(Heliopais personata)* (EN) and Straw-headed Bulbul *(Pycnonotus zeylanicus)* (VU). Besides that, six other threatened species which are forest dwelling specialists were also recorded in the study area. Four of them are listed as Near Threatened, including the Grey-Headed Fish Eagle *(Ichthyophaga ichthyaetus)*, Chestnut-bellied Malkoha *(Phaenicophaeus sumatranus)*, Red-crowned Barbet (*Megalaima rafflesii)*, and Short-tailed Babbler *(Malacocincla malaccensis)*. The remaining two species are listed as Vulnerable, including the Sambar Deer *(Rasa unicolor*) and the Malayan Flatshell Terrapin *(Notochelys platynota)*.

Apart from vertebrates, 28 dragonfly/damselflies species, 150 species of butterflies, 81 species of grasshoppers and crickets, 67 species of bees and wasps and a variety of species of spiders were also encountered during the survey.

It should be noted that many species recorded are also listed as threatened (CR, EN or VU) in the Singapore Red Data Book. These species are not presented here although this information is provided in the species list appended in *Annex A,* which presents the species observed during the 2007 and 2014 surveys. *Annex A* will be updated in the EIA report.

4.8 SURFACE WATER

4.8.1 Surface Water Bodies

The main surface water bodies (excluding surface water canals) within and in close proximity to the boundary of the Project are:

- Upper Seletar Reservoir and its watershed including the inlet stream to the north-west of the reservoir;
- A stream reportedly running through the Zoo that discharges into the Upper Seletar Reservoir; and
- A stream that runs parallel to the Project western boundary.

Under the stormwater management strategy implemented by the PUB, Singapore is divided into three watersheds. The waterways within these watersheds flow into either a reservoir or the sea. The surface water bodies listed above are part of the Eastern Watershed *(PUB, 2014)*.

Upper Seletar Reservoir was built in 1920 as the third impounding reservoir in Singapore. The primary use of the reservoir water is as a supply to the PUB for treatment and distribution as potable water. The reservoir is part of the Central Catchment Nature Reserve. It is also used for spot fishing and is home to numerous aquatic flora and fauna species.

The stream that runs parallel to the Project western boundary is partly natural and partly concreted. As observed during the site walkover conducted on 18 November 2014, the stream begins from a special use area and ends near the junction of the unnamed road and Mandai Lake Road. The stream is located within the Sungei Mandai Water Catchment Area that ultimately discharges to the Straits of Johor located north of Singapore.

4.8.2 Surface Water Quality

Similar to all other reservoirs, Upper Seletar Reservoir is under the management of PUB and water quality is regularly monitored to ensure compliance with the water quality standard at the treatment plant *(PUB, 2011)*. However water quality monitoring data from the reservoir is not publically available and will be requested for the purposes of the EIA.

The Pollution Control Department (PCD) of the NEA conducts quarterly monitoring of inland water bodies for Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS). One of the sampling points is at Sungei Mandai as shown in *Figure 4.3*. Available combined water quality data from recent monitoring of the inland waters of Singapore (see *Table 7.4*) indicates that the overall quality has been within acceptable levels for the monitored parameters from 2012 to 2013.

Figure 4.3 Surface Water Sampling Location at Sungei Mandai

Source: OpenStreetMap, 2014

Table 4.3 Inland Water Quality Data for 2012 and 2013

Parameter Monitored	Year	Water Catchment Streams (Percentage of Time)	Non-water Catchment Streams River/Streams (Percentage of Time)
DO (>2mg/l)	2012	100	100
	2013	100	100
BOD (<10mg/l)	2012	97	95
	2013	99	100
TSS (<200mg/l)	2012	100	100
	2013	99	100

Source: EPD, 2011

4.8.3 Aquatic Flora

A detailed survey for aquatic flora has not yet been completed. Observations during other surveys identified that habitat areas were surrounded by mature secondary forests, where water flows over clay and sand substratum; submerged bank vegetation and leaf litter also existed in survey areas. In addition the reservoir itself contains significant amounts of aquatic vegetation which needs further investigation.

4.8.4 Aquatic Fauna

A rich diversity of fish species was encountered during the study. The fish species recorded in the Upper Seletar Reservoir inlet stream include Einthoven's Rasbora, Threadfin Acara, and Lesser Bumblebee Goby. Fish species that were found in the unnamed stream along the Project western

boundary include the Pearl Danio, Common Walking Catfish and the Coaking Guoramy. The species that were found in both areas are recorded to be common and abundant.

4.9 CULTURAL HERITAGE

Limited information on cultural heritage in the area was available from published sources. It is understood that this will be supplemented by a separate study on the cultural heritage at the Project sites to be commissioned by the Client in 2015.

A road known as Stephen Lee Road, named after a Catholic priest, was located in the site to the north of Mandai Lake Road. This is believed to have been the site of a village and a church from the early 20th century to around 1986 *(Church of Saint Anthony Singapore, 2015)*.

4.9.1 Heritage Site

Yishun – Sembawang is one of the heritage trails developed by NHB under the "Community Heritage Trails" program that encourages appreciation of local heritage. Upper Seletar Reservoir is a part of the Yishun - Sembawang heritage trail due to its important historical contribution for the development of Yishun – Sembawang.

The reservoir was developed by damming Seletar River, which used to be an important waterway in northern Singapore. Singapore's first migrants arrived via the river. It was also used for shipping of goods to the town and east coast. In addition, the river also supported the gambier and pepper plantations at its surroundings.

4.9.2 Heritage Road and Heritage Tree

NParks initiated the designation of Heritage Roads and Heritage Trees in 2001 to conserve mature trees that are of botanical, historical or cultural value. A 1 km segment of Mandai Road extending from Upper Seletar Reservoir to the junction with Mandai Avenue is one of the five heritage roads designated by NParks. The Project concept design does not include any modifications to Mandai Road.

There are currently 224 trees registered under the Heritage Tree scheme, of which two are within the Project sites. Both are *Ceiba Pentandra* (Kapok trees) and are located inside the Zoo.

5 SCOPING

5.1 OVERVIEW

Scoping has been undertaken to identify potential interactions between Project features or activities and resources/receptors in the Area of Influence and the impacts that could result from these interactions.

Scoping is intended to ensure that the IA focuses on those issues that are most important for design, decision-making and stakeholder interest.

5.2 METHODOLOGY

A half-day scoping workshop was held with members of the core Project team representing the Client, WRS, National University of Singapore (the Client's strategic technical partner) as well as CPG (the master planning consultants appointed by the Client for the initial phase of the study).

A list of attendees is presented in *Table 5.1*.

Table 5.1 Scoping Workshop Attendees

Name	Organisation	Designation
Marc Cremades	Mandai Park Holdings	Project Advisor
Sheena Tan	Mandai Park Holdings	Project Consultant
Khaw Chun Lin	Mandai Park Holdings	Project Consultant
Ian Pang	Mandai Park Holdings	Project Consultant
Joy Su	Mandai Park Holdings	Project Consultant
Chester Chua	Mandai Park Holdings	Project Consultant
Ong Wei Bin	Mandai Park Holdings	Intern
Prof. Leo Tan	NUS	Professor
Prof. Peter Ng	NUS	Professor
Dr. Sonja Luz	WRS	Director of Conservation
Karthik Karkal	CPG	Deputy Director
Khew Sin Khoon	CPG	Chief Executive Office
Pier Touzel	ERM	Partner & Scoping workshop facilitator
Aditi Joshi	ERM	Senior Consultant
Duncan Lang	ERM	Senior Consultant
Eva Yew	ERM	Consultant

During scoping, potential environmental impacts were identified through a systematic process whereby Project activities (both planned and unplanned), were considered with respect to their potential to impact an environmental resource or receptor.

The resources/ receptors considered in the Scoping study are presented in *Table 5.2*.

Table 5.2 Resources/ Receptors and Potential Impacts Considered in Scoping

Resources/ Receptors	Potential Impacts
Physical	
Ambient air quality	• Emissions of NOx, SOx, PM, CO, VOC, ozone, TSP
Global climate	• Emissions of greenhouse gases (CO_2, CH_4, and N_2O)
Noise and vibration	Change in noise or vibration levels
Groundwater quality & Hydrogeology	• Contamination of groundwater resources, change in ground water resources • River/waterbed morphology, physical and chemical properties, benthic organisms.
Surface water	• Changes to physical, chemical or biological quality of rivers, lakes, seas and other surface water bodies; • Introduction of exotic species, changes in habitat quality, abundance, diversity; • Effluent discharge.
Soil Quality and structure	• Changes to physical and chemical properties and soil ecology; • Changes to geology.
Topography, Landscape & Visual Character	• Physical presence of facilities, increased lighting
Biological	
Terrestrial Habitats Terrestrial Flora & Fauna Aquatic Habitats (Freshwater) Aquatic Flora & Fauna (Freshwater)	• Changes to vegetation population, health, species abundance and diversity and impact on endangered species; food chain effects; • Introduction of invasive species; • Changes to wildlife assemblages, impact on endangered and economic species, food chain effects.
Protected Areas	• As above, and other disturbances specifically to the Nature Reserve
Human	
Public Health & Safety	• Creation of conditions hazardous to physical safety or health of the community and visitors to the zoo
Military	• Nuisance or health and safety impacts to members of the military stationed at Mandai Camp II
Road Traffic & Transportation	• Increased hazards to road users
Public utilities	• Improvement or pressure on existing urban/rural infrastructure or services including: public transportation; power, water, sanitation, waste handling facilities etc
Existing operations	• Disruption or disturbance to visitor experience and Zoo animals

A Scoping Matrix was used to enable the identification of interactions in a consistent and robust manner. The scoping matrix is attached in *Annex B*.

Potential interactions and impacts were identified using the following system:

- *No Interaction* – the activity will not interact with/ will have no impact on the environmental resource/receptor. A lack of interaction is indicated by white cells in the Matrix;

- *Negative Interaction* – the activity will interact with the environment resource/ receptor but this is not thought likely to be significant. This is indicated by a grey cell;

- *Potentially Significant Negative Interaction* – the activity will interact with the environmental resource/ receptor in a way that could be significant due to a larger impact magnitude. This is indicated in the Matrix by a black cell; and

- *Positive Interaction* – the activity will interact positively with the environmental resource/ receptor. This is shown in the Matrix using a green cell.

The list of activities in *Annex B* is not exhaustive, but rather is an identification of key activities at different phases of the Project that have the potential to interact with the environment and/or cause environmental impacts. It is noted that the Project is at the concept stage; therefore high-level activities are considered at this stage, which are subject to refinement and change as the Project progresses.

Those cells that are coloured white are 'scoped out' of further consideration in the IA Process. Those interactions that are grey are also 'scoped out', but the IA report will include a discussion that presents the evidence base (eg past experience, documented data, etc) used to justify the basis upon which this decision was made. Those interactions that are shaded black are retained for further consideration in the IA Process. As the Project is at the concept design stage, the identification of activities has been carried out at a high-level and the interactions identified will need to be verified and updated as the design progresses.

5.3 SUMMARY OF KEY ENVIRONMENTAL ISSUES

Table 5.3 presents a summary of the potentially significant interactions identified during the scoping workshop, which will be the focus of the impact assessment.

Table 5.3 Interactions Identified That Are Likely To Result In Significant Impacts

Resource/Receptor	Justification for Expectation of Potentially Significant Impacts
Ambient air quality	Earth moving activities such as excavation will generate atmospheric emissions of particulates, as will the operation of equipment within the Project sites during the pre-construction and construction phases (both PM_{10} and $PM_{2.5}$). Elevated levels of airborne particulates can have impacts on human health and the environment.
Noise and vibration	The operation of construction equipment during pre-construction and construction will generate noise and vibration, which will increase ambient levels.

Resource/Receptor	Justification for Expectation of Potentially Significant Impacts
Surface water	Surface water bodies within and in close proximity to the Project sites may be affected by run-off from construction work areas as well as from any leaks or run-off containing pesticides and/or other chemicals used by the Project. The Upper Seletar Reservoir is especially sensitive given its use as a drinking water reservoir. There is therefore a need for further evaluation in the EIA.
Soil and groundwater	Changes to the quality of soil and groundwater within the Project sites may arise as a result of the storage and handling of chemicals/ pesticides. Soil quality parameters related to replanting will also need to be considered in the EIA.
Terrestrial habitats	Habitat within the Project will be cleared to accommodate the Project Footprint. Portions of this habitat provide high biodiversity value for fauna and flora species and provide a valuable buffer to the CCNR.
Terrestrial flora	A significant number of threatened species were recorded within the Project area, and consequently impacts to flora are likely to be significant.
Terrestrial fauna	Habitat within the Project area has already been identified as important for fauna species (including threatened and protected species) and loss of this habitat, coupled with fragmentation, disturbance and displacement caused by construction and operational activities will have significant impacts to fauna species.
Aquatic habitats	Aquatic habitats may be affected directly by construction or operational activities or indirectly as a result of increased sediment loads reducing water quality. This may affect aquatic habitats within and adjacent to the Project area including the stream along the Project western boundary as well as in the Upper Seletar Reservoir.
Aquatic fauna	Any impacts to aquatic habitats will likely cause some level of impacts to aquatic fauna. It is unclear whether such impacts will be significant, however further investigation is needed.
Protected Area	While direct works within the CCNR will be extremely limited (potentially for the boardwalk), there will be project activities in the buffer zone and there is the potential for significant indirect impacts to occur from the construction and operational phases of the Project.
Human receptors (ie public health and safety, military, public utilities, existing WRS operations)	Construction activities and an increase in traffic during both the construction and operation phases of the Project will need to be studied in the context of public health and safety given the large number of visitors to the Zoo. The military personnel and WRS operations will also be affected by changes associated with the Project. Public utilities such as sewer lines may need to be diverted. The new sewer line to be built by the PUB will need to be assessed in the EIA as it is an 'associated facility' that would not be constructed independently of the Project.

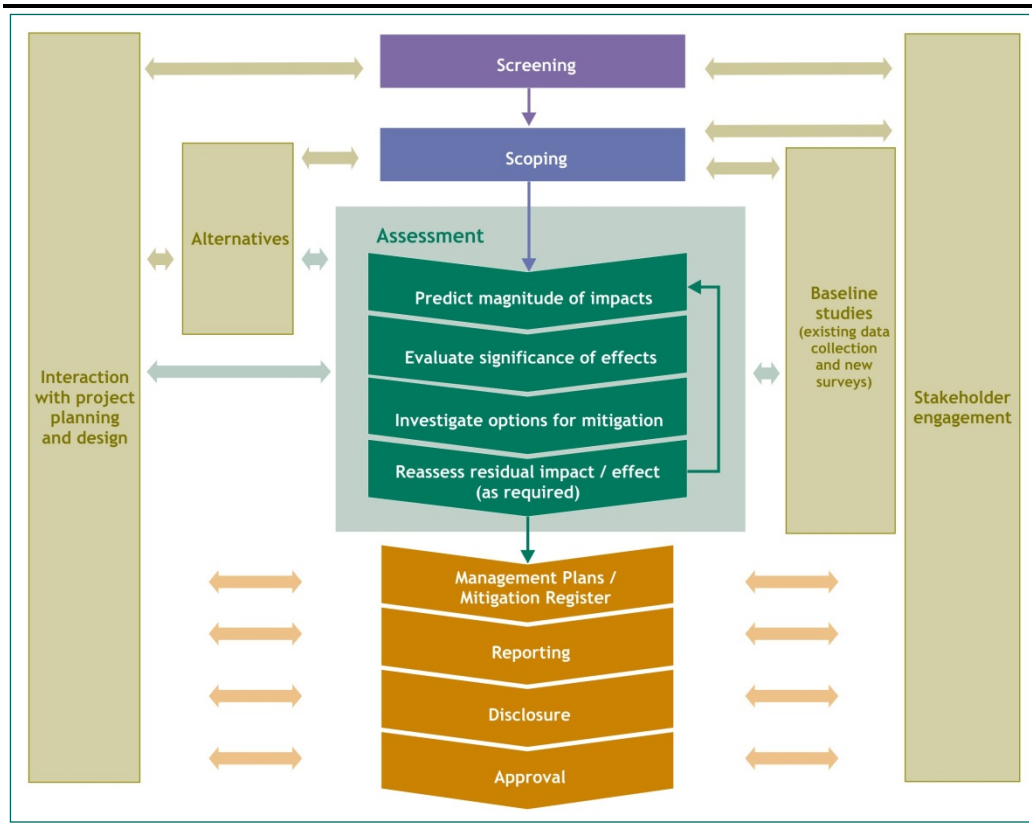
6.1 EIA APPROACH

An EIA will be carried out for the interactions that were identified to be "Significant" in the scoping matrix. Interactions that were identified as "Insignificant" do not require further assessment in the IA stage.

The EIA will be undertaken following a systematic process that predicts and evaluates the impacts from the Project activities on aspects listed in *Table 5.3*. Scoping results will be reviewed and confirmed in the event of any changes in the Project design/activities or new information about Project baseline conditions.

The impact assessment process is shown in *Figure 6.1*. The elements of the EIA are described in the sections that follow.

Figure 6.1 Impact Assessment Process



6.1.1 Screening and Scoping

At the initial stage of the EIA, preliminary information was provided by the Client to allow for an understanding of the Project concept design and to aid in the determination of what legal and other requirements apply to the Project. A list of Project activities was developed based on this information.

Scoping was undertaken to identify the potential Area of Influence for the Project and thus the appropriate Study Area for the EIA. This stage also included identifying the potential interactions between the Project activities and the receptors and/or resources in the environment.

6.1.2 Baseline Conditions

To provide a context within which the impacts of the Project can be assessed, a description of physical and biological conditions that would be expected to prevail in the absence of the Project is presented. The baseline includes information on all resources/receptors identified during scoping as having the potential to be significantly affected by the Project. The understanding of the baseline environment based on a review of secondary data is presented in *Section 4* of this report; data gaps and recommendations further baseline survey work are presented in *Section 6.2*.

6.1.3 Stakeholder Engagement

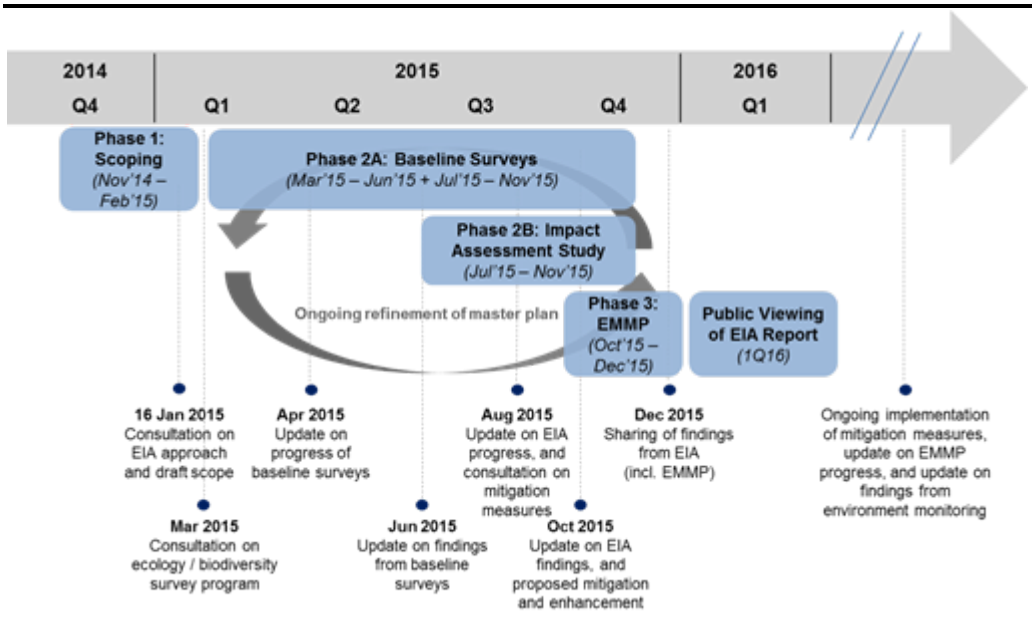
An effective EIA Process requires engagement with relevant stakeholders throughout the key stages. This assists in understanding stakeholder views on the Project and in identifying issues that will be taken into account in the prediction and evaluation of impacts.

Temasek has engaged with nature groups twice to date on the planned project. Organisations consulted with include:

- Animal Concerns Research and Education Society (ACRES);
- Bird Ecology Study Group;
- Cicada Eco Tree Place;
- Wallace Environmental Education Centre;
- Nature Society (Singapore);
- Singapore Environment Council;
- Singapore University of Technology and Design; and
- WildSingapore.

The current plan for future engagement with the nature groups is presented in *Figure 6.2*.

Figure 6.2 Planned Engagement Sessions



Source: Temasek, 2015

6.1.4 *Impact Assessment*

Impact identification and assessment starts with scoping and continues through the remainder of the EIA Process. The principal EIA steps comprise:

- **Impact prediction:** to determine what could potentially happen to resources/receptors as a consequence of the Project and its associated activities.
- **Impact evaluation:** to evaluate the significance of the predicted impacts by considering their magnitude and likelihood of occurrence, and the sensitivity, value and/or importance of the affected resource/receptor.
- **Mitigation and enhancement:** to identify appropriate and justified measures to mitigate negative impacts and enhance positive impacts.
- **Residual impact evaluation:** to evaluate the significance of impacts assuming effective implementation of mitigation and enhancement measures.

6.1.4.1 *Prediction of Impacts*

Prediction of impacts is essentially an objective exercise to determine what is likely to happen to the environment as a consequence of the Project and its associated activities. From the potentially significant interactions identified in Scoping, the impacts to the various resources/receptors are elaborated and evaluated. The diverse range of potential impacts considered in the EIA process typically results in a range of prediction methods being used, including quantitative, semi-quantitative and qualitative techniques.

6.1.4.2 Evaluation of Impacts

Each impact is described in terms of its various relevant characteristics (eg type, scale, duration, frequency, extent). An additional characteristic, *likelihood,* is to be defined for unplanned events. Once an impact's characteristics are defined, the next step in the impact assessment phase is to assign each impact a 'magnitude'. Magnitude is typically a function of some combination (depending on the resource/receptor in question) of the following impact characteristics:

- Extent
- Duration
- Scale
- Frequency

In the case of a *positive* impact, no magnitude designation (aside from 'positive') is assigned. It is considered sufficient for the purpose of the IA to indicate that the Project is expected to result in a *positive* impact, without characterising the exact degree of positive change likely to occur.

In the case of impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is utilised, but the 'likelihood' factor is considered, together with the other impact characteristics, when assigning a magnitude designation.

In addition to characterising the magnitude of impact, the other principal impact evaluation step is definition of the sensitivity/vulnerability/importance of the impacted resource/receptor. There are a range of factors to be taken into account when defining the sensitivity/vulnerability/importance of the resource/receptor, which may be physical, biological, cultural or human. Other factors may also be considered when characterising sensitivity/vulnerability/importance, such as legal protection, government policy, stakeholder views and economic value. As in the case of magnitude, the sensitivity/vulnerability/importance designations themselves are universally consistent, but the definitions for these designations vary on a resource/receptor basis. The sensitivity/vulnerability/importance designations used herein for all resources/receptors are:

- Low
- Medium
- High

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterised, the significance can be assigned for each impact. Impact significance is designated using the matrix shown in *Figure 6.3*.

Figure 6.3 Impact Significance Matrix

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	Medium	High
Magnitude of Impact	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

Impact prediction and evaluation take into account any embedded controls (ie physical or procedural controls that are already planned as part of the Project design, regardless of the results of the IA Process). An example of an embedded control is a standard acoustic enclosure that is designed to be installed around a piece of equipment.

In line with good EIA practice and concerns raised by government agencies and other stakeholders, the EIA will evaluate the potential for cumulative impacts from known developments within 2 km from the Project boundary. At the time of writing of this Scoping Report, known developments that may impact the CCNR and/ or are located within 2 km of the Project that may give rise to cumulative impacts include:

- The Cross Island Line;
- The Mandai depot, a train maintenance depot for the Thomson Line;
- The Thomson Mass Rapid Transit Line;
- The Singapore Power Cable Tunnel Project;
- Proposed sewers in Mandai Road area;
- Improvement to Roadside Drains at Woodlands Road and Mandai Road;
- Rehabilitation of Sewerage Network Phase 4 – Northern Catchment Contract 3;
- Rehabilitation of Sewerage Network Phase 4 – Central Water Catchment Contract 1; and
- Demolition of Pumping Installations at Upper Thomson Road.

This list will be reviewed for completeness and updated as necessary prior to the evaluation of potential cumulative impacts.

6.1.5 Identification of Mitigation and Enhancement Measures

Once the significance of an impact has been characterised, the next step is to evaluate what mitigation and enhancement measures are warranted. ERM will adopt the following Mitigation Hierarchy:

- **Avoid at Source, Reduce at Source:** avoiding or reducing at source through the design of the Project (e.g., avoiding by siting or re-routing activity away from sensitive areas or reducing by restricting the working area or changing the time of the activity).
- **Abate on Site:** add something to the design to abate the impact (e.g., pollution control equipment, traffic controls, perimeter screening and landscaping).
- **Abate at Receptor:** if an impact cannot be abated on-site then control measures can be implemented off-site (e.g., noise barriers to reduce noise impact).
- **Repair or Remedy:** some impacts involve unavoidable damage to a resource and these impacts will be addressed through repair, restoration or reinstatement measures.
- **Compensate in Kind, Compensate Through Other Means:** where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate (e.g., planting to replace damaged vegetation).

The priority in mitigation is to first apply mitigation measures to the source of the impact (ie to avoid or reduce the magnitude of the impact from the associated Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (ie to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

6.1.6 Residual Impact Assessment

Once mitigation and enhancement measures are declared, the next step in the IA Process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the implementation of the proposed mitigation and enhancement measures.

6.1.7 Environmental Management and Monitoring Plan

The final stage in the EIA Process is definition of the basic management and monitoring measures that are needed to identify whether: a) impacts or their associated Project components remain in conformance with applicable standards; and b) mitigation measures are effectively addressing impacts and

compensatory measures and offsets are reducing effects to the extent predicted. The Environmental Management and Monitoring Plan (EMMP) will consolidate the mitigation measures; enhancement measures; and management and monitoring activities, and will define the responsibilities and timelines for execution. The EMMP will include a change management process to be followed in the event that changes in the Project design necessitate amendments to the mitigation or monitoring measures.

6.2 *PROPOSED BASELINE STUDIES & IMPACT ASSESSMENT*

A review of the available baseline data (both from the Client and publicly available sources) and the likely interactions between Project activities and resource/ receptors indicated that there are baseline data gaps that need to be addressed in order to assess the impacts associated with the Project.

Proposed baseline studies to address these data gaps, and the methodology proposed to assess impacts, are presented in the following section.

6.2.1 *Biodiversity Studies*

6.2.1.1 *Baseline Data Gaps*

Additional studies are required for both the aquatic and terrestrial environment. Species groups covered for the terrestrial environment will include mammals, birds, herpetofauna, invertebrates and flora and in the aquatic environment fish, aquatic invertebrates and aquatic flora will be covered. Potential invasive species will also be identified. Previous studies did not cover bats in detail, nor were aquatic invertebrates or aquatic habitats surveyed. Further, the surveys were only carried out over one season in easily accessible locations.

6.2.1.2 *Area of Influence*

The Area of Influence of the Project in the context of biological receptors will include:

- Project area and existing Zoo;
- CCNR;
- Upper Seletar Reservoir;
- Habitat north of the Mandai Road and West of the unnamed road; and
- Stream parallel to the unnamed road.

The extent of the CCNR to be included in baseline surveys and impact evaluation will be further refined in discussion with specialists in each of the ecological subject areas.

6.2.1.3 *Baseline Surveys*

Additional surveys will seek to cover at least two seasons, covering the wet and dry season. Some species groups, such as birds, may require survey across a number of months to ensure migrants, breeding individuals, non-breeders, post breeding individuals and others are recorded and surveys will also be planned to ensure coverage across the entire Project area. Roadside trees will be included in the EIA and a specific floral survey as well as an arboriculture survey will be carried out to assess the importance of the roadside trees present.

Note: The proposed survey methods will be shared with government agencies for review and comment prior to commencement of field surveys.

6.2.1.4 *Impact Prediction and Evaluation*

In the evaluation of impact magnitude, several factors including the extent of removal of vegetation, types and amount of effluent, emissions and waste generated by the Project will be considered. The sensitivity of terrestrial and aquatic receptors will reflect their locations relative to Project sites and ecological significance. The EIA will address micro-climate and edge effects arising from clearance of land near the boundaries of the CCNR. The distribution of invasive species will also be considered.

Considering the importance of the ecological aspects in the EIA, this process will include interaction with the Client and the masterplanners to identify enhancement opportunities and to avoid impacts wherever possible.

The controls embedded in the Project design will be considered at the final stage of the impact prediction and evaluation exercise. Any additional mitigation measures needed to bring the impacts to an acceptable level will be recommended at this stage.

6.2.2 *Ambient Air Quality*

6.2.2.1 *Baseline Data Gaps*

As described in *Section 4.4.1*, ambient air quality averaged across Singapore is published on an annual basis. There is however no publicly available data on ambient air quality at the Project sites.

An understanding of ambient air quality, specifically in terms of the concentrations of the species of interest (PM_{10} and $PM_{2.5}$) can be established through long-term measurement. The nearest permanent monitoring stations established by the NEA are located at Choa Chu Kang, Yishun, Bishan, Clementi and Kranji. Long-term monitoring data from recent years from each of the permanent monitoring stations is not publicly available; this

will therefore be requested from the NEA as part of the EIA to understand the ambient air quality in the vicinity of Project site.

6.2.2.2 Area of Influence

Airborne particulate matter emitted from the Project during construction is likely to have a relatively localised impact. Dust particles between 30 to 100 μm in diameter generally settle within a hundred metres of the source (*USEPA, 1995*), while trackout from vehicles may occur up to 500 m from the Project site without mitigation *(Greater London Authority, 2014)*. The area of influence will therefore be set at 500 m from the Project site boundary; however the nearest residential and other sensitive receptors will also be evaluated in the EIA.

6.2.2.3 Baseline Surveys

The long-term monitoring data from the NEA will be supplemented by short-term monitoring data within the Project site. Typically, a comprehensive ambient air quality exercise should cover a period of at least six months and cover seasonality. In view of the schedule for the study and the small number of sources of atmospheric emissions from the Project, the long-term NEA data may instead be supplemented by short-term measurements that will provide a 'snapshot' of air quality at the Project site. Measurements will be taken at up to 6 locations within the Project area of influence. Measurements of PM_{10} and $PM_{2.5}$ may be taken for one week at each location and will be taken once each during the Northeast and Southwest monsoons to capture seasonal differences arising from changes in wind direction.

6.2.2.4 Impact Prediction and Evaluation

The main source of impact to ambient air quality from the Project will arise from atmospheric emissions of particulate matter from earth moving activities and equipment during the pre-construction and construction phases. Such emissions are likely to be localised are short-term in nature. Dust emissions from construction activities are typically evaluated qualitatively. If sufficient detail is available from the Project design, the assessment may be supplemented by a simple area source model to predict ground level concentrations of particulates emitted from construction sources.

In addition, there may be an impact to ambient air quality from additional traffic on Mandai Lake Road. As the transportation aspects of the Project are yet to be determined, no specific recommendations on assessing ambient air quality impacts from traffic in the operational phase are presented in this report. The EIA will however screen and if necessary evaluate the air quality impacts from the transportation scheme identified through the separate Transport Master Plan and Traffic Impact Assessment for the Project that will be commissioned by the client in 2015.

6.2.3 Noise

6.2.3.1 Baseline Data Gaps

The sources of noise within the baseline environment are described in *Section 4.5.1*. No publicly available data on ambient noise levels in the environment is available.

6.2.3.2 Area of Influence

The noise from the operation of construction equipment is likely to be localised in extent. The area of influence is therefore likely to extend approximately 500 m from the Project site boundary; however the impacts to the nearest residential and other sensitive receptors will also be evaluated in the EIA.

6.2.3.3 Baseline Surveys

Primary baseline surveys will be carried out to measure the ambient noise levels and to understand the contributions of the various noise sources already present in the environment. The parameters measured will include $L_{eq\text{-}1,hour}$, $L_{eq\text{-}5\ mins}$ and $L_{eq\text{-}12hour}$ to allow for a comparison against the Singapore *Environmental Protection and Management (Control of Noise At Construction Sites) Regulations 2011*, which allows for an adjustment of the standards. The measurement of other parameters including L_{max}, L_{90} and L_{10} will enhance the understanding of the baseline environment and the contributions of various sources will also be measured.

6.2.3.4 Impact Prediction and Evaluation

Based on the current Project concept design, noise is expected to be a concern mainly during the pre-construction and construction phases of the Project. Noise levels from construction equipment will be predicted using internationally recognised software such as SoundPLAN or similar. This will allow for plotting of contours that present the predicted extent of noise levels from a noise source or set of sources. The predicted levels can be compared against the criteria for the study, which will be based on Singapore requirements and international standards such as the WHO Guidelines for Community Noise. A literature review will be carried out to understand the potential sensitivity to noise of species identified within the Project area of influence, and incorporated into the noise assessment criteria as necessary.

6.2.4 Surface Water

Impacts to surface water receptors may occur from pre-construction and construction activities of the Project that generate liquid effluents, or where surface run-off from the site may enter nearby surface water bodies. During the operations, eutrophication could occur should surface run-off containing fertilizers flow into adjacent surface waterbodies.

6.2.4.1 Baseline Data Gaps

While not publicly available, it is expected that the PUB will have historical monitoring data for the Upper Seletar Reservoir. Such data is unlikely to be available for other surface water bodies in the Project area of influence, namely the stream parallel to the Project western boundary and the inlet to the Upper Seletar Reservoir that is located within the CCNR to the north-west of the reservoir.

6.2.4.2 Area of Influence

Based on the review of secondary data as well as government agency requirements, the Area of Influence of the Project comprises:

- Upper Seletar Reservoir and its watershed including the inlet stream to the north-west of the Upper Seletar Reservoir;
- Sungei Mandai Water Catchment Area including the stream parallel to the Project western boundary and associated catchment area; and
- The existing perimeter surface water drainage at the Zoo.

6.2.4.3 Baseline Surveys

The baseline surveys to characterise the surface water quality will include:

- Stream mapping and watershed delineation; and
- Surface water sampling, for the Upper Seletar Reservoir; the stream along the Project western boundary; and the perimeter surface water drainage.

The parameters may be analysed through a combination of in-situ and ex-situ methods. The parameters sampled will include:

- TSS, DO, oil and grease, Total Dissolved Solids (TDS), turbidity: Associated with pollutants that might be introduced by the Project pre-construction and construction activities;

- pH, temperature: Important parameters that help understand the baseline environment;

- COD, BOD_5, E.coli: Associated with the discharge of sanitary waste; and

- For Upper Seletar Reservoir, where eutrophication may be a concern, nutrients (specifically, total phosphorus and total nitrogen) and chlorophyll-a.

6.2.4.4 Impact Prediction and Evaluation

The assessment will consider direct impacts to the water quality of identified surface waterbodies as well as secondary impacts to aquatic habitats and species. The receptors associated with the identified surface waterbodies will

be determined through primary data gathering and secondary information review.

The assessment will involve qualitative judgements of predicted impacts and quantitative comparison of baseline results against relevant legislation for evaluation of the receptor sensitivities.

6.2.5 Soil and Groundwater

The soil and groundwater quality in the Project area may be affected by the storage and handling of chemicals during construction and operation. There is also a need to investigate the existing conditions in view of potentially contaminated land, specifically the orchid farm at the site to the south of Mandai Lake Road and the Wastewater Treatment Plant within the WRS back-of-house area.

6.2.5.1 Baseline Data Gaps

No publicly available information on soil and groundwater quality is available for the Project area. Groundwater levels may be inferred to be shallow given the proximity of the Upper Seletar Reservoir; however this can only be confirmed through site investigation.

Topographical surveys for the sites to the north and south of Mandai Lake Road were carried out in 2007 and 2009 respectively. The survey for the land to the south covered an area of 19.08 ha, which is slightly less than the total area of approximately 21 ha.

6.2.5.2 Area of Influence

The area of influence for soil and groundwater impacts is:

- The two Project sites;
- The back-of-house areas within Singapore Zoo; and
- Any locations in hydraulic connectivity with groundwater within the Project area.

6.2.5.3 Baseline Surveys

Given the sensitive nature of the environment within the Project's Area of Influence, it is proposed to use minimally intrusive survey methods. This may be done through the use of hand augers to collect soil samples, or through use of soil screening methods that require limited equipment and personnel.

These topographical studies will be updated as part of the EIA, and be extended to cover the land within the back-of-house areas within the WRS land.

6.2.5.4 Impact Prediction and Evaluation

Impacts to soil and groundwater quality may arise from chemical and waste storage and handling during the pre-construction, construction and operation phases of the Project. These impacts will be evaluated qualitatively in the EIA. Based on comments from government agencies, aspects such as the use of hardstand and/or grass at various parts within the Project sites will need to be considered in the Project design in the context of evaluating the potential for any substances released from Project sources entering the soil or groundwater in the area of influence.

6.2.6 Light

Lighting of facilities during the construction and operation phases could potentially impact the species within the CCNR as well as animals housed in the Singapore Zoo.

6.2.6.1 Baseline surveys

As part of this process a review of all proposed lighting types will be undertaken for construction and operation to determine the characteristics of the light emissions from each light type. The type and number of proposed light sources will be reviewed to determine the expected illumination, intensity and spectral range of each type of lighting proposed.

6.2.6.2 Impact Prediction and Evaluation

As part of the impact prediction, the EIA will review all lighting types and number of proposed sources for the construction and operation. Light modelling may be undertaken to inform the understanding of light distribution, which will filter in to the assessment of impacts to species. This information can be used to inform the Project design so as to avoid light impacts as far as possible.

6.2.7 Waste

6.2.7.1 Baseline surveys

While no primary data gathering for this aspect is envisaged in the scope of the EIA, a review of secondary data on the waste management capacity in Singapore will be undertaken.

6.2.7.2 Impact Prediction and Evaluation

The impacts of waste generated by the Project will be assessed in terms of the receptors, ie the waste management system as well as the surrounding environment, in particular soil and groundwater and surface water, which

may be affected if waste is not properly managed. Depending on the data available, the various sources of waste as well as their nature and quantity will need to be identified.

7 CONCLUSION

This EIA Scoping study was conducted to highlight environmental considerations for the construction and operation of the proposed nature-themed development at Mandai. These considerations will feed into the design of the Project and the future EIA. This process involved identifying potentially significant environmental impacts associated with the Project.

The Scoping study has identified the baseline data gaps, survey methods and area of influence for ecology (both terrestrial and aquatic species and habitats), surface water quality, soil and groundwater quality, ambient air quality and ambient noise. Recommendations for further study on additional aspects such as waste and light were also provided.

The findings of this study, including the methodology of the baseline studies, will be updated as the Project design progresses and in consultation with government agencies and nature groups.

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Annex A

Species List

Item	Family	Genus species	Full name and authorship / English Name	Source	Presence#
1	Aristolochiaceae	*Aristolochia tagala*	Indian Birthwort	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/20198851*	
2	Fabaceae	*Crotalaria retusa*	Rattleweed	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/11470687*	
3	Fabaceae	*Parkia speciosa*	Petai	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/11484544*	
4	Fabaceae	*Pithecellobium dulce*	Madras Thorn	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/11482874*	
5	Fabaceae	*Saraca thaipingensis*	Yellow Saraca	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/11484904*	
6	Loranthaceae	*Dendrophthoe pentandra*	Mistletoe	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/20271825*	
7	Loranthaceae	*Macrosolen cochinchinensis*	Mistletoe	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/20271094*	
8	Loranthaceae	*Macrosolen retusus*	Mistletoe	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/20271110*	
9	Plantaginaceae	*Russelia juncea*	Fountain Plant	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/20308073/synonym/20524752*	
10	Acanthaceae	*Andrographis paniculata*	Andrographis paniculata (Burm. f.) Wall. ex Nees	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20318830*	O
11	Acanthaceae	*Asystasia gangetica ssp. micrantha*	Asystasia gangetica (L.) T. Anderson ssp. micrantha (Nees) Ensermu	*(2014) Mandai Gate Vegetation Survey*	O
12	Acanthaceae	*Justicia gendarussa*	Justicia gendarussa Burm. f.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20320058*	O
13	Acanthaceae	*Thunbergia grandiflora*	Thunbergia grandiflora Roxb.	*(2014) Mandai Gate Vegetation Surveyhttp://www.catalogueoflife.org/col/details/species/id/20317539*	O
14	Acanthaceae	*Asystasia intrusa / Asystasia gangetica*	Common Asystasia	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/20319012*	O
15	Adiantaceae	*Adiantum latifolium*	Adiantum latifolium Lam.	*(2014) Mandai Gate Vegetation Survey*	O
16	Alismataceae	*Limnocharis flava*	Limnocharis flava (L.) Buchenau	*(2014) Mandai Gate Vegetation Survey*	O
17	Amaranthaceae	*Alternanthera sessilis*	Alternanthera sessilis (L.) R. Br. ex DC.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/164480/0*	O
18	Anacardiaceae	*Campnosperma auriculatum*	Campnosperma auriculatum Hook. f.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20254728*	O
19	Anacardiaceae	*Campnosperma squamatum*	Campnosperma squamatum Ridl.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20254739*	O
20	Anacardiaceae	*Gluta wallichii*	Gluta wallichii (Hook. f.) Ding Hou	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20254058*	O
21	Anacardiaceae	*Mangifera indica*	Mangifera indica L.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/31389/0*	O
22	Anisophyllaceae	*Anisophyllea disticha*	Anisophyllea disticha (Jack) Baill.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/32938/0*	O
23	Annonaceae	*Artabotrys suaveolens*	Artabotrys suaveolens (Blume) Blume	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/16320131*	O
24	Annonaceae	*Dasymaschalon dasymaschalum*	Dasymaschalon dasymaschalum (Blume) I.M.Turner	*(2014) Mandai Gate Vegetation Survey*	O
25	Annonaceae	*Drepananthus ridleyi*	Drepananthus ridleyi (King) Survesw. & R.M.K.Saunders	*(2014) Mandai Gate Vegetation Survey*	O
26	Annonaceae	*Fissistigma latifolium var. ovoideum*	Fissistigma latifolium (Dunal) Merr. var. ovoideum (King) Sinclair	*(2014) Mandai Gate Vegetation Survey*	O

Item	Family	Genus species	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Protected by Law
1	Aristolochiaceae	*Aristolochia tagala*	-	-	-	-	
2	Fabaceae	*Crotalaria retusa*	-	-	-	-	
3	Fabaceae	*Parkia speciosa*	-	-	-	-	
4	Fabaceae	*Pithecellobium dulce*	-	-	-	-	
5	Fabaceae	*Saraca thaipingensis*	-	-	-	-	
6	Loranthaceae	*Dendrophthoe pentandra*	-	-	-	-	
7	Loranthaceae	*Macrosolen cochinchinensis*	-	-	-	-	
8	Loranthaceae	*Macrosolen retusus*	Malaysia	-	-	-	
9	Plantaginaceae	*Russelia juncea*	-	-	-	-	
10	Acanthaceae	*Andrographis paniculata*	IM + EA + AS	No	-	-	
11	Acanthaceae	*Asystasia gangetica ssp. micrantha*	-	No	-	-	
12	Acanthaceae	*Justicia gendarussa*	IM + EA	No	-	-	
13	Acanthaceae	*Thunbergia grandiflora*	IM + EA +AS + Carribean + USA + Africa	No	-	-	
14	Acanthaceae	*Asystasia intrusa / Asystasia gangetica*	-	-	-	-	
15	Adiantaceae	*Adiantum latifolium*	-	No	-	-	
16	Alismataceae	*Limnocharis flava*	-	No	-	-	
17	Amaranthaceae	*Alternanthera sessilis*	Asia + Africa + AS + Carribean	-	LC	Least Concern ver 3.1	
18	Anacardiaceae	*Campnosperma auriculatum*	BO + TM	Yes	-	-	
19	Anacardiaceae	*Campnosperma squamatum*	BO + Malaysia	Yes	-	-	
20	Anacardiaceae	*Gluta wallichii*	SD	Yes	-	-	
21	Anacardiaceae	*Mangifera indica*	IM + EA	No	DD	Data Deficient ver 2.3	
22	Anisophyllaceae	*Anisophyllea disticha*	SD	Yes	LC	Lower Risk/least concern ver 2.3	
23	Annonaceae	*Artabotrys suaveolens*	-	Yes	-	-	
24	Annonaceae	*Dasymaschalon dasymaschalum*	-	Yes	-	-	
25	Annonaceae	*Drepananthus ridleyi*	-	Yes	-	-	
26	Annonaceae	*Fissistigma latifolium var. ovoideum*	-	Yes	-	-	

Item	Family	Genus species	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
1	Aristolochiaceae	*Aristolochia tagala*	-	-	-
2	Fabaceae	*Crotalaria retusa*	-	-	-
3	Fabaceae	*Parkia speciosa*	-	-	-
4	Fabaceae	*Pithecellobium dulce*	-	-	-
5	Fabaceae	*Saraca thaipingensis*	-	-	-
6	Loranthaceae	*Dendrophthoe pentandra*	-	-	-
7	Loranthaceae	*Macrosolen cochinchinensis*	-	-	-
8	Loranthaceae	*Macrosolen retusus*	-	-	-
9	Plantaginaceae	*Russelia juncea*	-	-	-
10	Acanthaceae	*Andrographis paniculata*	Naturalized	-	-
11	Acanthaceae	*Asystasia gangetica ssp. micrantha*	Naturalized	-	-
12	Acanthaceae	*Justicia gendarussa*	Cultivated only	-	-
13	Acanthaceae	*Thunbergia grandiflora*	Casual	-	-
14	Acanthaceae	*Asystasia intrusa / Asystasia gangetica*	-	-	-
15	Adiantaceae	*Adiantum latifolium*	Naturalized	-	-
16	Alismataceae	*Limnocharis flava*	Naturalized	-	-
17	Amaranthaceae	*Alternanthera sessilis*	Cryptogenic Weed	-	This is a pioneer or ruderal species typically growing on disturbed parts of a variety of wetland habitats, often in species-rich associations with a range of other aquatic and wetland plants.
18	Anacardiaceae	*Campnosperma auriculatum*	Common	-	-
19	Anacardiaceae	*Campnosperma squamatum*	Common	-	-
20	Anacardiaceae	*Gluta wallichii*	Common	-	-
21	Anacardiaceae	*Mangifera indica*	Casual	-	Terrestrial
22	Anisophyllaceae	*Anisophyllea disticha*	Common	-	A widespread shrub or small tree found in the understorey of mixed dipterocarp forest and old secondary forest on various soil types.
23	Annonaceae	*Artabotrys suaveolens*	Endangered (EN/D) *Davidson et.al (2008) The Singapore Red Data Book*	-	-
24	Annonaceae	*Dasymaschalon dasymaschalum*	Crit. End.	-	-
25	Annonaceae	*Drepananthus ridleyi*	Vulnerable	-	-
26	Annonaceae	*Fissistigma latifolium var. ovoideum*	Vulnerable	-	-

Item	Family	Genus species	Full name and authorship / English Name	Source	Presence#
27	Annonaceae	*Fissistigma manubriatum*	Fissistigma manubriatum (Hook.f. & Thoms.) Merr.	*(2014) Mandai Gate Vegetation Survey*	O
28	Annonaceae	*Friesodielsia glauca*	Friesodielsia glauca (Hook. f. & Thoms.) Steenis	*(2014) Mandai Gate Vegetation Survey*	O
29	Annonaceae	*Friesodielsia latifolia*	Friesodielsia latifolia (Hook. f. & Thoms.) Steenis	*(2014) Mandai Gate Vegetation Survey*	O
30	Annonaceae	*Mitrella kentii*	Mitrella kentii (Blume) Miq.	*(2014) Mandai Gate Vegetation Survey*	O
31	Annonaceae	Phaeanthus ophthalmicus	Phaeanthus ophthalmicus (Roxb. ex G. Don) J. Sinclair	*(2014) Mandai Gate Vegetation Survey*	O
32	Annonaceae	*Uvaria leptopoda*	Uvaria leptopoda (King) R.E. Fries	*(2014) Mandai Gate Vegetation Survey*	O
33	Annonaceae	*Xylopia caudata*	Xylopia caudata Hook. f. & Thoms.	*(2014) Mandai Gate Vegetation Survey*	O
34	Annonaceae	*Xylopia malayana*	Xylopia malayana Hook. f. & Thoms.	*(2014) Mandai Gate Vegetation Survey*	O
35	Apocynaceae	*Allamanda cathartica*	Allamanda cathartica L.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20300846*	O
36	Apocynaceae	*Alstonia angustifolia*	Alstonia angustifolia Wall. ex A. DC.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/33175/0*	O
37	Apocynaceae	Alstonia scholaris	Alstonia scholaris (L.) R. Br.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/32295/0*	O
38	Apocynaceae	*Anodendron candolleanum*	Anodendron candolleanum Wight	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20301604*	O
39	Apocynaceae	*Catharanthus roseus*	Catharanthus roseus (L.) G. Don	*(2014) Mandai Gate Vegetation Survey*	O
40	Apocynaceae	*Dyera costulata*	Dyera costulata (Miq.) Hook. f.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/33212/0*	O
41	Apocynaceae	*Hoya latifolia*	Hoya latifolia G. Don	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20302508*	O
42	Apocynaceae	*Leuconotis griffithii*	Leuconotis griffithii Hook.f.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20300288*	O
43	Apocynaceae	Strophanthus caudatus	Strophanthus caudatus (L.) Kurz	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20301103*	O
44	Apocynaceae	*Tabernaemontana corymbosa*	Tabernaemontana corymbosa Roxb. ex Wall.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/34504/0*	O
45	Apocynaceae	*Tabernaemontana divaricata*	Tabernaemontana divaricata (L.) R. Br. ex Roem. & Schult.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20300633*	O
46	Apocynaceae	*Willughbeia coriacea*	Willughbeia coriacea Wall.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20300293*	O
47	Apocynaceae	*Cerbera odollam*	Pong-Pong Tree	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/20300976*	O
48	Araceae	*Aglaonema commutatum*	Aglaonema commutatum Schott	*(2014) Mandai Gate Vegetation Survey*	O
49	Araceae	*Aglaonema* sp.		*(2014) Mandai Gate Vegetation Survey*	O
50	Araceae	*Alocasia longiloba*	Alocasia longiloba Miq.	*(2014) Mandai Gate Vegetation Survey*	O
51	Araceae	*Alocasia macrorrhizos*	Alocasia macrorrhizos (L.) G. Don	*(2014) Mandai Gate Vegetation Survey*	O
52	Araceae	*Colocasia esculenta*	Colocasia esculenta (L.) Schott	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/169058/0*	O
53	Araceae	*Dieffenbachia seguine*	Dieffenbachia seguine (Jacq.) Schott var. seguine	*(2014) Mandai Gate Vegetation Survey*	O
54	Araceae	*Epipremnum aureum*	Epipremnum aureum (Linden ex André) Bunting	*(2014) Mandai Gate Vegetation Survey*	O
55	Araceae	*Epipremnum pinnatum*	Epipremnum pinnatum (L.) Engl.	*(2014) Mandai Gate Vegetation Survey*	O
56	Araceae	*Philodendron hederaceum*	Philodendron hederaceum (Jacq.) Schott	*(2014) Mandai Gate Vegetation Survey*	O
57	Araceae	*Scindapsus hederaceus*	Scindapsus hederaceus (Zoll. & Moritizi) Miq.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/44392407/0*	O
58	Araceae	*Syngonium podophyllum*	Syngonium podophyllum Schott	*(2014) Mandai Gate Vegetation Survey*	O
59	Araliaceae	*Arthrophyllum diversifolium*	Arthrophyllum diversifolium Blume	*(2014) Mandai Gate Vegetation Survey*	O
60	Araliaceae	*Polyscias diversifolia*	Polyscias diversifolia (Blume) Lowry & G.M.Plunkett	*(2014) Mandai Gate Vegetation Survey*	O
61	Arecaceae	*Caryota mitis*	Fishtail Palm	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
62	Arecaceae	*Cocos nucifera*	Coconut Palm	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
63	Arecaceae	*Cyrtostachys renda*	Cyrtostachys renda Blume	*(2014) Mandai Gate Vegetation Survey*	O

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27	Annonaceae	*Fissistigma manubriatum*	-	Yes	-	-	
28	Annonaceae	*Friesodielsia glauca*	-	Yes	-	-	
29	Annonaceae	*Friesodielsia latifolia*	-	Yes	-	-	
30	Annonaceae	*Mitrella kentii*	-	Yes	-	-	
31	Annonaceae	Phaeanthus ophthalmicus	-	Yes	-	-	
32	Annonaceae	*Uvaria leptopoda*	-	Yes	-	-	
33	Annonaceae	*Xylopia caudata*	-	Yes	-	-	
34	Annonaceae	*Xylopia malayana*	-	Yes	-	-	
35	Apocynaceae	*Allamanda cathartica*	Asia + AS + South America	No	-	-	
36	Apocynaceae	*Alstonia angustifolia*	SD + PH + Vietnam	Yes	LC	Lower Risk/least concern ver 2.3	
37	Apocynaceae	Alstonia scholaris	Asia + Oceania	Yes	LC	Lower Risk/least concern ver 2.3	
38	Apocynaceae	*Anodendron candolleanum*	TM + BO + PH	Yes	-	-	
39	Apocynaceae	*Catharanthus roseus*	-	No	-	-	
40	Apocynaceae	*Dyera costulata*	BO + TM	Yes	LC	Lower Risk/least concern ver 2.3	
41	Apocynaceae	*Hoya latifolia*	BO + TM	Yes	-	-	
42	Apocynaceae	*Leuconotis griffithii*	SD + TM	Yes	-	-	
43	Apocynaceae	Strophanthus caudatus	IM + EA	Yes	-	-	
44	Apocynaceae	*Tabernaemontana corymbosa*	IM + China	Yes	LC	Lower Risk/least concern ver 2.3	
45	Apocynaceae	*Tabernaemontana divaricata*	Asia + US + Carribean	No	-	-	
46	Apocynaceae	*Willughbeia coriacea*	TM + BO	Yes	-	-	
47	Apocynaceae	*Cerbera odollam*	-	-	-	-	
48	Araceae	*Aglaonema commutatum*	-	No	-	-	
49	Araceae	*Aglaonema* sp.					
50	Araceae	*Alocasia longiloba*	-	Yes	-	-	
51	Araceae	*Alocasia macrorrhizos*	-	No	-	-	
52	Araceae	*Colocasia esculenta*	IM + China	No	LC	Least Concern ver 3.1	
53	Araceae	*Dieffenbachia seguine*	-	No	-	-	
54	Araceae	*Epipremnum aureum*	-	No	-	-	
55	Araceae	*Epipremnum pinnatum*	-	Yes	-	-	
56	Araceae	*Philodendron hederaceum*	-	No	-	-	
57	Araceae	*Scindapsus hederaceus*	PH + IC	Yes	LC	Least Concern ver 3.1	
58	Araceae	*Syngonium podophyllum*	-	No	-	-	
59	Araliaceae	*Arthrophyllum diversifolium*	-	Yes	-	-	
60	Araliaceae	*Polyscias diversifolia*	-	Yes	-	-	
61	Arecaceae	*Caryota mitis*	-	Yes	-	-	
62	Arecaceae	*Cocos nucifera*	-	Yes	-	-	
63	Arecaceae	*Cyrtostachys renda*	SD + Thailand	Yes	-	-	

Item	Family	Genus species	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
27	Annonaceae	*Fissistigma manubriatum*	Vulnerable (VU/D) *Davidson et.al (2008) The Singapore Red Data Book*	-	-
28	Annonaceae	*Friesodielsia glauca*	Rediscovered	-	-
29	Annonaceae	*Friesodielsia latifolia*	Common	-	-
30	Annonaceae	*Mitrella kentii*	Common	-	-
31	Annonaceae	Phaeanthus ophthalmicus	Vulnerable	-	-
32	Annonaceae	*Uvaria leptopoda*	Crit. End.	-	-
33	Annonaceae	*Xylopia caudata*	Vulnerable	-	-
34	Annonaceae	*Xylopia malayana*	Common	-	-
35	Apocynaceae	*Allamanda cathartica*	Casual	-	-
36	Apocynaceae	*Alstonia angustifolia*	Common	-	-
37	Apocynaceae	Alstonia scholaris	Common	-	Terrestrial
38	Apocynaceae	*Anodendron candolleanum*	Crit. End.	-	-
39	Apocynaceae	*Catharanthus roseus*	Naturalized	-	-
40	Apocynaceae	*Dyera costulata*	Common	-	A large timber tree, preferring primary evergreen lowland or hill forest up to 300 m
41	Apocynaceae	*Hoya latifolia*	Endangered	-	-
42	Apocynaceae	*Leuconotis griffithii*	Vulnerable	-	-
43	Apocynaceae	Strophanthus caudatus	Crit. End.	-	-
44	Apocynaceae	*Tabernaemontana corymbosa*	Endangered	-	-
45	Apocynaceae	*Tabernaemontana divaricata*	Cultivated only	-	-
46	Apocynaceae	*Willughbeia coriacea*	Erroneously extinct	-	-
47	Apocynaceae	*Cerbera odollam*	-	-	-
48	Araceae	*Aglaonema commutatum*	Casual	-	-
49	Araceae	*Aglaonema* sp.		-	-
50	Araceae	*Alocasia longiloba*	Common	-	-
51	Araceae	*Alocasia macrorrhizos*	Naturalized	-	-
52	Araceae	*Colocasia esculenta*	Casual	-	-
53	Araceae	*Dieffenbachia seguine*	Casual	-	-
54	Araceae	*Epipremnum aureum*	Casual	-	-
55	Araceae	*Epipremnum pinnatum*	Crit. End.	-	-
56	Araceae	*Philodendron hederaceum*	Casual	-	-
57	Araceae	*Scindapsus hederaceus*	Common	-	It has been reported climbing on trees. Rainforest is assumed to be the suitable habitat.
58	Araceae	*Syngonium podophyllum*	Naturalized	-	-
59	Araliaceae	*Arthrophyllum diversifolium*	Common	-	-
60	Araliaceae	*Polyscias diversifolia*	Common	-	-
61	Arecaceae	*Caryota mitis*	Common	-	-
62	Arecaceae	*Cocos nucifera*	Common	-	-
63	Arecaceae	*Cyrtostachys renda*	Extinct	-	-

Item	Family	Genus species	Full name and authorship / English Name	Source	Presence#
64	Arecaceae	*Dypsis lutescens*	Dypsis lutescens (H. Wendl.) Beentje & J. Dransf.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/195960/0*	O
65	Arecaceae	*Elaeis guineensis*	Elaeis guineensis Jacq.	*(2014) Mandai Gate Vegetation Survey*	O
66	Arecaceae	*Korthalsia* sp.	-	*(2014) Mandai Gate Vegetation Survey*	O
67	Arecaceae	*Licuala spinosa*	Licuala spinosa Wurmb	*(2014) Mandai Gate Vegetation Survey*	O
68	Arecaceae	*Nenga pumila var. pachystachya*	Nenga pumila (Mart.) H. Wendl. var. pachystachya (Blume) Fernando	*(2014) Mandai Gate Vegetation Survey*	O
69	Arecaceae	*Oncosperma horridum*	Oncosperma horridum (Griff.) Scheff.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/18998756*	O
70	Arecaceae	*Oncosperma tigillarium*	Oncosperma tigillarium (Jack) Ridl.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/18998759*	O
71	Arecaceae	*Phoenix reclinata*	Phoenix reclinata Jacq.	*(2014) Mandai Gate Vegetation Survey*	O
72	Arecaceae	*Plectocomia elongata*	Plectocomia elongata Mart. ex Blume	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/19015943*	O
73	Arecaceae	*Ptychosperma macarthurii*	MacArthur Palm	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
74	Arecaceae	Rattan	-	*(2014) Mandai Gate Vegetation Survey*	O
75	Arecaceae	*Archontophoenix alexandrae*	Alexandra Palm	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/19002391*	O
76	Arecaceae	*Livistona chinensis*	Chinese Fan Palm	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/18977101*	O
77	Arecaceae	*Rhopaloblaste ceramica*	Seram Palm	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/19035608*	O
78	Aristolochiaceae	*Thottea grandiflora*	Thottea grandiflora Rottb.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20198367*	O
79	Asparagaceae	*Cordyline fruticosa*	Cordyline fruticosa (L.) A. Chev.	*(2014) Mandai Gate Vegetation Survey*	O
80	Asparagaceae	*Dracaena cantleyi*	Dracaena cantleyi Baker	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/19160878*	O
81	Asparagaceae	*Dracaena fragrans*	Dracaena fragrans (L.) Ker Gawl.	*(2014) Mandai Gate Vegetation Survey*	O
82	Asparagaceae	Dracaena maingayi	Dracaena maingayi Hook. f.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/19161009*	O
83	Asparagaceae	*Dracaena* sp.	-	*(2014) Mandai Gate Vegetation Survey*	O
84	Asparagaceae	*Dracaena surculosa*	Dracaena surculosa Lindl.	*(2014) Mandai Gate Vegetation Survey*	O
85	Aspleniaceae	*Asplenium longissimum*	Asplenium longissimum Blume	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20134365*	O
86	Aspleniaceae	*Asplenium nidus*	Asplenium nidus L.	*(2014) Mandai Gate Vegetation Survey*	O
87	Asteraceae	*Ageratum conyzoides*	Ageratum conyzoides L.	*(2014) Mandai Gate Vegetation Survey*	O
88	Asteraceae	*Bidens pilosa*	Bidens pilosa L.	*(2014) Mandai Gate Vegetation Survey*	O
89	Asteraceae	*Chromolaena odorata*	Chromolaena odorata (L.) R.M.King & H.Rob.	*(2014) Mandai Gate Vegetation Survey*	O
90	Asteraceae	*Mikania micrantha*	Mikania micrantha Kunth	*(2014) Mandai Gate Vegetation Survey*	O
91	Asteraceae	*Sphagneticola trilobata*	Sphagneticola trilobata (L.) Pruski	*(2014) Mandai Gate Vegetation Survey*	O
92	Asteraceae	*Synedrella nodiflora*	Synedrella nodiflora (L.) Gaertn.	*(2014) Mandai Gate Vegetation Survey*	O
93	Asteraceae	*Vernonia cinerea*	Vernonia cinerea (L.) Less.	*(2014) Mandai Gate Vegetation Survey*	O
94	Asteraceae	*Pluchea indica*	Malayan Fleabane	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/17798417*	O
95	Asteraceae	*Vernonia arborea*	Tree Vernonia	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/17821801*	O
96	Asteraceae	*Wedelia biflora*	Sea Ox Eye	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/17822529/synonym/17842353*	O
97	Bignoniaceae	*Spathodea campanulata*	Spathodea campanulata P. Beauv.	*(2014) Mandai Gate Vegetation Survey*	O
98	Bignoniaceae	*Tabebuia rosea*	Tabebuia rosea (Bertol.) DC.	*(2014) Mandai Gate Vegetation Survey*	O
99	Blechnaceae	*Blechnum finlaysonianum*	Blechnum finlaysonianum Wall. ex Hook. & Grev.	*(2014) Mandai Gate Vegetation Survey*	O

Item	Family	Genus species	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Protected by Law
64	Arecaceae	*Dypsis lutescens*	Madagascar	No	NT	Near Threatened ver 3.1	
65	Arecaceae	*Elaeis guineensis*	-	No	-	-	
66	Arecaceae	*Korthalsia* sp.					
67	Arecaceae	*Licuala spinosa*	-	Yes	-	-	
68	Arecaceae	*Nenga pumila var. pachystachya*	-	Yes	-	-	
69	Arecaceae	*Oncosperma horridum*	PH + SD + Thailand	Yes	-	-	
70	Arecaceae	*Oncosperma tigillarium*	IM	Yes	-	-	
71	Arecaceae	*Phoenix reclinata*	-	No	-	-	
72	Arecaceae	*Plectocomia elongata*	SD+ IC	Yes	-	-	
73	Arecaceae	*Ptychosperma macarthurii*	-	No	-	-	
74	Arecaceae	Rattan	-		-	-	
75	Arecaceae	*Archontophoenix alexandrae*	-	-	-	-	
76	Arecaceae	*Livistona chinensis*	-	-	-	-	
77	Arecaceae	*Rhopaloblaste ceramica*	-	-	-	-	
78	Aristolochiaceae	*Thottea grandiflora*	TM	Yes	-	-	
79	Asparagaceae	*Cordyline fruticosa*	-	No	-	-	
80	Asparagaceae	*Dracaena cantleyi*	TM + BO	Yes	-	-	
81	Asparagaceae	*Dracaena fragrans*	-	No	-	-	
82	Asparagaceae	Dracaena maingayi	Malaysia	Yes	-	-	
83	Asparagaceae	*Dracaena* sp.	-		-	-	
84	Asparagaceae	*Dracaena surculosa*	-	No	-	-	
85	Aspleniaceae	*Asplenium longissimum*	IM	Yes	-	-	
86	Aspleniaceae	*Asplenium nidus*	-	Yes	-	-	
87	Asteraceae	*Ageratum conyzoides*	-	No	-	-	
88	Asteraceae	*Bidens pilosa*	-	No	-	-	
89	Asteraceae	*Chromolaena odorata*	-	No	-	-	
90	Asteraceae	*Mikania micrantha*	-	No	-	-	
91	Asteraceae	*Sphagneticola trilobata*	-	No	-	-	
92	Asteraceae	*Synedrella nodiflora*	-	No	-	-	
93	Asteraceae	*Vernonia cinerea*	-	-	-	-	
94	Asteraceae	*Pluchea indica*	-	-	-	-	
95	Asteraceae	*Vernonia arborea*	-	-	-	-	
96	Asteraceae	*Wedelia biflora*	-	-	-	-	
97	Bignoniaceae	*Spathodea campanulata*	-	No	-	-	
98	Bignoniaceae	*Tabebuia rosea*	-	No	-	-	
99	Blechnaceae	*Blechnum finlaysonianum*	-	Yes	-	-	

Item	Family	Genus species	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
64	Arecaceae	*Dypsis lutescens*	Cultivated only	-	The species occurs mainly in swampy areas along the white sand dunes in the littoral of the Indian Ocean but it may be also found on alluvium at much higher elevations (up to 300 m) in Mananara Avaratra, Makira and Daraina.
65	Arecaceae	*Elaeis guineensis*	Casual	-	-
66	Arecaceae	*Korthalsia* sp.		-	-
67	Arecaceae	*Licuala spinosa*	Vulnerable	-	-
68	Arecaceae	*Nenga pumila var. pachystachya*	Crit. End.	-	-
69	Arecaceae	*Oncosperma horridum*	Vulnerable	-	-
70	Arecaceae	*Oncosperma tigillarium*	Vulnerable	-	-
71	Arecaceae	*Phoenix reclinata*	Cultivated only	-	-
72	Arecaceae	*Plectocomia elongata*	Vulnerable	-	-
73	Arecaceae	*Ptychosperma macarthurii*	Naturalized	-	-
74	Arecaceae	Rattan		-	-
75	Arecaceae	*Archontophoenix alexandrae*	-	-	-
76	Arecaceae	*Livistona chinensis*	-	-	-
77	Arecaceae	*Rhopaloblaste ceramica*	-	-	-
78	Aristolochiaceae	*Thottea grandiflora*	Vulnerable	-	-
79	Asparagaceae	*Cordyline fruticosa*	Casual	-	-
80	Asparagaceae	*Dracaena cantleyi*	Vulnerable	-	-
81	Asparagaceae	*Dracaena fragrans*	Casual	-	-
82	Asparagaceae	Dracaena maingayi	Vulnerable	-	-
83	Asparagaceae	*Dracaena* sp.		-	-
84	Asparagaceae	*Dracaena surculosa*	Cultivated only	-	-
85	Aspleniaceae	*Asplenium longissimum*	Common	-	-
86	Aspleniaceae	*Asplenium nidus*	Common	-	-
87	Asteraceae	*Ageratum conyzoides*	Naturalized	-	-
88	Asteraceae	*Bidens pilosa*	Naturalized	-	-
89	Asteraceae	*Chromolaena odorata*	Naturalized	-	-
90	Asteraceae	*Mikania micrantha*	Naturalized	-	-
91	Asteraceae	*Sphagneticola trilobata*	Naturalized	-	-
92	Asteraceae	*Synedrella nodiflora*	Naturalized	-	-
93	Asteraceae	*Vernonia cinerea*	Cryptogenic Weed	-	-
94	Asteraceae	*Pluchea indica*	-	-	-
95	Asteraceae	*Vernonia arborea*	-	-	-
96	Asteraceae	*Wedelia biflora*	-	-	-
97	Bignoniaceae	*Spathodea campanulata*	Naturalized	-	-
98	Bignoniaceae	*Tabebuia rosea*	Casual	-	-
99	Blechnaceae	*Blechnum finlaysonianum*	Vulnerable (VU/D) *Davidson et.al (2008) The Singapore Red Data Book*	-	-

Item	Family	Genus species	Full name and authorship / English Name	Source	Presence#
100	Blechnaceae	*Blechnum orientale*	Blechnum orientale L.	*(2014) Mandai Gate Vegetation Survey*	O
101	Blechnaceae	*Stenochlaena palustris*	Stenochlaena palustris (Burm. f.) Bedd.	*(2014) Mandai Gate Vegetation Survey*	O
102	Boraginaceae	*Ehretia microphylla*	Ehretia microphylla Lam	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20331305/synonym/20564204*	O
103	Boraginaceae	*Heliotropium indicum*	Indian Turnsole	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/20330718*	O
104	Burseraceae	*Canarium littorale*	Canarium littorale Blume	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/33182/0*	O
105	Burseraceae	*Canarium pilosum*	Canarium pilosum Benn.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20255373*	O
106	Burseraceae	*Dacryodes longifolia*	Dacryodes longifolia (King) Lam	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20255440*	O
107	Burseraceae	*Santiria apiculata*	Santiria apiculata Benn.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/32130/0*	O
108	Burseraceae	*Santiria griffithii*	Santiria griffithii (Hook. f.) Engl.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/32843/0*	O
109	Burseraceae	*Santiria laevigata*	Santiria laevigata Blume	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/32842/0*	O
110	Burseraceae	*Santiria rubiginosa*	Santiria rubiginosa Blume	*(2014) Mandai Gate Vegetation Survey*	O
111	Burseraceae	Triomma malaccensis	Triomma malaccensis Hook. f.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20255573*	O
112	Calophyllaceae	*Calophyllum cf. tetrapterum*	Calophyllum tetrapterum Miq.	*(2014) Mandai Gate Vegetation Survey*	O
113	Calophyllaceae	*Calophyllum pulcherrimum*	Calophyllum pulcherrimum Wall. ex Choisy	*(2014) Mandai Gate Vegetation Survey*	O
114	Calophyllaceae	*Calophyllum teysmannii*	Calophyllum teysmannii Miq.	*(2014) Mandai Gate Vegetation Survey*	O
115	Calophyllaceae	Calophyllum wallichianum	Calophyllum wallichianum Planch. & Tr. var. incrassatum (Hend. & Wyatt-Smith) P. F. Stevens	*(2014) Mandai Gate Vegetation Survey*	O
116	Calophyllaceae	*Calophyllum wallichianum var. incrassatum*	Calophyllum wallichianum Planch. & Tr. var. incrassatum (Hend. & Wyatt-Smith) P. F. Stevens	*(2014) Mandai Gate Vegetation Survey*	O
117	Calophyllaceae	*Calophyllum* 1	-	*(2014) Mandai Gate Vegetation Survey*	O
118	Cannabaceae	*Gironniera nervosa*	Gironniera nervosa Planch.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20244239*	O
119	Cannabaceae	*Gironniera subaequalis*	Gironniera subaequalis Planch.	*(2014) Mandai Gate Vegetation Survey*	O
120	Cannabaceae	*Trema cannabina*	Trema cannabina Lour.	*(2014) Mandai Gate Vegetation Survey*	O
121	Cannaceae	*Canna indica*	Canna indica L.	*(2014) Mandai Gate Vegetation Survey*	O
122	Celastraceae	Salacia miqueliana	Salacia miqueliana Loes	*(2014) Mandai Gate Vegetation Survey*	O
123	Centroplacaceae	*Bhesa paniculata*	Bhesa paniculata Arn.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/33933/0*	O
124	Chrysobalanaceae	*Licania splendens*	Licania splendens (Korth.) Prance	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/33225/0*	O
125	Cleomaceae	*Cleome rutidosperma*	Cleome rutidosperma DC.	*(2014) Mandai Gate Vegetation Survey*	O
126	Clusiaceae	Garcinia eugeniifolia/rostrata		*(2014) Mandai Gate Vegetation Survey*	O
127	Clusiaceae	*Garcinia forbesii*	Garcinia forbesii King	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20230532*	O
128	Clusiaceae	*Garcinia griffithii*	Garcinia griffithii T. Anderson	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20230550*	O
129	Clusiaceae	*Garcinia nigrolineata*	Garcinia nigrolineata Planch. ex T. Anderson	*(2014) Mandai Gate Vegetation Survey*	O
130	Clusiaceae	*Garcinia parvifolia*	Garcinia parvifolia Miq.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20231094*	O
131	Clusiaceae	*Garcinia scortechinii*	Garcinia scortechinii King	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/34529/0*	O
132	Combretaceae	*Combretum indicum*	Combretum indicum (L.) DeFilipps	*(2014) Mandai Gate Vegetation Survey*	O
133	Combretaceae	*Quisqualis indica*	Quisqualis indica L.	*(2014) Mandai Gate Vegetation Survey*	O

Item	Family	Genus species	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Protected by Law
100	Blechnaceae	*Blechnum orientale*	-	Yes	-	-	
101	Blechnaceae	*Stenochlaena palustris*	-	Yes	-	-	
102	Boraginaceae	*Ehretia microphylla*	IM +AS	No	-	-	
103	Boraginaceae	*Heliotropium indicum*	-	-	-	-	
104	Burseraceae	*Canarium littorale*	SD + Vietnam	Yes	LC	Lower Risk/least concern ver 2.3	
105	Burseraceae	*Canarium pilosum*	BO + Malaysia	Yes	-	-	
106	Burseraceae	*Dacryodes longifolia*	PH + Malaysia	Yes	-	-	
107	Burseraceae	*Santiria apiculata*	SD + PH	Yes	LC	Lower Risk/least concern ver 2.3	
108	Burseraceae	*Santiria griffithii*	SD	Yes	LC	Lower Risk/least concern ver 2.3	
109	Burseraceae	*Santiria laevigata*	SD + PH	Yes	LC	Lower Risk/least concern ver 2.3	
110	Burseraceae	*Santiria rubiginosa*	-	Yes	-	-	
111	Burseraceae	Triomma malaccensis	SD	Yes	-	-	
112	Calophyllaceae	*Calophyllum cf. tetrapterum*	-	Yes	-	-	
113	Calophyllaceae	*Calophyllum pulcherrimum*	-	Yes	-	-	
114	Calophyllaceae	*Calophyllum teysmannii*	-	Yes	-	-	
115	Calophyllaceae	Calophyllum wallichianum	-	Yes	-	-	
116	Calophyllaceae	*Calophyllum wallichianum var. incrassatum*	-	Yes	-	-	
117	Calophyllaceae	*Calophyllum* 1	-	-	-	-	
118	Cannabaceae	*Gironniera nervosa*	SD + IC	Yes	-	-	
119	Cannabaceae	*Gironniera subaequalis*	-	Yes	-	-	
120	Cannabaceae	*Trema cannabina*	-	Yes	-	-	
121	Cannaceae	*Canna indica*	-	No	-	-	
122	Celastraceae	Salacia miqueliana	-	Yes	-	-	
123	Centroplacaceae	*Bhesa paniculata*	TM + PH + Indonesia	Yes	LC	Lower Risk/least concern ver 2.3	
124	Chrysobalanaceae	*Licania splendens*	SD + Thailand	Yes	LC	Lower Risk/least concern ver 2.3	
125	Cleomaceae	*Cleome rutidosperma*	-	No	-	-	
126	Clusiaceae	Garcinia eugeniifolia/rostrata	-	Yes	-	-	
127	Clusiaceae	*Garcinia forbesii*	Malaysia	Yes	-	-	
128	Clusiaceae	*Garcinia griffithii*	Malaysia	Yes	-	-	
129	Clusiaceae	*Garcinia nigrolineata*	-	Yes	-	-	
130	Clusiaceae	*Garcinia parvifolia*	Malaysia	Yes	-	-	
131	Clusiaceae	*Garcinia scortechinii*	SD	Yes	LC	Lower Risk/least concern ver 2.3	
132	Combretaceae	*Combretum indicum*	-	No	-	-	
133	Combretaceae	*Quisqualis indica*	-	No	-	-	

Item	Family	Genus species	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
100	Blechnaceae	*Blechnum orientale*	Common	-	-
101	Blechnaceae	*Stenochlaena palustris*	Common	-	-
102	Boraginaceae	*Ehretia microphylla*	Naturalized	-	-
103	Boraginaceae	*Heliotropium indicum*	-	-	-
104	Burseraceae	*Canarium littorale*	Common	-	Occurring in secondary forest, especially on periodically flooded sandy alluvium.
105	Burseraceae	*Canarium pilosum*	Endangered	-	-
106	Burseraceae	*Dacryodes longifolia*	Crit. End.	-	-
107	Burseraceae	*Santiria apiculata*	Common	-	-
108	Burseraceae	*Santiria griffithii*	Common	-	-
109	Burseraceae	*Santiria laevigata*	Vulnerable	-	Found in mixed dipterocarp, mixed peat swamp and kerangas forests up to 1,200 m.
110	Burseraceae	*Santiria rubiginosa*	Vulnerable	-	-
111	Burseraceae	Triomma malaccensis	Endangered	-	-
112	Calophyllaceae	*Calophyllum cf. tetrapterum*	Vulnerable	-	-
113	Calophyllaceae	*Calophyllum pulcherrimum*	Common	-	-
114	Calophyllaceae	*Calophyllum teysmannii*	Vulnerable	-	-
115	Calophyllaceae	Calophyllum wallichianum	Vulnerable	-	-
116	Calophyllaceae	*Calophyllum wallichianum var. incrassatum*	Vulnerable	-	-
117	Calophyllaceae	*Calophyllum* 1	-	-	-
118	Cannabaceae	*Gironniera nervosa*	Common	-	-
119	Cannabaceae	*Gironniera subaequalis*	Endangered	-	-
120	Cannabaceae	*Trema cannabina*	Common	-	-
121	Cannaceae	*Canna indica*	Naturalized	-	-
122	Celastraceae	Salacia miqueliana	Vulnerable	-	-
123	Centroplacaceae	*Bhesa paniculata*	Common	-	Found in a variety of habitat types.
124	Chrysobalanaceae	*Licania splendens*	Common	-	A common tree of lowland primary and secondary mixed dipterocarp forest.
125	Cleomaceae	*Cleome rutidosperma*	Naturalized	-	-
126	Clusiaceae	Garcinia eugeniifolia/rostrata		-	-
127	Clusiaceae	*Garcinia forbesii*	Crit. End.	-	-
128	Clusiaceae	*Garcinia griffithii*	Endangered	-	-
129	Clusiaceae	*Garcinia nigrolineata*	Crit. End.	-	-
130	Clusiaceae	*Garcinia parvifolia*	Common	-	-
131	Clusiaceae	*Garcinia scortechinii*	Crit. End.	-	A lowland species
132	Combretaceae	*Combretum indicum*	Casual	-	-
133	Combretaceae	*Quisqualis indica*	Casual	-	-

Item	Family	Genus species	Full name and authorship / English Name	Source	Presence#
134	Commelinaceae	*Commelina diffusa*	Commelina diffusa Burm. f.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/177028/0*	O
135	Connaraceae	*Agelaea borneensis*	Agelaea borneensis (Hook. f.) Merr.	*(2014) Mandai Gate Vegetation Survey*	O
136	Connaraceae	*Agelaea macrophylla*	Agelaea macrophylla (Zoll.) Leenh.	*(2014) Mandai Gate Vegetation Survey*	O
137	Connaraceae	*Cnestis palala*	Cnestis palala (Lour.) Merr.	*(2014) Mandai Gate Vegetation Survey*	O
138	Connaraceae	*Connarus semidecandrus*	Connarus semidecandrus Jack	*(2014) Mandai Gate Vegetation Survey*	O
139	Connaraceae	*Rourea asplenifolia*	Rourea asplenifolia (Schellenb.) Jongkind.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20221694*	O
140	Connaraceae	Rourea mimosoides	Rourea mimosoides (Vahl) Planch.	*(2014) Mandai Gate Vegetation Survey*	O
141	Connaraceae	*Rourea minor*	Rourea minor (Gaertn.) Leenh.	*(2014) Mandai Gate Vegetation Survey*	O
142	Connaraceae	*Santaloides filgens*	Santaloides filgens (Planch.) Kuntze	*(2014) Mandai Gate Vegetation Survey*	O
143	Convolvulaceae	*Erycibe leucoxyloides*	Erycibe leucoxyloides King ex Prain	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20323406*	O
144	Convolvulaceae	*Erycibe tomentosa*	Erycibe tomentosa Blume	*(2014) Mandai Gate Vegetation Survey*	O
145	Convolvulaceae	*Ipomoea cairica*	Ipomoea cairica (L.) Sweet	*(2014) Mandai Gate Vegetation Survey*	O
146	Convolvulaceae	*Ipomoea pes-caprae*	Ipomoea pes-caprae (L.) R. Br.	*(2014) Mandai Gate Vegetation Survey*	O
147	Convolvulaceae	*Ipomoea triloba*	Ipomoea triloba L.	*(2014) Mandai Gate Vegetation Survey*	O
148	Convolvulaceae	*Merremia umbellata*	Merremia umbellata (L.) Hallier f.	*(2014) Mandai Gate Vegetation Survey*	O
149	Costaceae	*Cheilocostus speciosus*	Cheilocostus speciosus (J. Koenig) C. D. Specht	*(2014) Mandai Gate Vegetation Survey*	O
150	Costaceae	*Costus lucanusianus*	Costus lucanusianus J. Braun & K. Sch.	*(2014) Mandai Gate Vegetation Survey*	O
151	Cucurbitaceae	*Coccinia grandis*	Coccinia grandis (L.) Voigt	*(2014) Mandai Gate Vegetation Survey*	O
152	Cucurbitaceae	*Cucumis maderaspatanus*	Cucumis maderaspatanus L.	*(2014) Mandai Gate Vegetation Survey*	O
153	Cucurbitaceae	*Melothria pendula*	Melothria pendula L.	*(2014) Mandai Gate Vegetation Survey*	O
154	Cucurbitaceae	*Momordica charantia*	Momordica charantia L.	*(2014) Mandai Gate Vegetation Survey*	O
155	Cucurbitaceae	*Trichosanthes wawraei*	Trichosanthes wawraei Cogn.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20249199*	O
156	Cyatheaceae	*Cyathea latebrosa*	Cyathea latebrosa (Wall.) Copel.	*(2014) Mandai Gate Vegetation Survey*	O
157	Cyatheaceae	*Cyathea squamulata*	Cyathea squamulata (Blume) Copel.	*(2014) Mandai Gate Vegetation Survey*	O
158	Cyperaceae	Cyperaceae	-	*(2014) Mandai Gate Vegetation Survey*	O
159	Cyperaceae	Cyperus digitatus	Cyperus digitatus Roxb.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/164510/0*	O
160	Cyperaceae	*Fimbristylis dichotoma*	Fimbristylis dichotoma (L.) Vahl ssp. dichotoma	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/169008/0*	O
161	Cyperaceae	*Fuirena ciliaris*	Fuirena ciliaris (L.) Roxb.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/158207/0*	O
162	Cyperaceae	*Kyllinga nemoralis*	Kyllinga nemoralis (J.R. Forst. & G. Forst.) Dandy ex Hutch. & Dalziel	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/177219/0*	O
163	Cyperaceae	*Kyllinga polyphylla*	Kyllinga polyphylla Willd. ex Kunth	*(2014) Mandai Gate Vegetation Survey*	O
164	Cyperaceae	*Rhynchospora corymbosa*	Rhynchospora corymbosa (L.) Britton	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/177041/0*	O
165	Cyperaceae	*Scleria ciliaris*	Scleria ciliaris Nees	*(2014) Mandai Gate Vegetation Survey*	O

Item	Family	Genus species	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Protected by Law
134	Commelinaceae	*Commelina diffusa*	IM + EA + Africa	-	LC	Least Concern ver 3.1	
135	Connaraceae	*Agelaea borneensis*	-	Yes	-	-	
136	Connaraceae	*Agelaea macrophylla*	-	Yes	-	-	
137	Connaraceae	*Cnestis palala*	-	Yes	-	-	
138	Connaraceae	*Connarus semidecandrus*	-	Yes	-	-	
139	Connaraceae	*Rourea asplenifolia*	Malaysia	Yes	-	-	
140	Connaraceae	Rourea mimosoides	-	Yes	-	-	
141	Connaraceae	*Rourea minor*	-	Yes	-	-	
142	Connaraceae	*Santaloides filgens*	-	Yes	-	-	
143	Convolvulaceae	*Erycibe leucoxyloides*	Malaysia	-	-	-	
144	Convolvulaceae	*Erycibe tomentosa*	-	Yes	-	-	
145	Convolvulaceae	*Ipomoea cairica*	-	No	-	-	
146	Convolvulaceae	*Ipomoea pes-caprae*	-	Yes	-	-	
147	Convolvulaceae	*Ipomoea triloba*	-	No	-	-	
148	Convolvulaceae	*Merremia umbellata*	-	-	-	-	
149	Costaceae	*Cheilocostus speciosus*	-	Yes	-	-	
150	Costaceae	*Costus lucanusianus*	-	No	-	-	
151	Cucurbitaceae	*Coccinia grandis*	-	No	-	-	
152	Cucurbitaceae	*Cucumis maderaspatanus*	-	No	-	-	
153	Cucurbitaceae	*Melothria pendula*	-		-	-	
154	Cucurbitaceae	*Momordica charantia*	-	No	-	-	
155	Cucurbitaceae	*Trichosanthes wawraei*	Malaysia + Singapore	Yes	-	-	
156	Cyatheaceae	*Cyathea latebrosa*	-	Yes	-	-	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*
157	Cyatheaceae	*Cyathea squamulata*	-	Yes	-	-	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*
158	Cyperaceae	Cyperaceae	-		-	-	
159	Cyperaceae	Cyperus digitatus	Asia + South America	Yes	LC	Least Concern ver 3.1	
160	Cyperaceae	*Fimbristylis dichotoma*	Asia + South America + Africa	-	LC	Least Concern ver 3.1	
161	Cyperaceae	*Fuirena ciliaris*	Asia + Africa		LC	Least Concern ver 3.1	
162	Cyperaceae	*Kyllinga nemoralis*	Asia + Africa	-	LC	Least Concern ver 3.1	
163	Cyperaceae	*Kyllinga polyphylla*	-	No	-	-	
164	Cyperaceae	*Rhynchospora corymbosa*	Asia + Africa	-	LC	Least Concern ver 3.1	
165	Cyperaceae	*Scleria ciliaris*	-	Yes	-	-	

Item	Family	Genus species	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
134	Commelinaceae	*Commelina diffusa*	Cryptogenic Weed	-	Globally, it is a common weed usually found in damp shady places near water but also found in open swamps and marshes and sometimes found floating in mats. This species also occurs as a weed in cultivated fields, forests, thickets, streamsides, and humid open places.
135	Connaraceae	*Agelaea borneensis*	Vulnerable	-	-
136	Connaraceae	*Agelaea macrophylla*	Crit. End.	-	-
137	Connaraceae	*Cnestis palala*	Common	-	-
138	Connaraceae	*Connarus semidecandrus*	Crit. End.	-	-
139	Connaraceae	*Rourea asplenifolia*	Crit. End.	-	-
140	Connaraceae	Rourea mimosoides	Endangered	-	-
141	Connaraceae	*Rourea minor*	Crit. End.	-	-
142	Connaraceae	*Santaloides filgens*	Vulnerable	-	-
143	Convolvulaceae	*Erycibe leucoxyloides*	Cryptogenic Weed	-	-
144	Convolvulaceae	*Erycibe tomentosa*	Common	-	-
145	Convolvulaceae	*Ipomoea cairica*	Naturalized	-	-
146	Convolvulaceae	*Ipomoea pes-caprae*	Common	-	-
147	Convolvulaceae	*Ipomoea triloba*	Naturalized	-	-
148	Convolvulaceae	*Merremia umbellata*	Cryptogenic Weed	-	-
149	Costaceae	*Cheilocostus speciosus*	Common	-	-
150	Costaceae	*Costus lucanusianus*	Casual	-	-
151	Cucurbitaceae	*Coccinia grandis*	Naturalized	-	-
152	Cucurbitaceae	*Cucumis maderaspatanus*	Naturalized	-	-
153	Cucurbitaceae	*Melothria pendula*		-	-
154	Cucurbitaceae	*Momordica charantia*	Casual	-	-
155	Cucurbitaceae	*Trichosanthes wawraei*	Vulnerable	-	-
156	Cyatheaceae	*Cyathea latebrosa*	Vulnerable (VU/D) *Davidson et.al (2008) The Singapore Red Data Book*	Appendix II	-
157	Cyatheaceae	*Cyathea squamulata*	Endangered (EN/D) *Davidson et.al (2008) The Singapore Red Data Book*	Appendix II	-
158	Cyperaceae	Cyperaceae		-	-
159	Cyperaceae	Cyperus digitatus	Common	-	It is a perennial herb, found in swamps or seasonally flooded areas, wet rice fields, ditches and river banks and also open grasslands.
160	Cyperaceae	*Fimbristylis dichotoma*	Cryptogenic Weed	-	A tufted annual or perennial sedge which commonly grows in damp grasslands, shallow water in marshes, along rivers and irrigation canals, and also as a weed in paddy fields
161	Cyperaceae	*Fuirena ciliaris*		-	Grows in seasonally wet ground, swamps, pools and lake edges. Also in seasonally flooded grasslands and savannas. Appears to be tolerant of disturbance and grows in rice paddies and other very wet cultivated areas. On Socotra it is described as occurring on wet ground by pools and wadis.
162	Cyperaceae	*Kyllinga nemoralis*	Cryptogenic Weed	-	Frequently grows in wet grasslands
163	Cyperaceae	*Kyllinga polyphylla*	Naturalized	-	-
164	Cyperaceae	*Rhynchospora corymbosa*	Cryptogenic Weed	-	It is perennial and common plant growing in and along streams, on the shores of lakes, pools and rivers, often found in shallow water in swamps and rice fields.
165	Cyperaceae	*Scleria ciliaris*	Common	-	-

Item	Family	Genus species	Full name and authorship / English Name	Source	Presence#
166	Davalliaceae	*Davallia denticulata*	Davallia denticulata (Burm.) Mett.	*(2014) Mandai Gate Vegetation Survey*	O
167	Dichapetalaceae	*Dichapetalum sordidum*	Dichapetalum sordidum (Hook. f.) Leenh.	*(2014) Mandai Gate Vegetation Survey*	O
168	Dilleniaceae	*Dillenia suffruticosa*	Simpoh Ayer	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
169	Dilleniaceae	*Tetracera akara*	Tetracera akara (Burm. f.) Merr.	*(2014) Mandai Gate Vegetation Survey*	O
170	Dilleniaceae	*Tetracera indica*	Tetracera indica (Christm. & Panz.) Merr.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20213821*	O
171	Dilleniaceae	*Tetracera macrophylla*	Tetracera macrophylla Wall. ex Hook. f. & Thoms.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20213830*	O
172	Dioscoreaceae	*Dioscorea* sp.		*(2014) Mandai Gate Vegetation Survey*	O
173	Dioscoreaceae	*Tacca integrifolia*	Tacca integrifolia Ker Gawl.	*(2014) Mandai Gate Vegetation Survey*	O
174	Dipterocarpaceae	*Anisoptera megistocarpa*	Anisoptera megistocarpa Slooten.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/33067/0*	O
175	Dipterocarpaceae	Hopea mengarawan	Hopea mengarawan Miq.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20263711*	O
176	Ebenaceae	*Diospyros lanceifolia*	Diospyros lanceifolia Roxb.	*(2014) Mandai Gate Vegetation Survey*	O
177	Elaeocarpaceae	*Elaeocarpus ferrugineus*	Elaeocarpus ferrugineus (Jack) Steud.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20223347*	O
178	Elaeocarpaceae	*Elaeocarpus mastersii*	Elaeocarpus mastersii King	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20223508*	O
179	Elaeocarpaceae	*Elaeocarpus petiolatus*	Elaeocarpus petiolatus (Jack) Wall	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20223582*	O
180	Elaeocarpaceae	*Elaeocarpus salicifolius*	Elaeocarpus salicifolius King	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20223548/synonym/20379984*	O
181	Elaeocarpaceae	*Elaeocarpus stipularis*	Elaeocarpus stipularis Blume	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/20223668*	O
182	Euphorbiaceae	*Acalypha alopecuroides*	Acalypha alopecuroides Jacq.	*(2014) Mandai Gate Vegetation Survey*	O
183	Euphorbiaceae	*Acalypha hispida*	Acalypha hispida Burm. f.	*(2014) Mandai Gate Vegetation Survey*	O
184	Euphorbiaceae	*Acalypha siamensis*	Acalypha siamensis Oliv. ex Gage	*(2014) Mandai Gate Vegetation Survey*	O
185	Euphorbiaceae	*Agrostistachys borneensis*	Agrostistachys borneensis Becc.	*(2014) Mandai Gate Vegetation Survey*	O
186	Euphorbiaceae	*Alchornea tiliifolia*	Alchornea tiliifolia (Benth.) Müll.Arg.	*(2014) Mandai Gate Vegetation Survey*	O
187	Euphorbiaceae	*Claoxylon indicum*	Claoxylon indicum (Reinw. ex Blume) Hassk.	*(2014) Mandai Gate Vegetation Survey*	O
188	Euphorbiaceae	Croton oblongus	Croton oblongus Burm. f.	*(2014) Mandai Gate Vegetation Survey*	O
189	Euphorbiaceae	*Euphorbia hirta*	Euphorbia hirta L.	*(2014) Mandai Gate Vegetation Survey*	O
190	Euphorbiaceae	*Euphorbia hypericifolia*	Euphorbia hypericifolia L.	*(2014) Mandai Gate Vegetation Survey*	O
191	Euphorbiaceae	*Euphorbia thymifolia*	Euphorbia thymifolia L	*(2014) Mandai Gate Vegetation Survey*	O
192	Euphorbiaceae	*Hevea brasiliensis*	Hevea brasiliensis (Willd. ex A. Juss.) Müll. Arg.	*(2014) Mandai Gate Vegetation Survey*	O
193	Euphorbiaceae	*Koilodepas longifolium*	Koilodepas longifolium Hook. f.	*(2014) Mandai Gate Vegetation Survey*	O
194	Euphorbiaceae	*Macaranga bancana*	Macaranga bancana (Miq.) Mull. Arg.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/18978310*	O
195	Euphorbiaceae	*Macaranga gigantea*	Macaranga gigantea (Rchb. f. & Zoll.) Mull. Arg.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/18978440*	O
196	Euphorbiaceae	*Macaranga heynei*	Macaranga heynei I.M. Johnst.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/18978483*	O
197	Euphorbiaceae	*Macaranga hullettii*	Macaranga hullettii King ex Hook. f.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/18978492*	O
198	Euphorbiaceae	*Macaranga hypoleuca*	Macaranga hypoleuca (Rchb. f. & Zoll.) Mull. Arg.	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/18978498*	O
199	Euphorbiaceae	*Macaranga trichocarpa*	Macaranga trichocarpa (Rchb.f. & Zoll.) Müll.Arg.	*(2014) Mandai Gate Vegetation Survey*	O
200	Euphorbiaceae	*Mallotus paniculatus*	Mallotus paniculatus (Lam.) Mull. Arg.	*(2014) Mandai Gate Vegetation Survey*	O

Item	Family	Genus species	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Protected by Law
166	Davalliaceae	*Davallia denticulata*	-	Yes	-	-	
167	Dichapetalaceae	*Dichapetalum sordidum*	-	Yes	-	-	
168	Dilleniaceae	*Dillenia suffruticosa*	-	Yes	-	-	
169	Dilleniaceae	*Tetracera akara*	-	Yes	-	-	
170	Dilleniaceae	*Tetracera indica*	IM	Yes	-	-	
171	Dilleniaceae	*Tetracera macrophylla*	SD + India	Yes	-	-	
172	Dioscoreaceae	*Dioscorea* sp.	-		-	-	
173	Dioscoreaceae	*Tacca integrifolia*	-	Yes	-	-	
174	Dipterocarpaceae	*Anisoptera megistocarpa*	SD	Yes	CR	Critically Endangered A1cd+2cd ver 2.3	
175	Dipterocarpaceae	Hopea mengarawan	SD	Yes	-	-	
176	Ebenaceae	*Diospyros lanceifolia*	-	Yes	-	-	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*
177	Elaeocarpaceae	*Elaeocarpus ferrugineus*	SD	Yes	-	-	
178	Elaeocarpaceae	*Elaeocarpus mastersii*	Malaysia	Yes	-	-	
179	Elaeocarpaceae	*Elaeocarpus petiolatus*	IM+ EA	Yes	-	-	
180	Elaeocarpaceae	*Elaeocarpus salicifolius*	Malaysia	Yes	-	-	
181	Elaeocarpaceae	*Elaeocarpus stipularis*	TM	Yes	-	-	
182	Euphorbiaceae	*Acalypha alopecuroides*	-		-	-	
183	Euphorbiaceae	*Acalypha hispida*	-	No	-	-	
184	Euphorbiaceae	*Acalypha siamensis*	-	No	-	-	
185	Euphorbiaceae	*Agrostistachys borneensis*	-	Yes	-	-	
186	Euphorbiaceae	*Alchornea tiliifolia*	-	yes	-	-	
187	Euphorbiaceae	*Claoxylon indicum*	-	Yes	-	-	
188	Euphorbiaceae	Croton oblongus	-	Yes	-	-	
189	Euphorbiaceae	*Euphorbia hirta*	-	No	-	-	
190	Euphorbiaceae	*Euphorbia hypericifolia*	-	No	-	-	
191	Euphorbiaceae	*Euphorbia thymifolia*	-	-	-	-	
192	Euphorbiaceae	*Hevea brasiliensis*	-	No	-	-	
193	Euphorbiaceae	*Koilodepas longifolium*	-	Yes	-	-	
194	Euphorbiaceae	*Macaranga bancana*	SD + Thailand	Yes	-	-	
195	Euphorbiaceae	*Macaranga gigantea*	SD + Thailand	Yes	-	-	
196	Euphorbiaceae	*Macaranga heynei*	SD + Thailand	Yes	-	-	
197	Euphorbiaceae	*Macaranga hullettii*	SD + Thailand	Yes	-	-	
198	Euphorbiaceae	*Macaranga hypoleuca*	SD + Thailand	Yes	-	-	
199	Euphorbiaceae	*Macaranga trichocarpa*	-	Yes	-	-	
200	Euphorbiaceae	*Mallotus paniculatus*	-	Yes	-	-	

Item	Family	Genus species	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
166	Davalliaceae	*Davallia denticulata*	Common	-	-
167	Dichapetalaceae	*Dichapetalum sordidum*	Rediscovered	-	-
168	Dilleniaceae	*Dillenia suffruticosa*	Common	-	-
169	Dilleniaceae	*Tetracera akara*	Vulnerable	-	-
170	Dilleniaceae	*Tetracera indica*	Common	-	-
171	Dilleniaceae	*Tetracera macrophylla*	Vulnerable	-	-
172	Dioscoreaceae	*Dioscorea* sp.		-	-
173	Dioscoreaceae	*Tacca integrifolia*	Vulnerable	-	-
174	Dipterocarpaceae	*Anisoptera megistocarpa*	Crit. End.	-	A large tree scattered throughout mixed dipterocarp forest on well-drained soil.
175	Dipterocarpaceae	Hopea mengarawan	Endangered	-	-
176	Ebenaceae	*Diospyros lanceifolia*	Common	Appendix II	-
177	Elaeocarpaceae	*Elaeocarpus ferrugineus*	Common	-	-
178	Elaeocarpaceae	*Elaeocarpus mastersii*	Common	-	-
179	Elaeocarpaceae	*Elaeocarpus petiolatus*	Common	-	-
180	Elaeocarpaceae	*Elaeocarpus salicifolius*	Vulnerable	-	-
181	Elaeocarpaceae	*Elaeocarpus stipularis*	Vulnerable	-	-
182	Euphorbiaceae	*Acalypha alopecuroides*		-	-
183	Euphorbiaceae	*Acalypha hispida*	Cultivated only	-	-
184	Euphorbiaceae	*Acalypha siamensis*	Casual	-	-
185	Euphorbiaceae	*Agrostistachys borneensis*	Common	-	-
186	Euphorbiaceae	*Alchornea tiliifolia*	Crit. End.	-	-
187	Euphorbiaceae	*Claoxylon indicum*	Common	-	-
188	Euphorbiaceae	Croton oblongus	Endangered	-	-
189	Euphorbiaceae	*Euphorbia hirta*	Naturalized	-	-
190	Euphorbiaceae	*Euphorbia hypericifolia*	Naturalized	-	-
191	Euphorbiaceae	*Euphorbia thymifolia*	Cryptogenic Weed	-	-
192	Euphorbiaceae	*Hevea brasiliensis*	Naturalized	-	-
193	Euphorbiaceae	*Koilodepas longifolium*	Vulnerable	-	-
194	Euphorbiaceae	*Macaranga bancana*	Common	-	-
195	Euphorbiaceae	*Macaranga gigantea*	Common	-	-
196	Euphorbiaceae	*Macaranga heynei*	Common	-	-
197	Euphorbiaceae	*Macaranga hullettii*	Crit. End.	-	-
198	Euphorbiaceae	*Macaranga hypoleuca*	Common	-	-
199	Euphorbiaceae	*Macaranga trichocarpa*	Endangered	-	-
200	Euphorbiaceae	*Mallotus paniculatus*	Common	-	-

Item	Family	Genus species	Full name and authorship / English Name	Source	Presence#
201	Euphorbiaceae	*Manihot carthaginensis subsp. glaziovii*	Manihot carthagenesis (Jack) Müll. Arg. ssp. glaziovii (Müll. Arg.) Allem	*(2014) Mandai Gate Vegetation Survey*	O
202	Euphorbiaceae	*Manihot esculenta*	Manihot esculenta Crantz	*(2014) Mandai Gate Vegetation Survey*	O
203	Fabaceae	*Acacia auriculiformis*	Acacia auriculiformis A. Cunn. ex Benth.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/19891902/0*	O
204	Fabaceae	*Acacia mangium*	Acacia mangium Willd.	*(2014) Mandai Gate Vegetation Survey*	O
205	Fabaceae	*Adenanthera pavonina*	Adenanthera pavonina L.	*(2014) Mandai Gate Vegetation Survey*	O
206	Fabaceae	*Albizia saman*	Albizia saman (Jacq.) Merr.	*(2014) Mandai Gate Vegetation Survey*	O
207	Fabaceae	*Alysicarpus vaginalis*	Alysicarpus vaginalis (L.) DC.	*(2014) Mandai Gate Vegetation Survey*	O
208	Fabaceae	*Andira inermis*	Andira inermis (W. Wright) Kunth ex DC.	*(2014) Mandai Gate Vegetation Survey*	O
209	Fabaceae	*Archidendron clypearia*	Archidendron clypearia (Jack) I. C. Nielsen	*(2014) Mandai Gate Vegetation Survey*	O
210	Fabaceae	*Archidendron jiringa*	Archidendron jiringa (Jack) Nielsen	*(2014) Mandai Gate Vegetation Survey*	O
211	Fabaceae	*Archidendron microcarpum*	Archidendron microcarpum (Benth.) Nielsen	*(2014) Mandai Gate Vegetation Survey*	O
212	Fabaceae	*Baphia nitida*	Baphia nitida Lodd. et al.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/19891986/0*	O
213	Fabaceae	*Bauhinia semibifida*	Bauhinia semibifida Roxb. var. semibifida	*(2014) Mandai Gate Vegetation Survey*	O
214	Fabaceae	*Bauhinia semibifida var. semibifida*	Bauhinia semibifida Roxb. var. semibifida	*(2014) Mandai Gate Vegetation Survey*	O
215	Fabaceae	*Callerya atropurpurea*	Callerya atropurpurea (Wall.) Schot	*(2014) Mandai Gate Vegetation Survey*	O
216	Fabaceae	*Calopogonium mucunoides*	Calopogonium mucunoides Desv.	*(2014) Mandai Gate Vegetation Survey*	O
217	Fabaceae	*Centrosema molle*	Centrosema molle Benth	*(2014) Mandai Gate Vegetation Survey*	O
218	Fabaceae	*Crotalaria pallida*	Crotalaria pallida Aiton	*(2014) Mandai Gate Vegetation Survey*	O
219	Fabaceae	*Dalbergia pseudo-sissoo*	Dalbergia pseudo-sissoo Miq.	*(2014) Mandai Gate Vegetation Survey*	O
220	Fabaceae	*Dalbergia velutina*	Dalbergia velutina Benth.	*(2014) Mandai Gate Vegetation Survey*	O
221	Fabaceae	Derris amoena	Derris amoena Benth. var. maingayana (Baker) Prain	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/19891592/0*	O
222	Fabaceae	*Derris amoena var. maingayana*	Derris amoena Benth. var. maingayana (Baker) Prain	*(2014) Mandai Gate Vegetation Survey*	O
223	Fabaceae	*Desmodium heterophyllum*	Desmodium heterophyllum (Willd.) DC.	*(2014) Mandai Gate Vegetation Survey*	O
224	Fabaceae	*Desmodium triflorum*	Desmodium triflorum (L.) DC.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/19892960/0*	O
225	Fabaceae	*Dialium platysepalum*	Dialium platysepalum Baker	*(2014) Mandai Gate Vegetation Survey*	O
226	Fabaceae	*Erythrina crista-galli*	Cockscomb Coral Tree	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
227	Fabaceae	*Falcataria moluccana*	Falcataria moluccana (Miq.) Barneby & J.W. Grimes	*(2014) Mandai Gate Vegetation Survey*	O
228	Fabaceae	*Koompassia malaccensis*	Koompassia malaccensis Maingay ex Benth.	*(2014) Mandai Gate Vegetation Survey*	O
229	Fabaceae	*Kunstleria ridleyi*	Kunstleria ridleyi Prain	*(2014) Mandai Gate Vegetation Survey*	O
230	Fabaceae	*Leucaena leucocephala*	Leucaena leucocephala (Lam.) de Wit	*(2014) Mandai Gate Vegetation Survey*	O
231	Fabaceae	*Macroptilium lathyroides*	Macroptilium lathyroides (L.) Urb.	*(2014) Mandai Gate Vegetation Survey*	O
232	Fabaceae	*Mimosa diplotricha*	Mimosa diplotricha C. Wright	*(2014) Mandai Gate Vegetation Survey*	O
233	Fabaceae	*Mimosa pigra*	Mimosa pigra L.	*(2014) Mandai Gate Vegetation Survey*	O
234	Fabaceae	*Mimosa pudica*	Sensitive Plant	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/175208/0*	O
235	Fabaceae	Ormosia bancana	Ormosia bancana (Miq.) Merr.	*(2014) Mandai Gate Vegetation Survey*	O
236	Fabaceae	Ormosia sumatrana	Ormosia sumatrana (Miq.) Prain	*(2014) Mandai Gate Vegetation Survey*	O
237	Fabaceae	*Peltophorum pterocarpum*	Yellow Flame	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
238	Fabaceae	*Pterocarpus indicus*	Burmese Rosewood	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/33241/0*	O
239	Fabaceae	*Pueraria phaseoloides*	Pueraria phaseoloides (Roxb.) Benth.	*(2014) Mandai Gate Vegetation Survey*	O
240	Fabaceae	*Senna alata*	Senna alata (L.) Roxb.	*(2014) Mandai Gate Vegetation Survey*	O
241	Fabaceae	*Sindora wallichii*	Sindora wallichii Benth.	*(2014) Mandai Gate Vegetation Survey*	O
242	Fabaceae	*Spatholobus ferrugineus*	Spatholobus ferrugineus (Zoll. & Moritzi) Benth.	*(2014) Mandai Gate Vegetation Survey*	O
243	Fabaceae	*Spatholobus maingayi*	Spatholobus maingayi King	*(2014) Mandai Gate Vegetation Survey*	O

Item	Family	Genus species	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Protected by Law
201	Euphorbiaceae	*Manihot carthaginensis subsp. glaziovii*	-	No	-	-	
202	Euphorbiaceae	*Manihot esculenta*	-	No	-	-	
203	Fabaceae	*Acacia auriculiformis*	AS + Indonesia	No	LC	Least Concern ver 3.1	
204	Fabaceae	*Acacia mangium*	-	No	-	-	
205	Fabaceae	*Adenanthera pavonina*	-	No	-	-	
206	Fabaceae	*Albizia saman*	-	No	-	-	
207	Fabaceae	*Alysicarpus vaginalis*	-	-	-	-	
208	Fabaceae	*Andira inermis*	-	No	-	-	
209	Fabaceae	*Archidendron clypearia*	-	Yes	-	-	
210	Fabaceae	*Archidendron jiringa*	-	Yes	-	-	
211	Fabaceae	*Archidendron microcarpum*	-	yes	-	-	
212	Fabaceae	*Baphia nitida*	IM	No	LC	Least Concern ver 3.1	
213	Fabaceae	*Bauhinia semibifida*	-	Yes	-	-	-
214	Fabaceae	*Bauhinia semibifida var. semibifida*	-	Yes	-	-	-
215	Fabaceae	*Callerya atropurpurea*	-	No	-	-	-
216	Fabaceae	*Calopogonium mucunoides*	-	No	-	-	-
217	Fabaceae	*Centrosema molle*	-	No	-	-	-
218	Fabaceae	*Crotalaria pallida*	-	No	-	-	-
219	Fabaceae	*Dalbergia pseudo-sissoo*	-		-	-	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*
220	Fabaceae	*Dalbergia velutina*	-	Yes	-	-	
221	Fabaceae	Derris amoena	SD + TM	Yes	LC	Least Concern ver 3.1	
222	Fabaceae	*Derris amoena var. maingayana*	-	Yes	-	-	
223	Fabaceae	*Desmodium heterophyllum*	-	-	-	-	
224	Fabaceae	*Desmodium triflorum*	Asia + Africa	-	LC	Least Concern ver 3.1	
225	Fabaceae	*Dialium platysepalum*	-	Yes	-	-	
226	Fabaceae	*Erythrina crista-galli*	-	No	-	-	
227	Fabaceae	*Falcataria moluccana*	-	No	-	-	
228	Fabaceae	*Koompassia malaccensis*	-	Yes	-	-	
229	Fabaceae	*Kunstleria ridleyi*	-	Yes	-	-	
230	Fabaceae	*Leucaena leucocephala*	-	No	-	-	
231	Fabaceae	*Macroptilium lathyroides*	-	No	-	-	
232	Fabaceae	*Mimosa diplotricha*	-	No	-	-	
233	Fabaceae	*Mimosa pigra*	-	No	-	-	
234	Fabaceae	*Mimosa pudica*	Asia + AS + Africa	No	LC	Least Concern ver 3.1	
235	Fabaceae	Ormosia bancana	-	Yes	-	-	
236	Fabaceae	Ormosia sumatrana	-	Yes	-	-	
237	Fabaceae	*Peltophorum pterocarpum*	-	yes	-	-	
238	Fabaceae	*Pterocarpus indicus*	SD + IC + Oceania	No	VU	Vulnerable A1d ver 2.3	
239	Fabaceae	*Pueraria phaseoloides*	-	No	-	-	
240	Fabaceae	*Senna alata*	-	No	-	-	
241	Fabaceae	*Sindora wallichii*	-	Yes	-	-	
242	Fabaceae	*Spatholobus ferrugineus*	-	Yes	-	-	
243	Fabaceae	*Spatholobus maingayi*	-	Yes	-	-	

Item	Family	Genus species	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
201	Euphorbiaceae	*Manihot carthaginensis subsp. glaziovii*	Naturalized	-	-
202	Euphorbiaceae	*Manihot esculenta*	Naturalized	-	-
203	Fabaceae	*Acacia auriculiformis*	Naturalized	-	*A. auriculiformis* is a fast growing tree, particularly drought resistant, but also tolerates seasonally waterlogged soils and it is able to grow in poor soils.
204	Fabaceae	*Acacia mangium*	Naturalized	-	-
205	Fabaceae	*Adenanthera pavonina*	Naturalized	-	-
206	Fabaceae	*Albizia saman*	Casual	-	-
207	Fabaceae	*Alysicarpus vaginalis*	Cryptogenic Weed	-	-
208	Fabaceae	*Andira inermis*	Casual	-	-
209	Fabaceae	*Archidendron clypearia*	Common	-	-
210	Fabaceae	*Archidendron jiringa*	Vulnerable	-	-
211	Fabaceae	*Archidendron microcarpum*	Endangered	-	-
212	Fabaceae	*Baphia nitida*	Casual	-	Grows in rain forests in coastal regions, secondary forests and abandoned farmlands.
213	Fabaceae	*Bauhinia semibifida*	Vulnerable	-	-
214	Fabaceae	*Bauhinia semibifida var. semibifida*	Vulnerable	-	-
215	Fabaceae	*Callerya atropurpurea*	Casual	-	-
216	Fabaceae	*Calopogonium mucunoides*	Naturalized	-	-
217	Fabaceae	*Centrosema molle*	Naturalized	-	-
218	Fabaceae	*Crotalaria pallida*	Naturalized	-	-
219	Fabaceae	*Dalbergia pseudo-sissoo*	-	Appendix II	-
220	Fabaceae	*Dalbergia velutina*	Crit. End.	-	-
221	Fabaceae	Derris amoena	Vulnerable	-	This perennial climbing shrub is found in lowland forests
222	Fabaceae	*Derris amoena var. maingayana*	Vulnerable	-	-
223	Fabaceae	*Desmodium heterophyllum*	Cryptogenic Weed	-	-
224	Fabaceae	*Desmodium triflorum*	Cryptogenic Weed	-	Occurs in a variety of habitats from forests to grasslands and in secondary/disturbed vegetation
225	Fabaceae	*Dialium platysepalum*	Crit. End.	-	-
226	Fabaceae	*Erythrina crista-galli*	Cultivated only	-	-
227	Fabaceae	*Falcataria moluccana*	Naturalized	-	-
228	Fabaceae	*Koompassia malaccensis*	Endangered	-	-
229	Fabaceae	*Kunstleria ridleyi*	Endangered	-	-
230	Fabaceae	*Leucaena leucocephala*	Naturalized	-	-
231	Fabaceae	*Macroptilium lathyroides*	Naturalized	-	-
232	Fabaceae	*Mimosa diplotricha*	Naturalized	-	-
233	Fabaceae	*Mimosa pigra*	Naturalized	-	-
234	Fabaceae	*Mimosa pudica*	Naturalized	-	M. pudica inhabits thickets, savannas, roadsides in pine or oak-pine forest.
235	Fabaceae	Ormosia bancana	Endangered	-	-
236	Fabaceae	Ormosia sumatrana	Extinct	-	-
237	Fabaceae	*Peltophorum pterocarpum*	Crit. End.	-	-
238	Fabaceae	*Pterocarpus indicus*	Casual	-	A widespread tree found in lowland primary and some secondary forest, mainly along tidal creeks and rocky shores.
239	Fabaceae	*Pueraria phaseoloides*	Naturalized	-	-
240	Fabaceae	*Senna alata*	Naturalized	-	-
241	Fabaceae	*Sindora wallichii*	Crit. End.	-	-
242	Fabaceae	*Spatholobus ferrugineus*	Common	-	-
243	Fabaceae	*Spatholobus maingayi*	Extinct	-	-

Item	Family	Genus species	Full name and authorship / English Name	Source	Presence#
244	Fabaceae	*Stylosanthes hamata*	-	*(2014) Mandai Gate Vegetation Survey*	O
245	Fagaceae	*Castanopsis wallichii*	Castanopsis wallichii King ex Hook. f.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/31838/0*	O
246	Fagaceae	*Lithocarpus conocarpus*	Lithocarpus conocarpus (Oudem.) Rehd.	*(2014) Mandai Gate Vegetation Survey*	O
247	Fagaceae	Lithocarpus ewyckii	Lithocarpus ewyckii (Korth.) Rehd.	*(2014) Mandai Gate Vegetation Survey*	O
248	Gleicheniaceae	*Dicranopteris linearis*	Dicranopteris linearis (Burm. f.) Underw.	*(2014) Mandai Gate Vegetation Survey*	O
249	Gleicheniaceae	Sticherus truncatus	Sticherus truncatus (Willd.) Nakai	*(2014) Mandai Gate Vegetation Survey*	O
250	Gnetaceae	*Gnetum* sp.	-	*(2014) Mandai Gate Vegetation Survey*	O
251	Heliconiaceae	*Heliconia psittacorum*	Heliconia psittacorum L. f.	*(2014) Mandai Gate Vegetation Survey*	O
252	Heliconiaceae	*Heliconia rostrata*	Heliconia rostrata Ruiz & Pav.	*(2014) Mandai Gate Vegetation Survey*	O
253	Hypericaceae	Cratoxylum formosum	Pink Mempat	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.iucnredlist.org/details/33354/0*	O
254	Hypericaceae	Cratoxylum maingayi	Cratoxylum maingayi Dyer	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/33937/0*	O
255	Icacinaceae	*Phytocrene bracteata*	Phytocrene bracteata Wall.	*(2014) Mandai Gate Vegetation Survey*	O
256	Ixonanthaceae	*Ixonanthes icosandra*	Ixonanthes icosandra Jack	*(2014) Mandai Gate Vegetation Survey*	O
257	Lamiaceae	*Clerodendrum deflexum*	Clerodendrum deflexum Wall.	*(2014) Mandai Gate Vegetation Survey*	O
258	Lamiaceae	*Clerodendrum disparifolium*	Clerodendrum disparifolium Blume	*(2014) Mandai Gate Vegetation Survey*	O
259	Lamiaceae	*Clerodendrum paniculatum*	Clerodendrum paniculatum L.	*(2014) Mandai Gate Vegetation Survey*	O
260	Lamiaceae	*Clerodendrum villosum*	Clerodendrum villosum Blume	*(2014) Mandai Gate Vegetation Survey*	O
261	Lamiaceae	*Hyptis capitata*	Hyptis capitata Jacq.	*(2014) Mandai Gate Vegetation Survey*	O
262	Lamiaceae	*Ocimum basilicum*	Ocimum basilicum L.	*(2014) Mandai Gate Vegetation Survey*	O
263	Lamiaceae	*Plectranthus monostachyus*	Plectranthus monostachyus (P.Beauv.) B.J.Pollard	*(2014) Mandai Gate Vegetation Survey*	O
264	Lamiaceae	*Vitex pinnata*	Malayan Teak	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
265	Lauraceae	*Actinodaphne macrophylla*	Actinodaphne macrophylla (Blume) Nees	*(2014) Mandai Gate Vegetation Survey*	O
266	Lauraceae	*Alseodaphne bancana*	Alseodaphne bancana Miq.	*(2014) Mandai Gate Vegetation Survey*	O
267	Lauraceae	*Beilschmiedia madang*	Beilschmiedia madang Blume	*(2014) Mandai Gate Vegetation Survey*	O
268	Lauraceae	*Cassytha filiformis*	Cassytha filiformis L.	*(2014) Mandai Gate Vegetation Survey*	O
269	Lauraceae	cf. *Alseodaphne malaccensis*	-	*(2014) Mandai Gate Vegetation Survey*	O
270	Lauraceae	*Cinnamomum iners*	Wild Cinnamon	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
271	Lauraceae	*Lindera lucida*	Lindera lucida (Blume) Boerl.	*(2014) Mandai Gate Vegetation Survey*	O
272	Lauraceae	*Litsea accedens*	Litsea accedens (Blume) Boerl.	*(2014) Mandai Gate Vegetation Survey*	O
273	Lauraceae	*Litsea castanea*	Litsea castanea Hook. f.	*(2014) Mandai Gate Vegetation Survey*	O
274	Lauraceae	*Litsea elliptica*	Litsea elliptica Blume	*(2014) Mandai Gate Vegetation Survey*	O
275	Lauraceae	*Litsea erectinervia*	Litsea erectinervia Kosterm.	*(2014) Mandai Gate Vegetation Survey*	O
276	Lauraceae	*Litsea ferruginea*	Litsea ferruginea Blume	*(2014) Mandai Gate Vegetation Survey*	O
277	Lauraceae	*Litsea firma*	Litsea firma Hook. f.	*(2014) Mandai Gate Vegetation Survey*	O
278	Lauraceae	*Litsea grandis*	Litsea grandis Hook. f.	*(2014) Mandai Gate Vegetation Survey*	O
279	Loganiaceae	*Spigelia anthelmia*	Spigelia anthelmia L.	*(2014) Mandai Gate Vegetation Survey*	O
280	Loganiaceae	*Strychnos ignatii*	Strychnos ignatii P.J. Bergius	*(2014) Mandai Gate Vegetation Survey*	O
281	Loganiaceae	*Strychnos* sp.	-	*(2014) Mandai Gate Vegetation Survey*	O
282	Lythraceae	*Lagerstroemia speciosa*	Lagerstroemia speciosa (L.) Pers.	*(2014) Mandai Gate Vegetation Survey*	O
283	Magnoliaceae	*Michelia champaca*	Orange Champaka	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.iucnredlist.org/details/191869/0*	O
284	Malvaceae	*Byttneria maingayi*	Byttneria maingayi Mast.	*(2014) Mandai Gate Vegetation Survey*	O
285	Malvaceae	*Durio zibethinus*	Durian	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
286	Malvaceae	*Grewia laevigata*	Grewia laevigata Vahl	*(2014) Mandai Gate Vegetation Survey*	O
287	Malvaceae	*Pentace triptera*	Pentace triptera Mast.	*(2014) Mandai Gate Vegetation Survey*	O
288	Malvaceae	*Sida acuta*	Sida acuta Burm. f.	*(2014) Mandai Gate Vegetation Survey*	O
289	Malvaceae	*Sterculia balanghas*	Sterculia balanghas L.	*(2014) Mandai Gate Vegetation Survey*	O
290	Malvaceae	Sterculia rubiginosa	Sterculia rubiginosa Vent.	*(2014) Mandai Gate Vegetation Survey*	O
291	Malvaceae	*Talipariti tiliaceum*	Talipariti tiliaceum (L.) Fryxell	*(2014) Mandai Gate Vegetation Survey*	O

Item	Family	Genus species	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Protected by Law
244	Fabaceae	*Stylosanthes hamata*	-	-	-	-	
245	Fagaceae	*Castanopsis wallichii*	Malaysia + Singapore	Yes	VU	Vulnerable B1+2c ver 2.3	
246	Fagaceae	*Lithocarpus conocarpus*	-	Yes	-	-	
247	Fagaceae	Lithocarpus ewyckii	-	Yes	-	-	
248	Gleicheniaceae	*Dicranopteris linearis*	-	Yes	-	-	
249	Gleicheniaceae	Sticherus truncatus	-	Yes	-	-	
250	Gnetaceae	*Gnetum* sp.	-		-	-	
251	Heliconiaceae	*Heliconia psittacorum*	-	No	-	-	
252	Heliconiaceae	*Heliconia rostrata*	-	No	-	-	
253	Hypericaceae	Cratoxylum formosum	IC + BO + PH	Yes	LC	Lower Risk/least concern ver 2.3	
254	Hypericaceae	Cratoxylum maingayi	TM + IC	Yes	LC	Lower Risk/least concern ver 2.3	
255	Icacinaceae	*Phytocrene bracteata*	-	Yes	-	-	
256	Ixonanthaceae	*Ixonanthes icosandra*	-	Yes	-	-	
257	Lamiaceae	*Clerodendrum deflexum*	-	Yes	-	-	
258	Lamiaceae	*Clerodendrum disparifolium*	-	Yes	-	-	
259	Lamiaceae	*Clerodendrum paniculatum*	-	No	-	-	
260	Lamiaceae	*Clerodendrum villosum*	-	Yes	-	-	
261	Lamiaceae	*Hyptis capitata*	-	No	-	-	
262	Lamiaceae	*Ocimum basilicum*	-	-	-	-	
263	Lamiaceae	*Plectranthus monostachyus*	-	-	-	-	
264	Lamiaceae	*Vitex pinnata*	-	Yes	-	-	
265	Lauraceae	*Actinodaphne macrophylla*	-	Yes	-	-	
266	Lauraceae	*Alseodaphne bancana*	-	Yes	-	-	
267	Lauraceae	*Beilschmiedia madang*	-	Yes	-	-	
268	Lauraceae	*Cassytha filiformis*	-	Yes	-	-	
269	Lauraceae	cf. *Alseodaphne malaccensis*	-	-	-	-	
270	Lauraceae	*Cinnamomum iners*	-	Yes	-	-	
271	Lauraceae	*Lindera lucida*	-	Yes	-	-	
272	Lauraceae	*Litsea accedens*	-	Yes	-	-	
273	Lauraceae	*Litsea castanea*	-	Yes	-	-	
274	Lauraceae	*Litsea elliptica*	-	Yes	-	-	
275	Lauraceae	*Litsea erectinervia*	-	Yes	-	-	
276	Lauraceae	*Litsea ferruginea*	-	Yes	-	-	
277	Lauraceae	*Litsea firma*	-	Yes	-	-	
278	Lauraceae	*Litsea grandis*	-	Yes	-	-	
279	Loganiaceae	*Spigelia anthelmia*	-	-	-	-	
280	Loganiaceae	*Strychnos ignatii*	-	Yes	-	-	
281	Loganiaceae	*Strychnos* sp.	-	-	-	-	
282	Lythraceae	*Lagerstroemia speciosa*	-	No	-	-	
283	Magnoliaceae	*Michelia champaca*	IM + EA	-	LC	Least Concern ver 3.1	
284	Malvaceae	*Byttneria maingayi*	-	Yes	-	-	
285	Malvaceae	*Durio zibethinus*	-	No	-	-	
286	Malvaceae	*Grewia laevigata*	-	Yes	-	-	
287	Malvaceae	*Pentace triptera*	-	Yes	-	-	
288	Malvaceae	*Sida acuta*	-	-	-	-	
289	Malvaceae	*Sterculia balanghas*	-	No	-	-	
290	Malvaceae	Sterculia rubiginosa	-	Yes	-	-	
291	Malvaceae	*Talipariti tiliaceum*	-	Yes	-	-	

Item	Family	Genus species	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
244	Fabaceae	*Stylosanthes hamata*	-	-	-
245	Fagaceae	*Castanopsis wallichii*	Crit. End.	-	Lowland rainforest.
246	Fagaceae	*Lithocarpus conocarpus*	Crit. End.	-	-
247	Fagaceae	Lithocarpus ewyckii	Endangered	-	-
248	Gleicheniaceae	*Dicranopteris linearis*	Common	-	-
249	Gleicheniaceae	Sticherus truncatus	Vulnerable (VU/D) *Davidson et.al (2008) The Singapore Red Data Book*	-	-
250	Gnetaceae	*Gnetum* sp.		-	-
251	Heliconiaceae	*Heliconia psittacorum*	Casual	-	-
252	Heliconiaceae	*Heliconia rostrata*	Cultivated only	-	-
253	Hypericaceae	Cratoxylum formosum	Endangered	-	A widespread species found mainly in lowland primary and secondary forest recorded on many soil types
254	Hypericaceae	Cratoxylum maingayi	Crit. End.	-	A rare tree found scattered in lowland primary and secondary forests.
255	Icacinaceae	*Phytocrene bracteata*	Vulnerable	-	-
256	Ixonanthaceae	*Ixonanthes icosandra*	Vulnerable	-	-
257	Lamiaceae	*Clerodendrum deflexum*	Vulnerable	-	-
258	Lamiaceae	*Clerodendrum disparifolium*	Common	-	-
259	Lamiaceae	*Clerodendrum paniculatum*	Casual	-	-
260	Lamiaceae	*Clerodendrum villosum*	Vulnerable	-	-
261	Lamiaceae	*Hyptis capitata*	Naturalized	-	-
262	Lamiaceae	*Ocimum basilicum*	Cryptogenic Weed	-	-
263	Lamiaceae	*Plectranthus monostachyus*	-	-	-
264	Lamiaceae	*Vitex pinnata*	Common	-	-
265	Lauraceae	*Actinodaphne macrophylla*	Rediscovered	-	-
266	Lauraceae	*Alseodaphne bancana*	Crit. End.	-	-
267	Lauraceae	*Beilschmiedia madang*	Endangered	-	-
268	Lauraceae	*Cassytha filiformis*	Common	-	-
269	Lauraceae	cf. *Alseodaphne malaccensis*	-	-	-
270	Lauraceae	*Cinnamomum iners*	Common	-	-
271	Lauraceae	*Lindera lucida*	Vulnerable	-	-
272	Lauraceae	*Litsea accedens*	Endangered	-	-
273	Lauraceae	*Litsea castanea*	Endangered	-	-
274	Lauraceae	*Litsea elliptica*	Common	-	-
275	Lauraceae	*Litsea erectinervia*	Crit. End.	-	-
276	Lauraceae	*Litsea ferruginea*	Crit. End.	-	-
277	Lauraceae	*Litsea firma*	Vulnerable	-	-
278	Lauraceae	*Litsea grandis*	Endangered	-	-
279	Loganiaceae	*Spigelia anthelmia*	-	-	-
280	Loganiaceae	*Strychnos ignatii*	Vulnerable	-	-
281	Loganiaceae	*Strychnos* sp.	-	-	-
282	Lythraceae	*Lagerstroemia speciosa*	Cultivated only	-	-
283	Magnoliaceae	*Michelia champaca*	-	-	It is found scattered in riparian primary lowland to montane evergreen broadleaf forests in moist vegetation.
284	Malvaceae	*Byttneria maingayi*	Crit. End.	-	-
285	Malvaceae	*Durio zibethinus*	Casual	-	-
286	Malvaceae	*Grewia laevigata*	Vulnerable	-	-
287	Malvaceae	*Pentace triptera*	Endangered	-	-
288	Malvaceae	*Sida acuta*	Cryptogenic Weed	-	-
289	Malvaceae	*Sterculia balanghas*	Cultivated only	-	-
290	Malvaceae	Sterculia rubiginosa	Vulnerable	-	-
291	Malvaceae	*Taliparitiliaceum*	Common	-	-

Item	Family	Genus species	Full name and authorship / English Name	Source	Presence#
292	Malvaceae	*Theobroma cacao*	Theobroma cacao L.	*(2014) Mandai Gate Vegetation Survey*	O
293	Malvaceae	*Ceiba pentandra*	Kapok Tree	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/20266561*	O
294	Marantaceae	*Calathea ornata*	Calathea ornata (Linden ex Lem.) Korn.	*(2014) Mandai Gate Vegetation Survey*	O
295	Marantaceae	*Thalia geniculata*	Thalia geniculata L.	*(2014) Mandai Gate Vegetation Survey*	O
296	Melastomataceae	*Clidemia hirta*	Clidemia hirta (L.) D. Don	*(2014) Mandai Gate Vegetation Survey*	O
297	Melastomataceae	*Melastoma malabathricum*	Sendudok	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
298	Melastomataceae	Memecylon paniculatum	Memecylon paniculatum Jack	*(2014) Mandai Gate Vegetation Survey*	O
299	Melastomataceae	Pternandra caerulescens	Pternandra caerulescens Jack	*(2014) Mandai Gate Vegetation Survey*	O
300	Melastomataceae	*Pternandra echinata*	Pternandra echinata Jack	*(2014) Mandai Gate Vegetation Survey*	O
301	Meliaceae	*Lansium parasiticum*	Lansium parasiticum (Osbeck) K.C.Sahni & Bennet	*(2014) Mandai Gate Vegetation Survey*	O
302	Meliaceae	*Sandoricum beccarianum*	Sandoricum beccarianum Baill.	*(2014) Mandai Gate Vegetation Survey*	O
303	Meliaceae	*Swietenia macrophylla*	Swietenia macrophylla King	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/32293/0*	O
304	Menispermaceae	*Cyclea laxiflora*	Cyclea laxiflora Miers	*(2014) Mandai Gate Vegetation Survey*	O
305	Menispermaceae	*Fibraurea tinctoria*	Fibraurea tinctoria Lour.	*(2014) Mandai Gate Vegetation Survey*	O
306	Menispermaceae	*Limacia scandens*	Limacia scandens Lour.	*(2014) Mandai Gate Vegetation Survey*	O
307	Moraceae	*Artocarpus elasticus*	Artocarpus elasticus Reinw. ex Blume	*(2014) Mandai Gate Vegetation Survey*	O
308	Moraceae	*Artocarpus heterophyllus*	Artocarpus heterophyllus Lam.	*(2014) Mandai Gate Vegetation Survey*	O
309	Moraceae	*Artocarpus integer*	Artocarpus integer (Thunb.) Merr.	*(2014) Mandai Gate Vegetation Survey*	O
310	Moraceae	*Ficus benjamina*	Waringin	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
311	Moraceae	*Ficus fistulosa*	Ficus fistulosa Reinw. ex Blume	*(2014) Mandai Gate Vegetation Survey*	O
312	Moraceae	*Ficus globosa*	Ficus globosa Blume	*(2014) Mandai Gate Vegetation Survey*	O
313	Moraceae	*Ficus heteropleura*	Ficus heteropleura Blume	*(2014) Mandai Gate Vegetation Survey*	O
314	Moraceae	*Ficus lyrata*	Ficus lyrata Warb.	*(2014) Mandai Gate Vegetation Survey*	O
315	Moraceae	*Ficus microcarpa*	Malayan Banyan	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
316	Moraceae	*Ficus pumila*	Ficus pumila L.	*(2014) Mandai Gate Vegetation Survey*	O
317	Moraceae	*Ficus punctata*	Ficus punctata Thunb.	*(2014) Mandai Gate Vegetation Survey*	O
318	Moraceae	*Ficus vasculosa*	Ficus vasculosa Wall. ex Miq.	*(2014) Mandai Gate Vegetation Survey*	O
319	Moraceae	*Streblus elongatus*	Streblus elongatus (Miq.) Corner	*(2014) Mandai Gate Vegetation Survey*	O
320	Moraceae	*Ficus auriculata*	Roxburgh's Fig	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/20245365*	O
321	Moraceae	*Ficus elastica*	Indian Rubber Tree	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/20245670*	O
322	Moraceae	*Ficus religiosa*	Bodh-Tree	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/20246066*	O
323	Muntingiaceae	*Muntingia calabura*	Buah Cheri	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
324	Musaceae	*Musa acuminata*	Musa acuminata Colla var. sumatrana	*(2014) Mandai Gate Vegetation Survey*	O
325	Myricaceae	*Morella esculenta*	Morella esculenta (Buch.-Ham. ex D. Don) I.M. Turner	*(2014) Mandai Gate Vegetation Survey*	O
326	Myristicaceae	*Horsfieldia polyspherula*	Horsfieldia polyspherula (Hook. f. emend. King) J. Sinclair	*(2014) Mandai Gate Vegetation Survey*	O
327	Myristicaceae	Knema communis	Knema communis J. Sinclair	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/31850/0*	O
328	Myristicaceae	*Knema curtisii*	Knema curtisii (King) Warb. var. paludosa J. Sinclair	*(2014) Mandai Gate Vegetation Survey*	O
329	Myrtaceae	*Rhodamnia cinerea*	Silverback	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
330	Myrtaceae	*Syzygium acuminatissimum*	Syzygium acuminatissimum (Blume) DC.	*(2014) Mandai Gate Vegetation Survey*	O
331	Myrtaceae	*Syzygium aqueum*	Syzygium aqueum (Burm. f.) Alston	*(2014) Mandai Gate Vegetation Survey*	O
332	Myrtaceae	*Syzygium borneense*	Syzygium borneense (Miq.) Miq.	*(2014) Mandai Gate Vegetation Survey*	O
333	Myrtaceae	*Syzygium claviflorum*	Syzygium claviflorum (Roxb.) Wall. ex A.M.Cowan & Cowan var. claviflorum	*(2014) Mandai Gate Vegetation Survey*	O
334	Myrtaceae	*Syzygium filiforme*	Syzygium filiforme (Wall. ex Duthie) Chantaran. & J. Parn. var. filiforme	*(2014) Mandai Gate Vegetation Survey*	O
335	Myrtaceae	*Syzygium grande*	Syzygium grande (Wight) Walp.	*(2014) Mandai Gate Vegetation Survey*	O

Item	Family	Genus species	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Protected by Law
292	Malvaceae	*Theobroma cacao*	-	No	-	-	
293	Malvaceae	*Ceiba pentandra*	-	-	-	-	
294	Marantaceae	*Calathea ornata*	-	No	-	-	
295	Marantaceae	*Thalia geniculata*	-	No	-	-	
296	Melastomataceae	*Clidemia hirta*	-	No	-	-	
297	Melastomataceae	*Melastoma malabathricum*	-	Yes	-	-	
298	Melastomataceae	Memecylon paniculatum	-	Yes	-	-	
299	Melastomataceae	Pternandra caerulescens	-	Yes	-	-	
300	Melastomataceae	*Pternandra echinata*	-	Yes	-	-	
301	Meliaceae	*Lansium parasiticum*	-	No	-	-	
302	Meliaceae	*Sandoricum beccarianum*	-	Yes	-	-	
303	Meliaceae	*Swietenia macrophylla*	Central America + South America	No	VU	Vulnerable A1cd+2cd ver 2.3	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*
304	Menispermaceae	*Cyclea laxiflora*	-	Yes	-	-	
305	Menispermaceae	*Fibraurea tinctoria*	-	Yes	-	-	
306	Menispermaceae	*Limacia scandens*	-	Yes	-	-	
307	Moraceae	*Artocarpus elasticus*	-	Yes	-	-	
308	Moraceae	*Artocarpus heterophyllus*	-	No	-	-	
309	Moraceae	*Artocarpus integer*	-	No	-	-	
310	Moraceae	*Ficus benjamina*	-	-	-	-	
311	Moraceae	*Ficus fistulosa*	-	Yes	-	-	
312	Moraceae	*Ficus globosa*	-	Yes	-	-	
313	Moraceae	*Ficus heteropleura*	-	Yes	-	-	
314	Moraceae	*Ficus lyrata*	-	No	-	-	
315	Moraceae	*Ficus microcarpa*	-	Yes	-	-	
316	Moraceae	*Ficus pumila*	-	No	-	-	
317	Moraceae	*Ficus punctata*	-	Yes	-	-	
318	Moraceae	*Ficus vasculosa*	-	Yes	-	-	
319	Moraceae	*Streblus elongatus*	-	Yes	-	-	
320	Moraceae	*Ficus auriculata*	-	-	-	-	
321	Moraceae	*Ficus elastica*	-	-	-	-	
322	Moraceae	*Ficus religiosa*	-	-	-	-	
323	Muntingiaceae	*Muntingia calabura*	-	No	-	-	
324	Musaceae	*Musa acuminata*	-	No	-	-	
325	Myricaceae	*Morella esculenta*	-	Yes	-	-	
326	Myristicaceae	*Horsfieldia polyspherula*	-	Yes	-	-	
327	Myristicaceae	Knema communis	Malaysia	Yes	VU	Vulnerable A1c ver 2.3	
328	Myristicaceae	*Knema curtisii*	-	Yes	-	-	
329	Myrtaceae	*Rhodamnia cinerea*	-	Yes	-	-	
330	Myrtaceae	*Syzygium acuminatissimum*	-	Yes	-	-	
331	Myrtaceae	*Syzygium aqueum*	-	No	-	-	
332	Myrtaceae	*Syzygium borneense*	-	Yes	-	-	
333	Myrtaceae	*Syzygium claviflorum*	-	Yes	-	-	
334	Myrtaceae	*Syzygium filiforme*	-	Yes	-	-	
335	Myrtaceae	*Syzygium grande*	-	Yes	-	-	

Item	Family	Genus species	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
292	Malvaceae	*Theobroma cacao*	Cultivated only	-	-
293	Malvaceae	*Ceiba pentandra*	-	-	-
294	Marantaceae	*Calathea ornata*	Cultivated only	-	-
295	Marantaceae	*Thalia geniculata*	Cultivated only	-	-
296	Melastomataceae	*Clidemia hirta*	Naturalized	-	-
297	Melastomataceae	*Melastoma malabathricum*	Common	-	-
298	Melastomataceae	Memecylon paniculatum	Crit. End.	-	-
299	Melastomataceae	Pternandra caerulescens	Vulnerable	-	-
300	Melastomataceae	*Pternandra echinata*	Vulnerable	-	-
301	Meliaceae	*Lansium parasiticum*	Cultivated only	-	-
302	Meliaceae	*Sandoricum beccarianum*	Crit. End.	-	-
303	Meliaceae	*Swietenia macrophylla*	Casual	Appendix II	Various forest types
304	Menispermaceae	*Cyclea laxiflora*	Crit. End.	-	-
305	Menispermaceae	*Fibraurea tinctoria*	Common	-	-
306	Menispermaceae	*Limacia scandens*	Vulnerable	-	-
307	Moraceae	*Artocarpus elasticus*	Common	-	-
308	Moraceae	*Artocarpus heterophyllus*	Casual	-	-
309	Moraceae	*Artocarpus integer*	Casual	-	-
310	Moraceae	*Ficus benjamina*	Cryptogenic Weed	-	-
311	Moraceae	*Ficus fistulosa*	Common	-	-
312	Moraceae	*Ficus globosa*	Endangered	-	-
313	Moraceae	*Ficus heteropleura*	Common	-	-
314	Moraceae	*Ficus lyrata*	Cultivated only	-	-
315	Moraceae	*Ficus microcarpa*	Common	-	-
316	Moraceae	*Ficus pumila*	Casual	-	-
317	Moraceae	*Ficus punctata*	Common	-	-
318	Moraceae	*Ficus vasculosa*	Endangered	-	-
319	Moraceae	*Streblus elongatus*	Vulnerable	-	-
320	Moraceae	*Ficus auriculata*	-	-	-
321	Moraceae	*Ficus elastica*	-	-	-
322	Moraceae	*Ficus religiosa*	-	-	-
323	Muntingiaceae	*Muntingia calabura*	Naturalized	-	-
324	Musaceae	*Musa acuminata*	Cultivated only	-	-
325	Myricaceae	*Morella esculenta*	Common	-	-
326	Myristicaceae	*Horsfieldia polyspherula*	Vulnerable	-	-
327	Myristicaceae	Knema communis	Endangered	-	This scattered species grows in lowland and hill rainforest up to 270 m.
328	Myristicaceae	*Knema curtisii*	Endangered	-	-
329	Myrtaceae	*Rhodamnia cinerea*	Common	-	-
330	Myrtaceae	*Syzygium acuminatissimum*	Endangered	-	-
331	Myrtaceae	*Syzygium aqueum*	Cultivated only	-	-
332	Myrtaceae	*Syzygium borneense*	Common	-	-
333	Myrtaceae	*Syzygium claviflorum*	Crit. End.	-	-
334	Myrtaceae	*Syzygium filiforme*	Endangered	-	-
335	Myrtaceae	*Syzygium grande*	Common	-	-

Item	Family	Genus species	Full name and authorship / English Name	Source	Presence#
336	Myrtaceae	*Syzygium jambos*	Syzygium jambos (L.) Alston	*(2014) Mandai Gate Vegetation Survey*	O
337	Myrtaceae	*Syzygium lineatum*	Syzygium lineatum (DC.) Merr. & L.M. Perry	*(2014) Mandai Gate Vegetation Survey*	O
338	Myrtaceae	*Syzygium malaccense*	Syzygium malaccense (L.) Merr. & L. M. Perry	*(2014) Mandai Gate Vegetation Survey*	O
339	Myrtaceae	*Syzygium myrtifolium*	Syzygium myrtifolium Walp.	*(2014) Mandai Gate Vegetation Survey*	O
340	Myrtaceae	*Syzygium polyanthum*	Syzygium polyanthum (Wight) Walp.	*(2014) Mandai Gate Vegetation Survey*	O
341	Myrtaceae	*Syzygium ridleyi*	Syzygium ridleyi (King) P. Chantaranothai & J. Parn.	*(2014) Mandai Gate Vegetation Survey*	O
342	Myrtaceae	*Syzygium scortechinii*	Syzygium scortechinii (King) P.Chantaranothai & J.Parn. var. scortechinii	*(2014) Mandai Gate Vegetation Survey*	O
343	Myrtaceae	*Syzygium singaporense*	Syzygium singaporense (King) Airy Shaw	*(2014) Mandai Gate Vegetation Survey*	O
344	Myrtaceae	*Syzygium* sp.	-	*(2014) Mandai Gate Vegetation Survey*	O
345	Myrtaceae	*Syzygium zeylanicum*	Syzygium zeylanicum (L.) DC.	*(2014) Mandai Gate Vegetation Survey*	O
346	Nyctaginaceae	*Bougainvillea glabra*	Bougainvillea glabra Choisy	*(2014) Mandai Gate Vegetation Survey*	O
347	Olacaceae	*Ochanostachys amentacea*	Ochanostachys amentacea Mast.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/33238/0*	O
348	Olacaceae	*Scorodocarpus borneensis*	Scorodocarpus borneensis Becc.	*(2014) Mandai Gate Vegetation Survey*	O
349	Olacaceae	*Strombosia ceylanica*	Strombosia ceylanica Gardn.	*(2014) Mandai Gate Vegetation Survey*	O
350	Oleandraceae	*Nephrolepis auriculata*	Nephrolepis auriculata (L.) Trimen	*(2014) Mandai Gate Vegetation Survey*	O
351	Oleandraceae	*Nephrolepis biserrata*	Nephrolepis biserrata (Sw.) Schott	*(2014) Mandai Gate Vegetation Survey*	O
352	Onagraceae	*Ludwigia octovalvis*	Ludwigia octovalvis (Jacq.) P.H. Raven	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/169056/0*	O
353	Orchidaceae	*Spathoglottis plicata*	Spathoglottis plicata Blume	*(2014) Mandai Gate Vegetation Survey*	O
354	Oxalidaceae	*Averrhoa bilimbi*	Belimbing	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
355	Oxalidaceae	*Averrhoa carambola*	Starfruit	*(2014) Mandai Gate Vegetation Survey*	O
356	Oxalidaceae	*Oxalis barrelieri*	Oxalis barrelieri L.	*(2014) Mandai Gate Vegetation Survey*	O
357	Pandanaceae	*Freycinetia sumatrana*	Freycinetia sumatrana Hemsley	*(2014) Mandai Gate Vegetation Survey*	O
358	Pandanaceae	*Pandanus amaryllifolius*	Pandanus amaryllifolius Roxb.	*(2014) Mandai Gate Vegetation Survey*	O
359	Pandanaceae	*Pandanus atrocarpus*	Pandanus atrocarpus Griff.	*(2014) Mandai Gate Vegetation Survey*	O
360	Pandanaceae	*Pandanus* sp.	-	*(2014) Mandai Gate Vegetation Survey*	O
361	Passifloraceae	*Passiflora foetida*	Passiflora foetida L.	*(2014) Mandai Gate Vegetation Survey*	O
362	Passifloraceae	*Passiflora laurifolia*	Passiflora laurifolia L.	*(2014) Mandai Gate Vegetation Survey*	O
363	Pentaphylacaceae	*Adinandra dumosa*	Tiup Tiup	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/20285322*	O
364	Phyllanthaceae	Antidesma cuspidatum	Antidesma cuspidatum Müll. Arg.	*(2014) Mandai Gate Vegetation Survey*	O
365	Phyllanthaceae	*Aporosa frutescens*	Aporosa frutescens Blume	*(2014) Mandai Gate Vegetation Survey*	O
366	Phyllanthaceae	*Aporosa lucida*	Aporosa lucida (Miq.) Airy Shaw var. lucida	*(2014) Mandai Gate Vegetation Survey*	O
367	Phyllanthaceae	*Aporosa lunata*	Aporosa lunata (Miq.) Kurz	*(2014) Mandai Gate Vegetation Survey*	O
368	Phyllanthaceae	*Aporosa nervosa*	Aporosa nervosa Hook. f.	*(2014) Mandai Gate Vegetation Survey*	O
369	Phyllanthaceae	Baccaurea motleyana	Baccaurea motleyana (Müll. Arg.) Müll. Arg.	*(2014) Mandai Gate Vegetation Survey*	O
370	Phyllanthaceae	*Baccaurea parviflora*	Baccaurea parviflora (Müll. Arg.) Müll. Arg.	*(2014) Mandai Gate Vegetation Survey*	O
371	Phyllanthaceae	Breynia coronata	Breynia coronata Hook. f.	*(2014) Mandai Gate Vegetation Survey*	O
372	Phyllanthaceae	*Bridelia stipularis*	Bridelia stipularis (L.) Blume	*(2014) Mandai Gate Vegetation Survey*	O
373	Phyllanthaceae	*Bridelia tomentosa*	Bridelia tomentosa Blume	*(2014) Mandai Gate Vegetation Survey*	O
374	Phyllanthaceae	*Phyllanthus debilis*	Phyllanthus debilis Klein ex Willd.	*(2014) Mandai Gate Vegetation Survey*	O
375	Phyllanthaceae	*Aporosa* 1	-	*(2014) Mandai Gate Vegetation Survey*	O
376	Phyllanthaceae	*Aporosa* 2	-	*(2014) Mandai Gate Vegetation Survey*	O
377	Piperaceae	Peperomia pellucida	Peperomia pellucida (L.) Kunth	*(2014) Mandai Gate Vegetation Survey*	O
378	Piperaceae	*Piper aduncum*	Piper aduncum L.	*(2014) Mandai Gate Vegetation Survey*	O
379	Piperaceae	*Piper betle*	Piper betle L.	*(2014) Mandai Gate Vegetation Survey*	O
380	Piperaceae	*Piper flavimarginatum*	Piper flavimarginatum C. DC.	*(2014) Mandai Gate Vegetation Survey*	O

Item	Family	Genus species	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Protected by Law
336	Myrtaceae	*Syzygium jambos*	-	No	-	-	
337	Myrtaceae	*Syzygium lineatum*	-	Yes	-	-	
338	Myrtaceae	*Syzygium malaccense*	-	No	-	-	
339	Myrtaceae	*Syzygium myrtifolium*	-	Yes	-	-	
340	Myrtaceae	*Syzygium polyanthum*	-	Yes	-	-	
341	Myrtaceae	*Syzygium ridleyi*	-	Yes	-	-	
342	Myrtaceae	*Syzygium scortechinii*	-	Yes	-	-	
343	Myrtaceae	*Syzygium singaporense*	-	Yes	-	-	
344	Myrtaceae	*Syzygium* sp.	-		-	-	
345	Myrtaceae	*Syzygium zeylanicum*	-	Yes	-	-	
346	Nyctaginaceae	*Bougainvillea glabra*	-	No	-	-	
347	Olacaceae	*Ochanostachys amentacea*	SD	Yes	DD	Data Deficient ver 2.3	
348	Olacaceae	*Scorodocarpus borneensis*	-	Yes	-	-	
349	Olacaceae	*Strombosia ceylanica*	-	Yes	-	-	
350	Oleandraceae	*Nephrolepis auriculata*	-	-	-	-	
351	Oleandraceae	*Nephrolepis biserrata*	-	-	-	-	
352	Onagraceae	*Ludwigia octovalvis*	Asia + Africa + South America + AS	-	LC	Least Concern ver 3.1	
353	Orchidaceae	*Spathoglottis plicata*	-	Yes	-	-	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*
354	Oxalidaceae	*Averrhoa bilimbi*	-	No	-	-	
355	Oxalidaceae	*Averrhoa carambola*	-	No	-	-	
356	Oxalidaceae	*Oxalis barrelieri*	-	No	-	-	
357	Pandanaceae	*Freycinetia sumatrana*	-	Yes	-	-	
358	Pandanaceae	*Pandanus amaryllifolius*	-	No	-	-	
359	Pandanaceae	*Pandanus atrocarpus*	-	Yes	-	-	
360	Pandanaceae	*Pandanus* sp.	-		-	-	
361	Passifloraceae	*Passiflora foetida*	-	No	-	-	
362	Passifloraceae	*Passiflora laurifolia*	-	No	-	-	
363	Pentaphylacaceae	*Adinandra dumosa*	Malaysia	-	-	-	
364	Phyllanthaceae	Antidesma cuspidatum	-	Yes	-	-	
365	Phyllanthaceae	*Aporosa frutescens*	-	Yes	-	-	
366	Phyllanthaceae	*Aporosa lucida*	-	Yes	-	-	
367	Phyllanthaceae	*Aporosa lunata*	-	Yes	-	-	
368	Phyllanthaceae	*Aporosa nervosa*	-	Yes	-	-	
369	Phyllanthaceae	Baccaurea motleyana	-	Yes	-	-	
370	Phyllanthaceae	*Baccaurea parviflora*	-	Yes	-	-	
371	Phyllanthaceae	Breynia coronata	-	Yes	-	-	
372	Phyllanthaceae	*Bridelia stipularis*	-	Yes	-	-	
373	Phyllanthaceae	*Bridelia tomentosa*	-	Yes	-	-	
374	Phyllanthaceae	*Phyllanthus debilis*	-	No	-	-	
375	Phyllanthaceae	*Aporosa* 1	-	-	-	-	
376	Phyllanthaceae	*Aporosa* 2	-	-	-	-	
377	Piperaceae	Peperomia pellucida	-	No	-	-	
378	Piperaceae	*Piper aduncum*	-	No	-	-	
379	Piperaceae	*Piper betle*	-	No	-	-	
380	Piperaceae	*Piper flavimarginatum*	-	Yes	-	-	

Item	Family	Genus species	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
336	Myrtaceae	*Syzygium jambos*	Casual	-	-
337	Myrtaceae	*Syzygium lineatum*	Common	-	-
338	Myrtaceae	*Syzygium malaccense*	Casual	-	-
339	Myrtaceae	*Syzygium myrtifolium*	Extinct	-	-
340	Myrtaceae	*Syzygium polyanthum*	Vulnerable	-	-
341	Myrtaceae	*Syzygium ridleyi*	Endangered	-	-
342	Myrtaceae	*Syzygium scortechinii*	Rediscovered	-	-
343	Myrtaceae	*Syzygium singaporense*	Crit. End.	-	-
344	Myrtaceae	*Syzygium* sp.		-	-
345	Myrtaceae	*Syzygium zeylanicum*	Common	-	-
346	Nyctaginaceae	*Bougainvillea glabra*	Cultivated only	-	-
347	Olacaceae	*Ochanostachys amentacea*	Vulnerable	-	Found scattered in the understorey, occasionally reaching the canopy, of primary and secondary lowland rainforest, often mixed dipterocarp forest.
348	Olacaceae	*Scorodocarpus borneensis*	Endangered	-	-
349	Olacaceae	*Strombosia ceylanica*	Vulnerable	-	-
350	Oleandraceae	*Nephrolepis auriculata*	Cryptogenic Weed	-	-
351	Oleandraceae	*Nephrolepis biserrata*	Cryptogenic Weed	-	-
352	Onagraceae	*Ludwigia octovalvis*	Cryptogenic Weed	-	-
353	Orchidaceae	*Spathoglottis plicata*	Common	Appendix II	-
354	Oxalidaceae	*Averrhoa bilimbi*	Casual	-	-
355	Oxalidaceae	*Averrhoa carambola*	Casual	-	-
356	Oxalidaceae	*Oxalis barrelieri*	Naturalized	-	-
357	Pandanaceae	*Freycinetia sumatrana*	Common	-	-
358	Pandanaceae	*Pandanus amaryllifolius*	Casual	-	-
359	Pandanaceae	*Pandanus atrocarpus*	Endangered	-	-
360	Pandanaceae	*Pandanus* sp.		-	-
361	Passifloraceae	*Passiflora foetida*	Naturalized	-	-
362	Passifloraceae	*Passiflora laurifolia*	Naturalized	-	-
363	Pentaphylacaceae	*Adinandra dumosa*	-	-	-
364	Phyllanthaceae	Antidesma cuspidatum	Common	-	-
365	Phyllanthaceae	*Aporosa frutescens*	Common	-	-
366	Phyllanthaceae	*Aporosa lucida*	Crit. End.	-	-
367	Phyllanthaceae	*Aporosa lunata*	Crit. End.	-	-
368	Phyllanthaceae	*Aporosa nervosa*	Vulnerable	-	-
369	Phyllanthaceae	Baccaurea motleyana	Crit. End.	-	-
370	Phyllanthaceae	*Baccaurea parviflora*	Common	-	-
371	Phyllanthaceae	Breynia coronata	Endangered	-	-
372	Phyllanthaceae	*Bridelia stipularis*	Vulnerable	-	-
373	Phyllanthaceae	*Bridelia tomentosa*	Common	-	-
374	Phyllanthaceae	*Phyllanthus debilis*	Naturalized	-	-
375	Phyllanthaceae	*Aporosa* 1	-	-	-
376	Phyllanthaceae	*Aporosa* 2	-	-	-
377	Piperaceae	Peperomia pellucida	Naturalized	-	-
378	Piperaceae	*Piper aduncum*	Naturalized	-	-
379	Piperaceae	*Piper betle*	Casual	-	-
380	Piperaceae	*Piper flavimarginatum*	Crit. End.	-	-

Item	Family	Genus species	Full name and authorship / English Name	Source	Presence#
381	Piperaceae	*Piper sarmentosum*	Piper sarmentosum Roxb.	(2014) Mandai Gate Vegetation Survey	O
382	Piperaceae	*Piper* sp. 1	-	(2014) Mandai Gate Vegetation Survey	O
383	Poaceae	*Axonopus compressus*	Axonopus compressus (Sw.) Beauv.	(2014) Mandai Gate Vegetation Survey	O
384	Poaceae	Bamboo	-	(2014) Mandai Gate Vegetation Survey	O
385	Poaceae	*Bambusa vulgaris*	Bambusa vulgaris Schrad. ex J. C. Wendl.	(2014) Mandai Gate Vegetation Survey	O
386	Poaceae	*Cenchrus echinatus*	Cenchrus echinatus L.	(2014) Mandai Gate Vegetation Survey	O
387	Poaceae	*Centotheca lappacea*	Centotheca lappacea (L.) Desv.	(2014) Mandai Gate Vegetation Survey	O
388	Poaceae	*Chloris barbata*	Chloris barbata Sw.	(2014) Mandai Gate Vegetation Survey	O
389	Poaceae	*Coix lacryma-jobi*	Coix lacryma-jobi L.	(2014) Mandai Gate Vegetation Survey	O
390	Poaceae	*Cynodon dactylon*	Cynodon dactylon (L.) Pers.	(2014) Mandai Gate Vegetation Survey	O
391	Poaceae	*Dactyloctenium aegyptium*	Dactyloctenium aegyptium (L.) Willd.	(2014) Mandai Gate Vegetation Survey	O
392	Poaceae	*Digitaria longiflora*	Digitaria longiflora (Retz.) Pers.	(2014) Mandai Gate Vegetation Survey	O
393	Poaceae	*Eleusine indica*	Eleusine indica (L.) Gaertn.	(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/177359/0	O
394	Poaceae	*Imperata cylindrica*	Imperata cylindrica (L.) P. Beauv.	(2014) Mandai Gate Vegetation Survey	O
395	Poaceae	*Ischaemum ciliare*	Ischaemum ciliare Retz.	(2014) Mandai Gate Vegetation Survey	O
396	Poaceae	*Ischaemum muticum*	Ischaemum muticum L.	(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/177115/0	O
397	Poaceae	*Panicum maximum*	Panicum maximum Jacq.	(2014) Mandai Gate Vegetation Survey	O
398	Poaceae	*Paspalum conjugatum*	Paspalum conjugatum P.J. Bergius	(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/177227/0	O
399	Poaceae	*Paspalum scrobiculatum*	Paspalum scrobiculatum L. var. biscuspidatum Hack.	(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/168983/0	O
400	Poaceae	*Pennisetum purpureum*	Pennisetum purpureum Schumach.	(2014) Mandai Gate Vegetation Survey	O
401	Poaceae	*Setaria barbata*	Setaria barbata (Lam.) Kunth	(2014) Mandai Gate Vegetation Survey	O
402	Poaceae	*Sporobolus indicus*	Sporobolus indicus (L.) R. Br. var. flaccidus (Roem. & Schult.) Veldk.	(2014) Mandai Gate Vegetation Survey	O
403	Poaceae	*Stenotaphrum secundatum*	Stenotaphrum secundatum (Walter) Kuntze	(2014) Mandai Gate Vegetation Survey	O
404	Poaceae	*Themeda villosa*	Themeda villosa (Poir.) A. Camus	(2014) Mandai Gate Vegetation Survey	O
405	Poaceae	*Zoysia matrella*	Zoysia matrella (L.) Merr.	(2014) Mandai Gate Vegetation Survey	O
406	Polygalaceae	*Xanthophyllum ellipticum*	Xanthophyllum ellipticum Korth.	(2014) Mandai Gate Vegetation Survey	O
407	Polygalaceae	*Xanthophyllum eurhynchum*	Xanthophyllum eurhynchum Miq.	(2014) Mandai Gate Vegetation Survey	O
408	Polygalaceae	*Xanthophyllum flavescens*	Xanthophyllum flavescens Roxb.	(2014) Mandai Gate Vegetation Survey	O
409	Polygalaceae	*Xanthophyllum vitellinum*	Xanthophyllum vitellinum (Blume) Dietr.	(2014) Mandai Gate Vegetation Survey	O
410	Polygonaceae	*Antigonon leptopus*	Antigonon leptopus Hook. & Arn.	(2014) Mandai Gate Vegetation Survey	O
411	Polypodiaceae	*Drynaria quercifolia*	Drynaria quercifolia (L.) J. Sm.	(2014) Mandai Gate Vegetation Survey	O
412	Primulaceae	*Ardisia elliptica*	Seashore Ardisia	Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)	O
413	Primulaceae	*Ardisia sanguinolenta*	Ardisia sanguinolenta Blume	(2014) Mandai Gate Vegetation Survey	O
414	Primulaceae	*Ardisia teysmanniana*	Ardisia teysmanniana Scheff.	(2014) Mandai Gate Vegetation Survey	O
415	Primulaceae	*Grenacheria amentacea*	Grenacheria amentacea (C.B. Clarke) Mez	(2014) Mandai Gate Vegetation Survey	O
416	Primulaceae	*Ardisia* 1	-	(2014) Mandai Gate Vegetation Survey	O
417	Pteridaceae	*Pteris vittata*	Pteris vittata L.	(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/177137/0	O
418	Pteridaceae	*Taenitis blechnoides*	Taenitis blechnoides (Willd.) Sw.	(2014) Mandai Gate Vegetation Survey	O
419	Putranjivaceae	Drypetes pendula	Drypetes pendula Ridl.	(2014) Mandai Gate Vegetation Survey	O
420	Rhamnaceae	Smythea lanceata	Smythea lanceata Summerh.	(2014) Mandai Gate Vegetation Survey	O
421	Rhamnaceae	*Ventilago malaccensis*	Ventilago malaccensis Ridl.	(2014) Mandai Gate Vegetation Survey	O

Item	Family	Genus species	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Protected by Law
381	Piperaceae	*Piper sarmentosum*	-	Yes	-	-	
382	Piperaceae	*Piper* sp. 1	-		-	-	
383	Poaceae	*Axonopus compressus*	-	No	-	-	
384	Poaceae	Bamboo	-		-	-	
385	Poaceae	*Bambusa vulgaris*	-	No	-	-	
386	Poaceae	*Cenchrus echinatus*	-	No	-	-	
387	Poaceae	*Centotheca lappacea*	-	Yes	-	-	
388	Poaceae	*Chloris barbata*	-	No	-	-	
389	Poaceae	*Coix lacryma-jobi*	-	No	-	-	
390	Poaceae	*Cynodon dactylon*	-	Yes	-	-	
391	Poaceae	*Dactyloctenium aegyptium*	-	Yes	-	-	
392	Poaceae	*Digitaria longiflora*	-	Yes	-	-	
393	Poaceae	*Eleusine indica*	Asia + Africa + Europe (Portugal, Poland)	No	LC	Least Concern ver 3.1	
394	Poaceae	*Imperata cylindrica*	-	-	-	-	
395	Poaceae	*Ischaemum ciliare*	-	-	-	-	
396	Poaceae	*Ischaemum muticum*	Oceania + India	Yes	LC	Least Concern ver 3.1	
397	Poaceae	*Panicum maximum*	-	No	-	-	
398	Poaceae	*Paspalum conjugatum*	South America + Asia	No	LC	Least Concern ver 3.1	
399	Poaceae	*Paspalum scrobiculatum*	Africa + AS + Asia (India, China)	-	LC	Least Concern ver 3.1	
400	Poaceae	*Pennisetum purpureum*	-	No	-	-	
401	Poaceae	*Setaria barbata*	-	No	-	-	
402	Poaceae	*Sporobolus indicus*	-	yes	-	-	
403	Poaceae	*Stenotaphrum secundatum*	-	no	-	-	
404	Poaceae	*Themeda villosa*	-	Yes	-	-	
405	Poaceae	*Zoysia matrella*	-	Yes	-	-	
406	Polygalaceae	*Xanthophyllum ellipticum*	-	Yes	-	-	
407	Polygalaceae	*Xanthophyllum eurhynchum*	-	Yes	-	-	
408	Polygalaceae	*Xanthophyllum flavescens*	-	Yes	-	-	
409	Polygalaceae	*Xanthophyllum vitellinum*	-	Yes	-	-	
410	Polygonaceae	*Antigonon leptopus*	-	no	-	-	
411	Polypodiaceae	*Drynaria quercifolia*	-	Yes	-	-	
412	Primulaceae	*Ardisia elliptica*	-	Yes	-	-	
413	Primulaceae	*Ardisia sanguinolenta*	-	Yes	-	-	
414	Primulaceae	*Ardisia teysmanniana*	-	Yes	-	-	
415	Primulaceae	*Grenacheria amentacea*	-	Yes	-	-	
416	Primulaceae	*Ardisia* 1	-	-	-	-	
417	Pteridaceae	*Pteris vittata*	Asia + America + Africa + AS	-	LC	Least Concern ver 3.1	
418	Pteridaceae	*Taenitis blechnoides*	-	Yes	-	-	
419	Putranjivaceae	Drypetes pendula	-	Yes	-	-	
420	Rhamnaceae	Smythea lanceata	-	Yes	-	-	
421	Rhamnaceae	*Ventilago malaccensis*	-	Yes	-	-	

Item	Family	Genus species	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
381	Piperaceae	*Piper sarmentosum*	Common	-	-
382	Piperaceae	*Piper* sp. 1		-	-
383	Poaceae	*Axonopus compressus*	Naturalized	-	-
384	Poaceae	Bamboo		-	-
385	Poaceae	*Bambusa vulgaris*	Casual	-	-
386	Poaceae	*Cenchrus echinatus*	Naturalized	-	-
387	Poaceae	*Centotheca lappacea*	Crit. End.	-	-
388	Poaceae	*Chloris barbata*	Naturalized	-	-
389	Poaceae	*Coix lacryma-jobi*	Naturalized	-	-
390	Poaceae	*Cynodon dactylon*	Common	-	-
391	Poaceae	*Dactyloctenium aegyptium*	Common	-	-
392	Poaceae	*Digitaria longiflora*	Common	-	-
393	Poaceae	*Eleusine indica*	Naturalized	-	It grows in moist as well as marshy areas, puddles, shallow ponds, fields, river and stream edges, ditches, canals etc
394	Poaceae	*Imperata cylindrica*	Cryptogenic Weed	-	-
395	Poaceae	*Ischaemum ciliare*	Cryptogenic Weed	-	-
396	Poaceae	*Ischaemum muticum*	Common	-	It is found growing in stagnant water around pools and in seasonally flooded and marshy places. It also inhabits backwaters, coastal sands, estuaries and salt marshes
397	Poaceae	*Panicum maximum*	Naturalized	-	-
398	Poaceae	*Paspalum conjugatum*	Naturalized	-	It grows from near sea-level up to 1700 m altitude in open to moderately shaded and moist places. It is adapted to humid climates. It is found growing gregariously under plantation crops and also frequently found on the banks of water courses, back waters and roadsides and in disturbed areas, and polluted waters. It also grows in seasonally flooded places, in marshes, in ditches, in rice fields and draining plantations.
399	Poaceae	*Paspalum scrobiculatum*	Cryptogenic Weed	-	This species typically occurs in seasonally inundated areas and wet depressions, often association with cultivation and settlements, such as along roadsides, ditches, waste ground and rice fields
400	Poaceae	*Pennisetum purpureum*	Naturalized	-	-
401	Poaceae	*Setaria barbata*	Naturalized	-	-
402	Poaceae	*Sporobolus indicus*	Common	-	-
403	Poaceae	*Stenotaphrum secundatum*	Naturalized	-	-
404	Poaceae	*Themeda villosa*	Common	-	-
405	Poaceae	*Zoysia matrella*	Common	-	-
406	Polygalaceae	*Xanthophyllum ellipticum*	Crit. End.	-	-
407	Polygalaceae	*Xanthophyllum eurhynchum*	Vulnerable	-	-
408	Polygalaceae	*Xanthophyllum flavescens*	Endangered	-	-
409	Polygalaceae	*Xanthophyllum vitellinum*	Vulnerable	-	-
410	Polygonaceae	*Antigonon leptopus*	Casual	-	-
411	Polypodiaceae	*Drynaria quercifolia*	Common	-	-
412	Primulaceae	*Ardisia elliptica*	Endangered	-	-
413	Primulaceae	*Ardisia sanguinolenta*	Common	-	-
414	Primulaceae	*Ardisia teysmanniana*	Endangered	-	-
415	Primulaceae	*Grenacheria amentacea*	Rediscovered	-	-
416	Primulaceae	*Ardisia* 1	-	-	-
417	Pteridaceae	*Pteris vittata*	Cryptogenic Weed	-	This species typically grows in humid or moist walls, cliffs and rocks near or on the margins of streams, usually in shade and usually near permanent water
418	Pteridaceae	*Taenitis blechnoides*	Common	-	-
419	Putranjivaceae	Drypetes pendula	Crit. End.	-	-
420	Rhamnaceae	Smythea lanceata	Crit. End.	-	-
421	Rhamnaceae	*Ventilago malaccensis*	Endangered	-	-

Item	Family	Genus species	Full name and authorship / English Name	Source	Presence#
422	Rhamnaceae	*Ziziphus calophylla*	Ziziphus calophylla Wall. ex Hook.f.	*(2014) Mandai Gate Vegetation Survey*	O
423	Rhizophoraceae	*Gynotroches axillaris*	Gynotroches axillaris Blume	*(2014) Mandai Gate Vegetation Survey*	O
424	Rhizophoraceae	*Pellacalyx axillaris*	Pellacalyx axillaris Korth.	*(2014) Mandai Gate Vegetation Survey*	O
425	Rosaceae	*Prunus polystachya*	Prunus polystachya (Hook. f.) Kalkm.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/33722/0*	O
426	Rubiaceae	*Diplospora malaccensis*	Diplospora malaccensis Hook. f.	*(2014) Mandai Gate Vegetation Survey*	O
427	Rubiaceae	*Gaertnera obesa*	Gaertnera obesa Hook. f. ex C.B. Clarke	*(2014) Mandai Gate Vegetation Survey*	O
428	Rubiaceae	*Gynochthodes coriacea*	Gynochthodes coriacea Blume	*(2014) Mandai Gate Vegetation Survey*	O
429	Rubiaceae	*Gynochthodes sublanceolata*	Gynochthodes sublanceolata Miq.	*(2014) Mandai Gate Vegetation Survey*	O
430	Rubiaceae	*Hedyotis verticillata*	Hedyotis verticillata (L.) Lam	*(2014) Mandai Gate Vegetation Survey*	O
431	Rubiaceae	*Ixora congesta*	Malayan Ixora	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
432	Rubiaceae	*Ixora lobbii*	Ixora lobbii Loudon	*(2014) Mandai Gate Vegetation Survey*	O
433	Rubiaceae	*Lasianthus sp.*	-	*(2014) Mandai Gate Vegetation Survey*	O
434	Rubiaceae	*Morinda citrifolia*	Mengkudu Besar	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
435	Rubiaceae	*Mussaenda glabra*	Mussaenda glabra Vahl	*(2014) Mandai Gate Vegetation Survey*	O
436	Rubiaceae	*Oxyceros bispinosus*	Oxyceros bispinosus (Griff.) Tirveng.	*(2014) Mandai Gate Vegetation Survey*	O
437	Rubiaceae	*Paederia foetida*	Paederia foetida L.	*(2014) Mandai Gate Vegetation Survey*	O
438	Rubiaceae	*Pavetta wallichiana*	Pavetta wallichiana Steud.	*(2014) Mandai Gate Vegetation Survey*	O
439	Rubiaceae	*Porterandia anisophylla*	Porterandia anisophylla (Jack ex Roxb.) Ridl.	*(2014) Mandai Gate Vegetation Survey*	O
440	Rubiaceae	*Psychotria helferiana*	Psychotria helferiana Kurz	*(2014) Mandai Gate Vegetation Survey*	O
441	Rubiaceae	*Psychotria penangensis*	Psychotria penangensis Hook. f.	*(2014) Mandai Gate Vegetation Survey*	O
442	Rubiaceae	*Psychotria sarmentosa*	Psychotria sarmentosa Blume	*(2014) Mandai Gate Vegetation Survey*	O
443	Rubiaceae	*Psydrax* sp. 10	-	*(2014) Mandai Gate Vegetation Survey*	O
444	Rubiaceae	*Spermacoce laevis*	Spermacoce laevis Lam.	*(2014) Mandai Gate Vegetation Survey*	O
445	Rubiaceae	*Timonius flavescens*	Timonius flavescens (Jack) Baker	*(2014) Mandai Gate Vegetation Survey*	O
446	Rubiaceae	*Timonius wallichianus*	Timonius wallichianus (Korth.) Valeton	*(2014) Mandai Gate Vegetation Survey*	O
447	Rubiaceae	*Uncaria* sp.	-	*(2014) Mandai Gate Vegetation Survey*	O
448	Rubiaceae	*Urophyllum* sp. 2	-	*(2014) Mandai Gate Vegetation Survey*	O
449	Rubiaceae	*Ixora pendula*	Pink Needles	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/18966876*	O
450	Rutaceae	*Clausena excavata*	Clausena excavata Burm. f.	*(2014) Mandai Gate Vegetation Survey*	O
451	Rutaceae	*Glycosmis chlorosperma var. chlorosperma*	Glycosmis chlorosperma (Blume) Spreng. var. chlorosperma	*(2014) Mandai Gate Vegetation Survey*	O
452	Rutaceae	*Luvunga crassifolia*	Luvunga crassifolia Tanaka	*(2014) Mandai Gate Vegetation Survey*	O
453	Rutaceae	*Maclurodendron porteri*	Maclurodendron porteri (Hook. f.) T.G. Hartley	*(2014) Mandai Gate Vegetation Survey*	O
454	Rutaceae	Melicope lunu-ankenda	Melicope lunu-ankenda (Gaertn.) T.G. Hartley	*(2014) Mandai Gate Vegetation Survey*	O
455	Sapindaceae	*Dimocarpus longan*	Dimocarpus longan Lour.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/32399/0*	O
456	Sapindaceae	*Guioa pleuropteris*	Guioa pleuropteris (Blume) Radlk.	*(2014) Mandai Gate Vegetation Survey*	O
457	Sapindaceae	*Nephelium lappaceum*	Rambutan	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.iucnredlist.org/details/33266/0*	O
458	Sapindaceae	*Nephelium ramboutan-ake*	Nephelium ramboutan-ake (Labill.) Leenh.	*(2014) Mandai Gate Vegetation Survey*	O
459	Sapotaceae	*Palaquium obovatum*	Palaquium obovatum (Griff.) Engl.	*(2014) Mandai Gate Vegetation Survey*	O
460	Schizaeaceae	Lygodium circinnatum	Lygodium circinnatum (Burm. f.) Sw.	*(2014) Mandai Gate Vegetation Survey*	O
461	Schizaeaceae	*Lygodium microphyllum*	Lygodium microphyllum (Cav.) R. Br.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/194153/0*	O
462	Simaroubaceae	*Eurycoma longifolia*	Eurycoma longifolia Jack	*(2014) Mandai Gate Vegetation Survey*	O
463	Smilacaceae	Smilax setosa	Smilax setosa Miq.	*(2014) Mandai Gate Vegetation Survey*	O
464	Solanaceae	*Solanum torvum*	Solanum torvum Sw.	*(2014) Mandai Gate Vegetation Survey*	O
465	Thelypteridaceae	*Christella dentata*	Christella dentata (Forsk.) Brownsey & Jermy	*(2014) Mandai Gate Vegetation Survey*	O
466	Thelypteridaceae	*Christella subpubescens*	Christella subpubescens (Blume) Holttum	*(2014) Mandai Gate Vegetation Survey*	O

Item	Family	Genus species	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Protected by Law
422	Rhamnaceae	*Ziziphus calophylla*	-	Yes	-	-	
423	Rhizophoraceae	*Gynotroches axillaris*	-	Yes	-	-	
424	Rhizophoraceae	*Pellacalyx axillaris*	-	Yes	-	-	
425	Rosaceae	*Prunus polystachya*	Singapore	Yes	LC	Lower Risk/least concern ver 2.3	
426	Rubiaceae	*Diplospora malaccensis*	-	Yes	-	-	
427	Rubiaceae	*Gaertnera obesa*	-	Yes	-	-	
428	Rubiaceae	*Gynochthodes coriacea*	-	Yes	-	-	
429	Rubiaceae	*Gynochthodes sublanceolata*	-	Yes	-	-	
430	Rubiaceae	*Hedyotis verticillata*	-	-	-	-	
431	Rubiaceae	*Ixora congesta*	-	Yes	-	-	
432	Rubiaceae	*Ixora lobbii*	-	Yes	-	-	
433	Rubiaceae	*Lasianthus sp.*	-		-	-	
434	Rubiaceae	*Morinda citrifolia*	-	-	-	-	
435	Rubiaceae	*Mussaenda glabra*	-	Yes	-	-	
436	Rubiaceae	*Oxyceros bispinosus*	-	Yes	-	-	
437	Rubiaceae	*Paederia foetida*	-	Yes	-	-	
438	Rubiaceae	*Pavetta wallichiana*	-	Yes	-	-	
439	Rubiaceae	*Porterandia anisophylla*	-	Yes	-	-	
440	Rubiaceae	*Psychotria helferiana*	-	Yes	-	-	
441	Rubiaceae	*Psychotria penangensis*	-	Yes	-	-	
442	Rubiaceae	*Psychotria sarmentosa*	-	Yes	-	-	
443	Rubiaceae	*Psydrax* sp. 10	-		-	-	
444	Rubiaceae	*Spermacoce laevis*	-	No	-	-	
445	Rubiaceae	*Timonius flavescens*	-	Yes	-	-	
446	Rubiaceae	*Timonius wallichianus*	-	Yes	-	-	
447	Rubiaceae	*Uncaria* sp.	-		-	-	
448	Rubiaceae	*Urophyllum* sp. 2	-		-	-	
449	Rubiaceae	*Ixora pendula*	TM	-	-	-	
450	Rutaceae	*Clausena excavata*	-	Yes	-	-	
451	Rutaceae	*Glycosmis chlorosperma var. chlorosperma*	-	Yes	-	-	
452	Rutaceae	*Luvunga crassifolia*	-	Yes	-	-	
453	Rutaceae	*Maclurodendron porteri*	-	Yes	-	-	
454	Rutaceae	Melicope lunu-ankenda	-	Yes	-	-	
455	Sapindaceae	*Dimocarpus longan*	China (Hainan)	No	NT	Lower Risk/near threatened ver 2.3	
456	Sapindaceae	*Guioa pleuropteris*	-	Yes	-	-	
457	Sapindaceae	*Nephelium lappaceum*	TM + Indonesia + Vietnam	Yes	LC	Lower Risk/least concern ver 2.3	
458	Sapindaceae	*Nephelium ramboutan-ake*	-	Yes	-	-	
459	Sapotaceae	*Palaquium obovatum*	-	Yes	-	-	
460	Schizaeaceae	Lygodium circinnatum	-	Yes	-	-	
461	Schizaeaceae	*Lygodium microphyllum*	Africa + Asia	Yes	LC	Least Concern ver 3.1	
462	Simaroubaceae	*Eurycoma longifolia*	-	Yes	-	-	
463	Smilacaceae	Smilax setosa	-	Yes	-	-	
464	Solanaceae	*Solanum torvum*	-	No	-	-	
465	Thelypteridaceae	*Christella dentata*	-	-	-	-	
466	Thelypteridaceae	*Christella subpubescens*	-	Yes	-	-	

Item	Family	Genus species	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
422	Rhamnaceae	*Ziziphus calophylla*	Vulnerable	-	-
423	Rhizophoraceae	*Gynotroches axillaris*	Common	-	-
424	Rhizophoraceae	*Pellacalyx axillaris*	Endangered	-	-
425	Rosaceae	*Prunus polystachya*	Common	-	-
426	Rubiaceae	*Diplospora malaccensis*	Crit. End.	-	-
427	Rubiaceae	*Gaertnera obesa*	Endangered	-	-
428	Rubiaceae	*Gynochthodes coriacea*	Vulnerable	-	-
429	Rubiaceae	*Gynochthodes sublanceolata*	Common	-	-
430	Rubiaceae	*Hedyotis verticillata*	Cryptogenic Weed	-	-
431	Rubiaceae	*Ixora congesta*	Common	-	-
432	Rubiaceae	*Ixora lobbii*	Endangered	-	-
433	Rubiaceae	*Lasianthus sp.*		-	-
434	Rubiaceae	*Morinda citrifolia*	Cryptogenic Weed	-	-
435	Rubiaceae	*Mussaenda glabra*	Endangered	-	-
436	Rubiaceae	*Oxyceros bispinosus*	Endangered	-	-
437	Rubiaceae	*Paederia foetida*	Common	-	-
438	Rubiaceae	*Pavetta wallichiana*	Vulnerable	-	-
439	Rubiaceae	*Porterandia anisophylla*	Vulnerable	-	-
440	Rubiaceae	*Psychotria helferiana*	Crit. End.	-	-
441	Rubiaceae	*Psychotria penangensis*	Vulnerable	-	-
442	Rubiaceae	*Psychotria sarmentosa*	Crit. End.	-	-
443	Rubiaceae	*Psydrax* sp. 10		-	-
444	Rubiaceae	*Spermacoce laevis*	Naturalized	-	-
445	Rubiaceae	*Timonius flavescens*	Crit. End.	-	-
446	Rubiaceae	*Timonius wallichianus*	Common	-	-
447	Rubiaceae	*Uncaria* sp.		-	-
448	Rubiaceae	*Urophyllum* sp. 2		-	-
449	Rubiaceae	*Ixora pendula*	-	-	-
450	Rutaceae	*Clausena excavata*	Common	-	-
451	Rutaceae	*Glycosmis chlorosperma var. chlorosperma*	Vulnerable	-	-
452	Rutaceae	*Luvunga crassifolia*	Crit. End.	-	-
453	Rutaceae	*Maclurodendron porteri*	Vulnerable	-	-
454	Rutaceae	Melicope lunu-ankenda	Crit. End.	-	-
455	Sapindaceae	*Dimocarpus longan*	Casual	-	-
456	Sapindaceae	*Guioa pleuropteris*	Vulnerable	-	-
457	Sapindaceae	*Nephelium lappaceum*	Crit. End.	-	Rambutan is a widely-cultivated fruit tree.
458	Sapindaceae	*Nephelium ramboutan-ake*	Rediscovered	-	-
459	Sapotaceae	*Palaquium obovatum*	Vulnerable	-	-
460	Schizaeaceae	Lygodium circinnatum	Vulnerable (VU/D) *Davidson et.al (2008) The Singapore Red Data Book*	-	-
461	Schizaeaceae	*Lygodium microphyllum*	Common	-	Grows in open marshy or semi marshy areas and disturbed forests from plains to high altitudes as climber
462	Simaroubaceae	*Eurycoma longifolia*	Crit. End.	-	-
463	Smilacaceae	Smilax setosa	Common	-	-
464	Solanaceae	*Solanum torvum*	Naturalized	-	-
465	Thelypteridaceae	*Christella dentata*	Cryptogenic Weed	-	-
466	Thelypteridaceae	*Christella subpubescens*	Common	-	-

Item	Family	Genus species	Full name and authorship / English Name	Source	Presence#
467	Thymelaeaceae	*Aquilaria hirta*	Aquilaria hirta Ridl.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/34561/0*	O
468	Thymelaeaceae	*Aquilaria malaccensis*	Aquilaria malaccensis Lamk.	*(2014) Mandai Gate Vegetation Survey http://www.iucnredlist.org/details/32056/0*	O
469	Thymelaeaceae	*Enkleia malaccensis*	Enkleia malaccensis Griff.	*(2014) Mandai Gate Vegetation Survey*	O
470	Thymelaeaceae	*Gonystylus confusus*	Gonystylus confusus Airy Shaw	*(2014) Mandai Gate Vegetation Survey*	O
471	Typhaceae	*Typha angustifolia*	Cat-tail	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.iucnredlist.org/details/164199/0*	O
472	Urticaceae	*Cecropia pachystachya*	Cecropia pachystachya Trécul	*(2014) Mandai Gate Vegetation Survey*	O
473	Urticaceae	*Pipturus argenteus*	Pipturus argenteus (G. Forst.) Wedd.	*(2014) Mandai Gate Vegetation Survey*	O
474	Urticaceae	*Poikilospermum suaveolens*	Poikilospermum suaveolens (Blume) Merr.	*(2014) Mandai Gate Vegetation Survey*	O
475	Verbenaceae	*Lantana camara*	Common Lantana	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
476	Verbenaceae	*Stachytarpheta jamaicensis*	Stachytarpheta jamaicensis (L.) Vahl	*(2014) Mandai Gate Vegetation Survey*	O
477	Vitaceae	*Ampelocissus elegans*	Ampelocissus elegans (Kurz) Gegnep.	*(2014) Mandai Gate Vegetation Survey*	O
478	Vitaceae	*Ampelocissus gracilis*	Ampelocissus gracilis (Wall.) Planch.	*(2014) Mandai Gate Vegetation Survey*	O
479	Vitaceae	*Ampelocissus spicifer*	Ampelocissus spicifer (Griff.) Planch.	*(2014) Mandai Gate Vegetation Survey*	O
480	Vitaceae	Cissus hastata	Cissus hastata Miq.	*(2014) Mandai Gate Vegetation Survey*	O
481	Vitaceae	*Leea indica*	Leea indica (Burm. f.) Merr.	*(2014) Mandai Gate Vegetation Survey*	O
482	Zingiberaceae	*Alpinia purpurata*	Alpinia purpurata (Vieill.) K. Schum.	*(2014) Mandai Gate Vegetation Survey*	O
483	Zingiberaceae	*Etlingera elatior*	Torch Ginger	*(2014) Mandai Gate Vegetation Survey http://www.catalogueoflife.org/col/details/species/id/19099352*	O
484		*Callistemon speciosa*	Bottlebrush Tree	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O
485		*Citrus* spp.	Lime	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	
486		*Clerodendron paniculatum*	Pagoda Flower	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	
487		*Cordia cylindistachya*	Stringbush	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	
488		*Ficus bengalensis*	Indian Banyan	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	
489		*Fragrea fragrans*	Tembusu	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	

Item	Family	Genus species	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Protected by Law
467	Thymelaeaceae	*Aquilaria hirta*	Indonesia + Singapore	yes	VU	Vulnerable A1d ver 2.3	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*
468	Thymelaeaceae	*Aquilaria malaccensis*	IM + Iran	Yes	VU	Vulnerable A1d ver 2.3	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*
469	Thymelaeaceae	*Enkleia malaccensis*	-	Yes	-	-	
470	Thymelaeaceae	*Gonystylus confusus*	-	Yes	-	-	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*
471	Typhaceae	*Typha angustifolia*	Europe + Asia (China) + USA	-	LC	Least Concern ver 3.1	
472	Urticaceae	*Cecropia pachystachya*	-	No	-	-	
473	Urticaceae	*Pipturus argenteus*	-	No	-	-	
474	Urticaceae	*Poikilospermum suaveolens*	-	Yes	-	-	
475	Verbenaceae	*Lantana camara*	-	No	-	-	
476	Verbenaceae	*Stachytarpheta jamaicensis*	-	No	-	-	
477	Vitaceae	*Ampelocissus elegans*	-	Yes	-	-	
478	Vitaceae	*Ampelocissus gracilis*	-	Yes	-	-	
479	Vitaceae	*Ampelocissus spicifer*	-	Yes	-	-	
480	Vitaceae	Cissus hastata	-	Yes	-	-	
481	Vitaceae	*Leea indica*	-	Yes	-	-	
482	Zingiberaceae	*Alpinia purpurata*	-	No	-	-	
483	Zingiberaceae	*Etlingera elatior*	-	-	-	-	
484		*Callistemon speciosa*	-	-	-	-	
485		*Citrus* spp.	-	-	-	-	
486		*Clerodendron paniculatum*	-	-	-	-	
487		*Cordia cylindistachya*	-	-	-	-	
488		*Ficus bengalensis*	-	-	-	-	
489		*Fragrea fragrans*	-	-	-	-	

Item	Family	Genus species	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
467	Thymelaeaceae	*Aquilaria hirta*	Rediscovered	Appendix II	A small tree occurring in lowland forest on hill slopes.
468	Thymelaeaceae	*Aquilaria malaccensis*	Vulnerable	Appendix II	-
469	Thymelaeaceae	*Enkleia malaccensis*	Crit. End.	-	-
470	Thymelaeaceae	*Gonystylus confusus*	Endangered	Appendix II	-
471	Typhaceae	*Typha angustifolia*	-	-	It grows in shallow water of lakes, rivers, ponds, marshes, and ditches.
472	Urticaceae	*Cecropia pachystachya*	Naturalized	-	-
473	Urticaceae	*Pipturus argenteus*	Naturalized	-	-
474	Urticaceae	*Poikilospermum suaveolens*	Vulnerable	-	-
475	Verbenaceae	*Lantana camara*	Naturalized	-	-
476	Verbenaceae	*Stachytarpheta jamaicensis*	Naturalized	-	-
477	Vitaceae	*Ampelocissus elegans*	Endangered	-	-
478	Vitaceae	*Ampelocissus gracilis*	Endangered	-	-
479	Vitaceae	*Ampelocissus spicifer*	Crit. End.	-	-
480	Vitaceae	Cissus hastata	Common	-	-
481	Vitaceae	*Leea indica*	Common	-	-
482	Zingiberaceae	*Alpinia purpurata*	Cultivated only	-	-
483	Zingiberaceae	*Etlingera elatior*	-	-	-
484		*Callistemon speciosa*	-	-	-
485		*Citrus* spp.	-	-	-
486		*Clerodendron paniculatum*	-	-	-
487		*Cordia cylindistachya*	-	-	-
488		*Ficus bengalensis*	-	-	-
489		*Fragrea fragrans*	-	-	-

Item	Family	Genus species	Full name and authorship / English Name	Source	Presence#
490		*Heliconia* spp.	Heliconia	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	
491		*Hibiscus rosa-sinensis*	Chinese Hibiscus	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	
492		*Paraserianthes falcatari / Falcataria moluccana*	Albizia	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	
493		*Psidium guajava*	Guava	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	
494		*Syzygium* (Eugenia) *grande*	Sea Apple	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	
495		*Syzygium* (Eugenia) *jambos*	Rose Apple	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	
496		*Syzygium* (Eugenia) *polyanthum*	Salam	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	
497		*Syzygium malaccensis*	Jambu Bol	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	
498		*c.f. Decaspermum fruiticosum*	-	*(2014) Mandai Gate Vegetation Survey*	O
499		c.f. Glochidion superbum	-	*(2014) Mandai Gate Vegetation Survey*	O
500		c.f. Syzygium	-	*(2014) Mandai Gate Vegetation Survey*	O
501		*Castanopsis* 1	-	*(2014) Mandai Gate Vegetation Survey*	O
502		*Cyathocalyx* 1	-	*(2014) Mandai Gate Vegetation Survey*	O
503		*Dissochaeta* 1	-	*(2014) Mandai Gate Vegetation Survey*	O
504		*Ficus* 1	-	*(2014) Mandai Gate Vegetation Survey*	O
505		Ficus c.f. vasculosa	-	*(2014) Mandai Gate Vegetation Survey*	O
506		*Fissistigma* 1	-	*(2014) Mandai Gate Vegetation Survey*	O
507		*Gnetum* 1	-	*(2014) Mandai Gate Vegetation Survey*	O
508		Lauraceae 1	-	*(2014) Mandai Gate Vegetation Survey*	O
509		Lauraceae 2	-	*(2014) Mandai Gate Vegetation Survey*	O
510		Lauraceae 3	-	*(2014) Mandai Gate Vegetation Survey*	O
511		Lauraceae 4	-	*(2014) Mandai Gate Vegetation Survey*	O
512		Lauraceae 5	-	*(2014) Mandai Gate Vegetation Survey*	O
513		Lauraceae 6	-	*(2014) Mandai Gate Vegetation Survey*	O
514		Lauraceae 7	-	*(2014) Mandai Gate Vegetation Survey*	O
515		Malvaceae 1	-	*(2014) Mandai Gate Vegetation Survey*	O
516		Meliaceae 1	-	*(2014) Mandai Gate Vegetation Survey*	O
517		Meliaceae 2	-	*(2014) Mandai Gate Vegetation Survey*	O
518		Meliaceae 3	-	*(2014) Mandai Gate Vegetation Survey*	O
519		Meliaceae 4	-	*(2014) Mandai Gate Vegetation Survey*	O
520		Meliaceae 5	-	*(2014) Mandai Gate Vegetation Survey*	O
521		Memecylon 1	-	*(2014) Mandai Gate Vegetation Survey*	O
522		Memecylon 2	-	*(2014) Mandai Gate Vegetation Survey*	O
523		*Memecylon c.f. lilacinum*	-	*(2014) Mandai Gate Vegetation Survey*	O
524		Phyllanthaceae 1	-	*(2014) Mandai Gate Vegetation Survey*	O
525		*Polyalthia* 1	-	*(2014) Mandai Gate Vegetation Survey*	O
526		*Pyramidanthe* 1	-	*(2014) Mandai Gate Vegetation Survey*	O
527		*Rhaphidophora* 1	-	*(2014) Mandai Gate Vegetation Survey*	O
528		Rubiaceae 1	-	*(2014) Mandai Gate Vegetation Survey*	O
529		Rubiaceae 2	-	*(2014) Mandai Gate Vegetation Survey*	O
530		Rubiaceae 3	-	*(2014) Mandai Gate Vegetation Survey*	O
531		Rubiaceae 4	-	*(2014) Mandai Gate Vegetation Survey*	O
532		Rubiaceae 5	-	*(2014) Mandai Gate Vegetation Survey*	O
533		*Scindapsus* 1	-	*(2014) Mandai Gate Vegetation Survey*	O
534		Sterculiaceae 1	-	*(2014) Mandai Gate Vegetation Survey*	O
535		Tetracera 1	-	*(2014) Mandai Gate Vegetation Survey*	O
536		*Uncaria* 1	-	*(2014) Mandai Gate Vegetation Survey*	O
537		Uncaria 2	-	*(2014) Mandai Gate Vegetation Survey*	O
538		*Xanthophyllum* 1	-	*(2014) Mandai Gate Vegetation Survey*	O

Item	Family	Genus species	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Protected by Law
490		*Heliconia* spp.	-	-	-	-	
491		*Hibiscus rosa-sinensis*	-	-	-	-	
492		*Paraserianthes falcatari / Falcataria moluccana*	-	-	-	-	
493		*Psidium guajava*	-	-	-	-	
494		*Syzygium* (Eugenia) *grande*	-	-	-	-	
495		*Syzygium* (Eugenia) *jambos*	-	-	-	-	
496		*Syzygium* (Eugenia) *polyanthum*	-	-	-	-	
497		*Syzygium malaccensis*	-	-	-	-	
498		*c.f. Decaspermum fruiticosum*	-	-	-	-	
499		c.f. Glochidion superbum	-	-	-	-	
500		c.f. Syzygium	-	-	-	-	
501		*Castanopsis* 1	-	-	-	-	
502		*Cyathocalyx* 1	-	-	-	-	
503		*Dissochaeta* 1	-	-	-	-	
504		*Ficus* 1	-	-	-	-	
505		Ficus c.f. vasculosa	-	-	-	-	
506		*Fissistigma* 1	-	-	-	-	
507		*Gnetum* 1	-	-	-	-	
508		Lauraceae 1	-	-	-	-	
509		Lauraceae 2	-	-	-	-	
510		Lauraceae 3	-	-	-	-	
511		Lauraceae 4	-	-	-	-	
512		Lauraceae 5	-	-	-	-	
513		Lauraceae 6	-	-	-	-	
514		Lauraceae 7	-	-	-	-	
515		Malvaceae 1	-	-	-	-	
516		Meliaceae 1	-	-	-	-	
517		Meliaceae 2	-	-	-	-	
518		Meliaceae 3	-	-	-	-	
519		Meliaceae 4	-	-	-	-	
520		Meliaceae 5	-	-	-	-	
521		Memecylon 1	-	-	-	-	
522		Memecylon 2	-	-	-	-	
523		*Memecylon c.f. lilacinum*	-	-	-	-	
524		Phyllanthaceae 1	-	-	-	-	
525		*Polyalthia* 1	-	-	-	-	
526		*Pyramidanthe* 1	-	-	-	-	
527		*Rhaphidophora* 1	-	-	-	-	
528		Rubiaceae 1	-	-	-	-	
529		Rubiaceae 2	-	-	-	-	
530		Rubiaceae 3	-	-	-	-	
531		Rubiaceae 4	-	-	-	-	
532		Rubiaceae 5	-	-	-	-	
533		*Scindapsus* 1	-	-	-	-	
534		Sterculiaceae 1	-	-	-	-	
535		Tetracera 1	-	-	-	-	
536		*Uncaria* 1	-	-	-	-	
537		Uncaria 2	-	-	-	-	
538		*Xanthophyllum* 1	-	-	-	-	

Item	Family	Genus species	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
490		*Heliconia* spp.	-	-	-
491		*Hibiscus rosa-sinensis*	-	-	-
492		*Paraserianthes falcatari / Falcataria moluccana*	-	-	-
493		*Psidium guajava*	-	-	-
494		*Syzygium* (Eugenia) *grande*	-	-	-
495		*Syzygium* (Eugenia) *jambos*	-	-	-
496		*Syzygium* (Eugenia) *polyanthum*	-	-	-
497		*Syzygium malaccensis*	-	-	-
498		*c.f. Decaspermum fruiticosum*	-	-	-
499		c.f. Glochidion superbum	-	-	-
500		c.f. Syzygium	-	-	-
501		*Castanopsis* 1	-	-	-
502		*Cyathocalyx* 1	-	-	-
503		*Dissochaeta* 1	-	-	-
504		*Ficus* 1	-	-	-
505		Ficus c.f. vasculosa	-	-	-
506		*Fissistigma* 1	-	-	-
507		*Gnetum* 1	-	-	-
508		Lauraceae 1	-	-	-
509		Lauraceae 2	-	-	-
510		Lauraceae 3	-	-	-
511		Lauraceae 4	-	-	-
512		Lauraceae 5	-	-	-
513		Lauraceae 6	-	-	-
514		Lauraceae 7	-	-	-
515		Malvaceae 1	-	-	-
516		Meliaceae 1	-	-	-
517		Meliaceae 2	-	-	-
518		Meliaceae 3	-	-	-
519		Meliaceae 4	-	-	-
520		Meliaceae 5	-	-	-
521		Memecylon 1	-	-	-
522		Memecylon 2	-	-	-
523		*Memecylon c.f. lilacinum*	-	-	-
524		Phyllanthaceae 1	-	-	-
525		*Polyalthia* 1	-	-	-
526		*Pyramidanthe* 1	-	-	-
527		*Rhaphidophora* 1	-	-	-
528		Rubiaceae 1	-	-	-
529		Rubiaceae 2	-	-	-
530		Rubiaceae 3	-	-	-
531		Rubiaceae 4	-	-	-
532		Rubiaceae 5	-	-	-
533		*Scindapsus* 1	-	-	-
534		Sterculiaceae 1	-	-	-
535		Tetracera 1	-	-	-
536		*Uncaria* 1	-	-	-
537		Uncaria 2	-	-	-
538		*Xanthophyllum* 1	-	-	-

Item	Family	Sub-Family	Genus species	English Name	Source	Presence*	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
Butterflies													
1	Hesperiidae	Coeliadinae	*Burara harisa consobrina*	Orange Awlet	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
2	Hesperiidae	Coeliadinae	*Hasora badra badra*	Common Awl	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
3	Hesperiidae	Coeliadinae	*Hasora vitta vitta*	Plain Banded Awl	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
4	Hesperiidae	Coeliadinae	*Badamia exclamationis*	Brown Awl	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
5	Hesperiidae	Pyrginae	*Odina hieroglyphica ortina*	Hieroglyphic Flat	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
6	Hesperiidae	Pyrginae	*Tagiades japetus atticus*	Common Snow Flat	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
7	Hesperiidae	Pyrginae	*Tagiades gana gana*	Large Snow Flat	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
8	Hesperiidae	Pyrginae	*Tagiades ultra*	Ultra Snow Flat	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
9	Hesperiidae	Pyrginae	*Tagiades calligana*	Malayan Snow Flat	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
10	Hesperiidae	Pyrginae	*Odontoptilum angulatum angul*	Chestnut Angle	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
11	Hesperiidae	Hesperiinae	*Ampittia dioscorides camertes*	Bush Hopper	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
12	Hesperiidae	Hesperiinae	*Halpe ormenes vilasina*	Dark Banded Ace	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
13	Hesperiidae	Hesperiinae	*Iambrix salsala salsala*	Chestnut Bob	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
14	Hesperiidae	Hesperiinae	*Ancistroides nigrita maura*	Chocolate Demon	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
15	Hesperiidae	Hesperiinae	*Udaspes folus*	Grass Demon	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
16	Hesperiidae	Hesperiinae	*Plastingia naga*	Chequered Lancer	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
17	Hesperiidae	Hesperiinae	*Plastingia pellonia*	Yellow Chequered Lar	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
18	Hesperiidae	Hesperiinae	*Pemara pugnans*	Pugnacious Lancer	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
19	Hesperiidae	Hesperiinae	*Pyroneura latoia latoia*	Yellow Vein Lancer	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
20	Hesperiidae	Hesperiinae	*Gangara lebadea lebadea*	Banded Redeye	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	NE	Not Assessed	-	-	-	-
21	Hesperiidae	Hesperiinae	*Matapa aria*	Common Redeye	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
22	Hesperiidae	Hesperiinae	*Erionota torus*		*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
23	Hesperiidae	Hesperiinae	*Erionota thrax thrax*	Banana Skipper	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
24	Hesperiidae	Hesperiinae	*Hidari irava*	Coconut Skipper	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
25	Hesperiidae	Hesperiinae	*Eetion elia*	White Spotted Palmer	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
26	Hesperiidae	Hesperiinae	*Taractrocera archias quinta*	Yellow Grass Dart	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
27	Hesperiidae	Hesperiinae	*Oriens gola pseudolus*	Common Dartlet	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
28	Hesperiidae	Hesperiinae	*Potanthus omaha omaha*	Lesser Dart	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
29	Hesperiidae	Hesperiinae	*Telicota besta bina*	Besta Palm Dart	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
30	Hesperiidae	Hesperiinae	*Telicota augias augias*	Palm Dart	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
31	Hesperiidae	Hesperiinae	*Pelopidas mathias mathias*	Small Branded Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
32	Hesperiidae	Hesperiinae	*Borbo cinnara*	Formosan Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	NE	Not Assessed	-	-	-	-
33	Hesperiidae	Hesperiinae	*Pelopidas assamensis*	Great Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
34	Hesperiidae	Hesperiinae	*Pelopidas conjunctus conjunctu*	Conjoined Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
35	Hesperiidae	Hesperiinae	*Polytremis lubricans lubricans*	Contiguous Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
36	Hesperiidae	Hesperiinae	*Baoris oceia*	Paintbrush Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
37	Hesperiidae	Hesperiinae	*Caltoris cormasa*	Full Stop Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
38	Hesperiidae	Hesperiinae	*Caltoris philippina philippina*	Philippine Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
39	Lycaenidae	Poritiinae	*Poritia sumatrae sumatrae*	Sumatran Gem	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
40	Lycaenidae	Miletinae	*Miletus biggsii biggsii*	Bigg's Brownwing	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
41	Lycaenidae	Miletinae	*Miletus symethus petronius*	Blue Brownwing	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-

Item	Family	Sub-Family	Genus species	English Name	Source	Presence*	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
42	Lycaenidae	Miletinae	*Allotinus unicolor unicolor*	Lesser Darkwing	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
43	Lycaenidae	Miletinae	*Logania marmorata damis*	Pale Mottle	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
44	Lycaenidae	Curetinae	*Curetis santana malayica*	Malayan Sunbeam	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
45	Lycaenidae	Lycaeninae	*Caleta elna elvira*	Elbowed Pierrot	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
46	Lycaenidae	Lycaeninae	*Zizina otis lampa*	Lesser Grass Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
47	Lycaenidae	Lycaeninae	*Zizula hylax pygmaea*	Pygmy Grass Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
48	Lycaenidae	Lycaeninae	*Chilades pandava pandava*	Cycad Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
49	Lycaenidae	Lycaeninae	*Euchrysops cnejus cnejus*	Gram Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
50	Lycaenidae	Lycaeninae	*Catochrysops panormus exiguus*	Silver Forget-Me-Not	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
51	Lycaenidae	Lycaeninae	*Lampides boeticus*	Pea Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
52	Lycaenidae	Lycaeninae	*Jamides alecto ageladas*	Metallic Caerulean	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	NE	Not Assessed	-	-	-	-
53	Lycaenidae	Lycaeninae	*Jamides celeno aelianus*	Common Caerulean	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
54	Lycaenidae	Lycaeninae	*Nacaduba berenice icena*	Rounded 6-Line Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
55	Lycaenidae	Lycaeninae	*Nacaduba calauria malayica*	Dark Malayan Sixline	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
56	Lycaenidae	Lycaeninae	*Ionolyce helicon merguiana*	Pointed Line Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
57	Lycaenidae	Lycaeninae	*Prosotas nora superdates*	Common Line Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
58	Lycaenidae	Lycaeninae	*Prosotas dubiosa lumpura*	Tailless Line Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
59	Lycaenidae	Lycaeninae	*Anthene emolus goberus*	Ciliate Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
60	Lycaenidae	Lycaeninae	*Anthene lycaenina miya*	Pointed Ciliate Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
61	Lycaenidae	Lycaeninae	*Arhopala amphimuta amphimuta*		*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	NE	Not Assessed	-	-	-	-
62	Lycaenidae	Lycaeninae	*Arhopala major major*		*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
63	Lycaenidae	Lycaeninae	*Arhopala athada athada*	Vinous Oakblue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
64	Lycaenidae	Lycaeninae	*Arhopala abseus abseus*	Aberrant Oakblue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
65	Lycaenidae	Lycaeninae	*Flos diardi capeta*	Bifid Plushblue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
66	Lycaenidae	Lycaeninae	*Flos fulgida singhapura*	Shining Plushblue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
67	Lycaenidae	Lycaeninae	*Flos anniella anniella*	Darky Plushblue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
68	Lycaenidae	Lycaeninae	*Flos apidanus saturatus*	Plain PlushBlue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
69	Lycaenidae	Lycaeninae	*Semanga superba deliciosa*		*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
70	Lycaenidae	Lycaeninae	*Surendra vivarna amisena*	Acacia Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
71	Lycaenidae	Lycaeninae	*Iraota rochana bosvelliana*	Scarce Silverstreak	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
72	Lycaenidae	Lycaeninae	*Eooxylides tharis distanti*	Branded Imperial	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
73	Lycaenidae	Lycaeninae	*Jaxona anasuja anasuja*	Great Imperial	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	DD	Not Assessed	-	-	-	-
74	Lycaenidae	Lycaeninae	*Deudorix epijarbas cinnabarus*	Cornelian	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
75	Lycaenidae	Lycaeninae	*Rapala domitia domitia*	Yellow Flash	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
76	Lycaenidae	Lycaeninae	*Rapala suffusa barthema*	Suffused Flash	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
77	Lycaenidae	Lycaeninae	*Rapala varuna orseis*	Indigo Flash	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
78	Nymphalidae	Danainae	*Parantica agleoides agleoides*	Dark Glassy Tiger	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
79	Nymphalidae	Danainae	*Ideopsis vulgaris macrina*	Blue Glassy Tiger	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
80	Nymphalidae	Danainae	*Euploea mulciber mulciber*	Striped Blue Crow	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
81	Nymphalidae	Danainae	*Euploea radamanthus radamanth*	Magpie Crow	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
82	Nymphalidae	Satyrinae	*Melanitis leda leda*	Common Evening Bro	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-

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83	Nymphalidae	Satyrinae	*Elymnias panthera panthera*	Tawny Palmfly	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
84	Nymphalidae	Satyrinae	*Elymnias hypermnestra agina*	Common Palmfly	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
85	Nymphalidae	Satyrinae	*Mycalesis fusca fusca*	Malayan Bush Brown	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
86	Nymphalidae	Satyrinae	*Mycalesis mineus macromalayan*	Dark Brand Bush Brow	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
87	Nymphalidae	Satyrinae	*Mycalesis visala phamis*	Long Brand Bush Brow	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	DD	Not Assessed	-	-	-	-
88	Nymphalidae	Satyrinae	*Orsotriaena medus cinerea*	Dark Grass Brown	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
89	Nymphalidae	Satyrinae	*Ypthima fasciata torone*	Malayan Six Ring	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	CR	Not Assessed	-	Critically Endangered (CR) *Davidson et.al (2008) The Singapore Red Data Book*	-	-
90	Nymphalidae	Satyrinae	*Ypthima baldus newboldi*	Common Five Ring	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
91	Nymphalidae	Satyrinae	*Ypthima horsfieldii humei*	Malayan Five Ring	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
92	Nymphalidae	Morphinae	*Faunis canens arcesilas*	Common Faun	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
93	Nymphalidae	Morphinae	*Amathusia phidippus phidippus*	Palm King	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
94	Nymphalidae	Nymphalinae	*Ariadne ariadne ariadne*	Angled Castor	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	NE	Not Assessed	-	-	-	-
95	Nymphalidae	Nymphalinae	*Hypolimnas anomala anomala*	Malayan Eggfly	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
96	Nymphalidae	Nymphalinae	*Hypolimnas bolina bolina*	Great Eggfly	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
97	Nymphalidae	Nymphalinae	*Hypolimnas bolina jacintha*	Jacintha Eggfly	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
98	Nymphalidae	Nymphalinae	*Doleschallia bisaltide bisaltide*	Autumn Leaf	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
99	Nymphalidae	Nymphalinae	*Doleschallia bisaltide pratipa*	Autumn Leaf	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
100	Nymphalidae	Nymphalinae	*Junonia hedonia ida*	Chocolate Pansy	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
101	Nymphalidae	Nymphalinae	*Junonia atlites atlites*	Grey Pansy	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
102	Nymphalidae	Nymphalinae	*Junonia almana javana*	Peacock Pansy	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
103	Nymphalidae	Nymphalinae	*Junonia orithya wallacei*	Blue Pansy	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
104	Nymphalidae	Heliconiinae	*Cethosia hypsea hypsina*	Malay Lacewing	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
105	Nymphalidae	Heliconiinae	*Phalanta phalantha phalantha*	Leopard	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
106	Nymphalidae	Heliconiinae	*Cupha erymanthis lotis*	Rustic	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
107	Nymphalidae	Heliconiinae	*Vindula dejone erotella*	Cruiser	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
108	Nymphalidae	Limenitidinae	*Moduza procris milonia*	Commander	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
109	Nymphalidae	Limenitidinae	*Lebadea martha parkeri*	Knight	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
110	Nymphalidae	Limenitidinae	*Athyma pravara helma*	Lance Sergeant	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
111	Nymphalidae	Limenitidinae	*Athyma kanwa kanwa*	Dot-Dash Sergeant	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
112	Nymphalidae	Limenitidinae	*Athyma nefte subrata*	Colour Sergeant	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
113	Nymphalidae	Limenitidinae	*Pandita sinope sinope*	Colonel	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
114	Nymphalidae	Limenitidinae	*Neptis hylas papaja*	Common Sailor	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
115	Nymphalidae	Limenitidinae	*Neptis leucoporos cresina*	Grey Sailor	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
116	Nymphalidae	Limenitidinae	*Neptis harita harita*	Chocolate Sailor	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	VU	Not Assessed	-	Vulnerable (VU) *Davidson et.al (2008) The Singapore Red Data Book*	-	-
117	Nymphalidae	Limenitidinae	*Phaedyma columella singa*	Short Banded Sailor	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
118	Nymphalidae	Limenitidinae	*Lasippa heliodore dorelia*	Burmese Lascar	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	DD	Not Assessed	-	-	-	-
119	Nymphalidae	Limenitidinae	*Lasippa tiga siaka*	Malayan Lascar	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
120	Nymphalidae	Limenitidinae	*Pantoporia hordonia hordonia*	Common Lascar	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
121	Nymphalidae	Limenitidinae	*Pantoporia paraka paraka*	Perak Lascar	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
122	Nymphalidae	Limenitidinae	*Tanaecia pelea pelea*	Malay Viscount	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-

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123	Nymphalidae	Limenitidinae	*Tanaecia iapis puseda*	Horsfield's Baron	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
124	Nymphalidae	Limenitidinae	*Euthalia monina monina*	Malay Baron	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
125	Nymphalidae	Limenitidinae	*Lexias pardalis dirteana*	Archduke	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
126	Nymphalidae	Apaturinae	*Eulaceura osteria kumana*	Purple Duke	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
127	Nymphalidae	Apaturinae	*Euripus nyctelius euploeoides*	Courtesan	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	CR	Not Assessed	-	Critically Endangered (CR) *Davidson et.al (2008) The Singapore Red Data Book*	-	-
128	Nymphalidae	Charaxinae	*Polyura hebe plautus*	Plain Nawab	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
129	Papilionidae	Papilionidae	*Troides helena cerberus*	Common Birdwing	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	VU	Not Assessed	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*	Vulnerable (VU) *Davidson et.al (2008) The Singapore Red Data Book*	Appendix II	-
130	Papilionidae	Papilionidae	*Pachliopta aristolochiae asteris*	Common Rose	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	VU	Not Assessed	-	Vulnerable (VU) *Davidson et.al (2008) The Singapore Red Data Book*	-	-
131	Papilionidae	Papilionidae	*Chilasa clytia clytia*	Common Mime	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
132	Papilionidae	Papilionidae	*Papilio demoleus malayanus*	Lime Butterfly	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
133	Papilionidae	Papilionidae	*Papilio demolion demolion*	Banded Swallowtail	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
134	Papilionidae	Papilionidae	*Papilio polytes romulus*	Common Mormon	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
135	Papilionidae	Papilionidae	*Papilio memnon agenor*	Great Mormon	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
136	Papilionidae	Papilionidae	*Graphium sarpedon luctatius*	Common Bluebottle	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
137	Papilionidae	Papilionidae	*Graphium evemon eventus*	Blue Jay	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
138	Papilionidae	Papilionidae	*Graphium agamemnon agamem*	Tailed Jay	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
139	Papilionidae	Papilionidae	*Graphium antiphates itamputi*	Five Bar Swordtail	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
140	Pieridae	Pieridae	*Delias hyparete metarete*	Painted Jezebel	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
141	Pieridae	Pieridae	*Leptosia nina malayana*	Psyche	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
142	Pieridae	Pieridae	*Appias libythea olferna*	Striped Albatross	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
143	Pieridae	Coliadinae	*Catopsilia pyranthe pyranthe*	Mottled Emigrant	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
144	Pieridae	Coliadinae	*Catopsilia pomona pomona*	Lemon Emigrant	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
145	Pieridae	Coliadinae	*Catopsilia scylla cornelia*	Orange Emigrant	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
146	Pieridae	Coliadinae	*Eurema hecabe contubernalis*	Common Grass Yellow	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
147	Pieridae	Coliadinae	*Eurema simulatrix tecmessa*	Forest Grass Yellow	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
148	Pieridae	Coliadinae	*Eurema blanda snelleni*	Three Spot Grass Yello	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
149	Pieridae	Coliadinae	*Eurema andersonii andersonii*	Anderson's Grass Yell	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
150	Pieridae	Coliadinae	*Eurema sari sodalis*	Chocolate Grass Yello	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
151	Pieridae	Coliadinae	*Gandaca harina distanti*	Tree Yellow	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
152	Riodinidae	-	*Abisara savitri savitri*	Malay Tailed Judy	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
153	Riodinidae	-	*Abisara saturata kausambioides*	Malayan Plum Judy	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
154	Riodinidae	-	*Laxita thuisto thuisto*	Lesser Harlequin	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not Assessed	Not Assessed	-	-	-	-
155	Papilionidae	-	*Pachliopta aristolochiae*	Common Rose	*http://www.catalogueoflife.org/col/details/species/id/11522262*	O	-	Not Assessed	Not Assessed	-	-	-	-
156	Papilionidae	-	*Papilio demolion*	Banded Swallowtail	*http://www.catalogueoflife.org/col/details/species/id/11522021*	O	-	Not Assessed	Not Assessed	-	-	-	-
157	Papilionidae	-	*Papilio polytes*	Common Mormon	*http://www.catalogueoflife.org/col/details/species/id/11522125*	O	-	Not Assessed	Not Assessed	-	-	-	-
158	Papilionidae	-	*Troides helena*	Common Birdwing	*http://www.catalogueoflife.org/col/details/species/id/11522321*	O	-	Not Assessed	Not Assessed	-	-	-	-
159	-	-	*Leptosia mina*	Psyche		O	-	Not Assessed	Not Assessed	-	-	-	-
160	Pieridae	-	*Catopsilia pomona*	Lemon Emigrant		O	-	Not Assessed	Not Assessed	-	-	-	-
161	Nymphalidae	Danainae	*Euploea crameri*	Spotted Black Crow		O	-	Not Assessed	Not Assessed	-	-	-	-
162	-	-	*Euploea mulciber*	Striped Blue Crow		O	-	Not Assessed	Not Assessed	-	-	-	-
163	Nymphalidae	Satyrinae	*Elymnias hypermnestra*	Common Palmfly		O	-	Not Assessed	Not Assessed	-	-	-	-
164	Nymphalidae	Satyrinae	*Elymnias panthera*	Tawny Palmfly	*NSS Report on STB*	O	-	Not Assessed	Not Assessed	-	-	-	Forest dependent species
165	Nymphalidae	-	*Melanitis leda*	Common Evening Bro	*http://www.catalogueoflife.org/col/details/species/id/10686266*	O	-	Not Assessed	Not Assessed	-	-	-	-

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166	Nymphalidae	-	*Orsotriaena medus*	Nigger	*http://www.catalogueoflife.org/col/details/species/id/10686605*	O	-	Not Assessed	Not Assessed	-	-	-	Grassland dependent species
167	Nymphalidae	Satyrinae	*Ypthima pandocus*	Common Three Ring	*http://www.catalogueoflife.org/col/details/species/id/10686689*	O	-	Not Assessed	Not Assessed	-	-	-	-
168	Nymphalidae	-	*Faunis canens*	Common Faun	*http://www.catalogueoflife.org/col/details/species/id/10687357*	O	-	Not Assessed	Not Assessed	-	-	-	Forest dependent species
169	Nymphalidae	-	*Cupha erymanthis*	Rustic	*http://www.catalogueoflife.org/col/details/species/id/10688898*	O	-	Not Assessed	Not Assessed	-	-	-	Forest dependent species
170	Nymphalidae	-	*Junonia almana*	Peacock Pansy	*http://www.iucnredlist.org/details/160318/0*	O	-	LC	Least Concern ver 3.1	-	-	-	This species inhabits a wide variety of habitats including secondary rainforest, monsoon forest, plantations, rural areas and gardens
171	Nymphalidae	-	*Junonia hedonia*	Chocolate Pansy	*http://www.catalogueoflife.org/col/details/species/id/10689164*	O	-	Not Assessed	Not Assessed	-	-	-	-
172	-	-	*Lascar* sp.	-		O	-	Not Assessed	Not Assessed	-	-	-	-
173	-	-	*Sailor* sp.	-		O	-	Not Assessed	Not Assessed	-	-	-	-
174	Nymphalidae	-	*Pandita sinope*	-	*http://www.catalogueoflife.org/col/details/species/id/10690540*	O	-	Not Assessed	Not Assessed	-	-	-	-
175	-	-	*Phalantha phalantha*	Leopard		O	-	Not Assessed	Not Assessed	-	-	-	-
176	-	-	*Euchrysops cnejus*	Gram Blue		O	-	Not Assessed	Not Assessed	-	-	-	-
177	Hesperiidae	-	*Udaspes folus*	Grass Demon	*http://www.catalogueoflife.org/col/details/species/id/10694905*	O	-	Not Assessed	Not Assessed	-	-	-	Grassland dependent species
178	-	-	-	Saturn	*NSS Report on STB*	O	-	-	-	-	-	-	-
179	-	-	-	Common Posy	*NSS Report on STB*	O	-	-	-	-	-	-	-
Dragonflies													
1	Coenagrionidae	-	*Ceriagrion cerinorubellum*	Ornate Coraltail	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167444/0*	O	IM	LC	Least Concern ver 3.1	-	-	-	This species breeds in a wide variety of standing water habitats, from drains in town and cities to marshes and swamp forest, and even the landward margins of mangrove swamp.
2	Coenagrionidae	-	*Pseudagrion microcephalum*	Common Blue Sprite	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167199/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	Habitat preferences include ponds, lakes and streams
3	Platycnemididae	-	*Copera marginipes*	Yellow Featherlegs	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167328/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	Found in ponds, puddles, canals and streams.
4	Aeshnidae	-	*Gynacantha basiguttata*	Spoon-tailed Duskhaw	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167287/0*	O	IM	LC	Least Concern ver 3.1	-	-	-	This is a species of lowland forest, especially swamp forest. It breeds in forest pools and appears tolerant of disturbance, occurring in logged forest.
5	Gomphidae	-	*Ictinogomphus decoratus*	Common Flangetail	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167416/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	This is a lentic species, breeding in ponds, lakes and slow flowing streams.
6	Libellulidae	-	*Agriomoptera insignis*	Grenadier	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167298/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	Usually found in swampy lowland forest, and is tolerant of some disturbance.
7	Libellulidae	-	*Agriomoptera sexlineata*	Handsome Grenadier	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/9695837*	O	-	Not Assessed	Not Assessed	-	Critically Endangered (CR) *Davidson et.al (2008) The Singapore Red Data Book*	-	-
8	Libellulidae	-	*Camacinia gigantea*	Sultan	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167427/0*	O	IM	LC	Least Concern ver 3.1	-	Critically Endangered (CR) *Davidson et.al (2008) The Singapore Red Data Book*	-	This species breeds in shallow stagnant waters. It is mainly found near the coast, at lagoons and shallow ponds, and at the rearward edges of mangrove, although it is also sometimes encountered far inland (e.g. Chiang Mai in Thailand). In Sarawak numbers of this species have been reported on shallow coastal pools that dry up after a few days without rain.
9	Libellulidae	-	*Cratilla metallica*	Dark-tipped Forest-sk	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/163752/0*	O	IM	LC	Least Concern ver 3.1	-	-	-	The species breeds in forest pools, and occurs in secondary forest.
10	Libellulidae	-	*Orchithemis pulcherrima*	Orchithemis pulcherri	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/190838/0*	O	IM	LC	Least Concern ver 3.1	-	-	-	This species occupies a broad range of swamp and swampy forest habitats. It is most common at low altitudes but it has been found at above 1,000 m in the Tama Abu Range in Sarawak. It occurs in highly disturbed forest and it has been found on a stream in mature oil palm in eastern Kalimantan and in Peninsular Malaysia.
11	Libellulidae	-	*Orthetrum chrysis*	Spine-tufted Skimmer	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167408/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	Common in marshes, ponds, lakes, sluggish streams and irregation canals.
12	Libellulidae	-	*Orthetrum glaucum*	Common Blue Skimm	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/163780/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	This species breeds in ponds, drains, ditches and other open lentic habitats.
13	Libellulidae	-	*Orthetrum sabina*	Variegated Green Skin	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/165470/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	This species occupies a broad range of slow flowing and still water habitats, from ponds and lakes to wet rice fields, irrigation ditch and marshes. It is very tolerant of high salt contents and to habitat disturbance.
14	Libellulidae	-	*Lathrecista asiatica*	Scarlet Grenadier	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167353/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	This species breeds in ponds, marshes, swamp forest and shallow forest pools. It has been found in Kalimantan on small pools in oil palm plantations where agrochemicals are heavily used, so it is tolerant of disturbance and pollution.

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15	Libellulidae	-	*Tholymis tillarga*	White-barred Duskhaw	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/60048/0*	O	IM + EA + Oceania	LC	Least Concern ver 3.1	-	-	-	Tholymis tillarga is a migrant with permanent presence in the humid parts of the tropics. Migrants enter the desert areas and can potentially be found anywhere. The species is a very ubiquitous and opportunistic one and breeds in pools, ponds, marshes on sides of large lakes, and swamps in bush, woodland and forest as well as in river backwaters and man-made sewage lagoons, pools, ponds and water tanks
16	Libellulidae	-	*Trameа transmarina*	Saddlebag Glider	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167183/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	The species is widespread throughout tropical Asia occurring in well vegetated lakes, ponds and drains from sea level to 2,000 m; it occurs everywhere throughout Malaysia in the lowlands, is salt tolerant, wanders far from its breeding places upon emergence, frequently soars to altitudes of over 2,000 m, soaring high above mountain plateaux and jungle clearings, and is migratory
17	Libellulidae	-	*Urothemis signata*	Scarlet Basker	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/165562/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	This species breeds in ponds and slow flowing rivers, typically in lowland areas.
18	Libellulidae	-	*Zyxomma petiolatum*	Long-trailed Dusk-dar	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167216/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	The species breeds in small stagnant pools, ponds, swamp forest and slow flowing rivers.
19	Libellulidae	-	*Trithemis festiva*	Indogo Dropwing	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/163609/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	Breeds in streams and rivers.
20	Libellulidae	-	*Trithemis aurora*	Dawn Dropwing	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167395/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	The species uses diverse wetland habitats such as ponds, lakes, marshes, wet paddy fields, streams, rivers, and irrigation canals
21	Libellulidae	-	*Rhyothemis phyllis*	Yellow-striped Flutter	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167448/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	In Malaysia, the species is commonly found at open pond/marsh and from swamp forest.
22	Libellulidae	-	*Pseudothemis jorina*	Asian Pied Dragonfly	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/190851/0*	O	SD + IC	LC	Least Concern ver 3.1	-	Critically Endangered (CR) *Davidson et.al (2008) The Singapore Red Data Book*	-	It occurs in lentic bodies and slow flowing rivers.
23	Libellulidae	-	*Pantala flavescens*	Globe Skimmer	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/59971/0*	O	Asia + Africa + Oceania	LC	Least Concern ver 3.1	-	-	-	It used commonly temporary pools and ponds watered by monsoon rainfalls but may occasionally breed in permanent water.
24	Libellulidae	-	*Orthetrum testaceum*	Red-nosed Skimmer	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167384/0*	O	IM	LC	Least Concern ver 3.1	-	-	-	It occurs in a wide variety of standing water and stream habitats, including mildly organically polluted streams.
25	Libellulidae	-	*Orthetrum luzonicum*	Marsh Skimmer	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167309/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	This species breeds in habitats such as marshes, boggy areas and wet abandoned rice fields.
26	Libellulidae	-	*Neurothemis fluctuans*	Maroon Grasshawk	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167488/0*	O	IM	LC	Least Concern ver 3.1	-	-	-	This species is found at ponds, marshes, swamps and other stagnant waters.
27	Libellulidae	-	*Brachydiplax chalybea*	Powder Blue Dwarf	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/167148/0*	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	This species is found in marshes and weedy ponds, may be able to tolerate brackish water, and is tolerant of disturbance.
28	-	-	*Prodasineura humeralis*	Orange-striped Threac	-	O	-	-	-	-	-	-	-
29	-	-	*Latherista asiatica*	Australian Slimwing	-	O	-	-	-	-	-	-	-
30	-	-	*Trameа* sp.		-	O	-	-	-	-	-	-	-
31	-	-	*Orethetrum crhysis*	Black-backed Skimmer	-	O	-	-	-	-	-	-	-
Spiders													
1	Araneidae	-	*Acucilas coccineus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	EA + Indonesia	Not Assessed	Not Assessed	-	-	-	-
2	Araneidae	-	*Arachnura sp. BB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
3	Araneidae	-	*Araneus sp. MB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
4	Araneidae	-	*Argiope aemula*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
5	Araneidae	-	*Argiope sp. NM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
6	Araneidae	-	*Argiope versicolor*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + IC	Not Assessed	Not Assessed	-	-	-	-
7	Araneidae	-	*Caerostris sp. MG*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
8	Araneidae	-	*Cyclosa bifida*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
9	Araneidae	-	*Cyphalonotus sp. MF*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
10	Araneidae	-	*Cyrtophora unicolor*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	SD	Not Assessed	Not Assessed	-	-	-	-
11	Araneidae	-	*Eriovixia excelsa*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Indonesia + PH	Not Assessed	Not Assessed	-	-	-	-
12	Araneidae	-	*Eriovixia laglaizei*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	SD + PH + Myanmar	Not Assessed	Not Assessed	-	-	-	-
13	Araneidae	-	*Eriovixia pseudocentrodes*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM + EA	Not Assessed	Not Assessed	-	-	-	-
14	Araneidae	-	*Gasteracantha hasselti*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
15	Araneidae	-	*Gasteracantha kuhli*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
16	Araneidae	-	*Gasteracantha sp. SM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-

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17	Araneidae	-	*Gea spiniipes*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	TM + SD	Not Assessed	Not Assessed	-	-	-	-
18	Araneidae	-	*Liprocea fusiformis*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	BO	Not Assessed	Not Assessed	-	-	-	-
19	Araneidae	-	*Neoscona bengalensis*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	Indonesia	Not Assessed	Not Assessed	-	-	-	-
20	Araneidae	-	*Neoscona punctigera*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	IM	Not Assessed	Not Assessed	-	-	-	-
21	Araneidae	-	*Neoscona vigilans*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	IM	Not Assessed	Not Assessed	-	-	-	-
22	Araneidae	-	*Parawixia dehaani*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	IM	Not Assessed	Not Assessed	-	-	-	-
23	Araneidae	-	*Poltys illepidus*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	IM	Not Assessed	Not Assessed	-	-	-	-
24	Araneidae	-	*Singa perpolita*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	IM	Not Assessed	Not Assessed	-	-	-	-
25	Araneidae	-	*Unidentified sp. AM*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
26	Clubionidae	-	*Cheiracanthium sp. 4F*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
27	Clubionidae	-	*Cheiracanthium sp. WE*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
28	Clubionidae	-	*Clubionia sp. JB*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
29	Clubionidae	-	*Nusatidia sp. JB*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
30	Corinnidae	-	*Corinnomma severum*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	PH + BO + TM	Not Assessed	Not Assessed	-	-	-	-
31	Corinnidae	-	*Corinnomma thorelli*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	IM	Not Assessed	Not Assessed	-	-	-	-
32	Corinnidae	-	*Oedignatha scrobiculata*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
33	Corinnidae	-	*Serendib muadai*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	IM	Not Assessed	Not Assessed	-	-	-	-
34	Ctenidae	-	*Ctenus sp. BR*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
35	Ctenidae	-	*Ctenus sp. SH*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
36	Ctenidae	-	*Unidentified Ctenus sp.*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
37	Hersiliidae	-	*Hersilia savignyi*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	IM + EA	Not Assessed	Not Assessed	-	-	-	-
38	Hersiliidae	-	*Hersilia deelemanae*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	BO + Indonesia	Not Assessed	Not Assessed	-	-	-	-
39	Linyphiidae	-	*Nasoona chrysanthusi*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
40	Linyphiidae	-	*Nasoona prominula*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	TM	Not Assessed	Not Assessed	-	-	-	-
41	Linyphiidae	-	*Parameioneta spicata*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	TM	Not Assessed	Not Assessed	-	-	-	-
42	Linyphiidae	-	*Unidentified sp. DB*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
43	Linyphiidae	-	*Unidentified sp. 8B*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
44	Liocranidae	-	*Sphingius vivax*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	IC + PH	Not Assessed	Not Assessed	-	-	-	-
45	Liocranidae	-	*Sphingius sp. AV*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
46	Lycosidae	-	*Hippasa holmerae*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	IM + EA	Not Assessed	Not Assessed	-	-	-	-
47	Lycosidae	-	*Pardosa pusiola*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	SD + Myanmar	Not Assessed	Not Assessed	-	-	-	-
48	Lycosidae	-	*Pardosa sumatrana*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
49	Lycosidae	-	*Pardosa sp. AS*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
50	Lycosidae	-	*Venonia coruscans*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
51	Mysmenidae	-	*Unidentified sp. PO*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
52	Nephilidae	-	*Herennia multipuncta*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	IM + Oceania	Not Assessed	Not Assessed	-	-	-	-
53	Nephilidae	-	*Nephila pilipes*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
54	Nesticidae	-	*Unidentified sp. LE*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
55	Ochyroceratidae	-	*Unidentified sp. SA*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
56	Oonopidae	-	*"Opopaea" sp. 4S*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
57	Oonopidae	-	*"Opopaea" sp. BB*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
58	Oonopidae	-	*"Opopaea" sp. LR*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
59	Oonopidae	-	*"Opopaea" sp. PO*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
60	Oonopidae	-	*Ischnothyreus sp. BS*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
61	Oonopidae	-	*Ischnothyreus sp. WR*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
62	Oonopidae	-	*Ischnothyreus sp. LM*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
63	Oxyopidae	-	*Hamataliwa incompta*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	PH + BO	Not Assessed	Not Assessed	-	-	-	-
64	Oxyopidae	-	*Hamataliwa sp. AB*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
65	Oxyopidae	-	*Oxyopes auratus*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	IM	Not Assessed	Not Assessed	-	-	-	-
66	Oxyopidae	-	*Oxyopes javanus*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	IM	Not Assessed	Not Assessed	-	-	-	-
67	Oxyopidae	-	*Oxyopes lineatipes*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	IM	Not Assessed	Not Assessed	-	-	-	-
68	Oxyopidae	-	*Oxyopes sp. IM*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
69	Pholcidae	-	*Pholcus gracillimus*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	Indonesia	Not Assessed	Not Assessed	-	-	-	-
70	Pholcidae	-	*Spermophora sp. CK*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-
71	Pholcidae	-	*Unidentified Spermophora sp.*	-	Joseph K H Koh et.al (2014) Mandai Spiders	O	-	Not Assessed	Not Assessed	-	-	-	-

Item	Family	Sub-Family	Genus species	English Name	Source	Presence*	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
72	Pisauridae	-	*Hygropoda sp. 2D*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
73	Pisauridae	-	*Polyboea vulpina*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	TM	Not Assessed	Not Assessed	-	-	-	-
74	Psechridae	-	*Fecenia protensa*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
75	Psechridae	-	*Psechrus singaporensis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
76	Salticidae	-	*Cosmophasis thalassina*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + Indonesia	Not Assessed	Not Assessed	-	-	-	-
77	Salticidae	-	*Epeus sumatranus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Indonesia	Not Assessed	Not Assessed	-	-	-	-
78	Salticidae	-	*Epeus tener*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
79	Salticidae	-	*Euryattus sp. MM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
80	Salticidae	-	*Euryattus sp. SR*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
81	Salticidae	-	*Myrmarachne cornuta*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + Myanmar	Not Assessed	Not Assessed	-	-	-	-
82	Salticidae	-	*Myrmarachne maxillosa*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM + EA	Not Assessed	Not Assessed	-	-	-	-
83	Salticidae	-	*Myrmarachne melanocephala*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
84	Salticidae	-	*Myrmarachne wanlessi*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
85	Salticidae	-	*Myrmarachne sp. LL*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
86	Salticidae	-	*Namnenus syrphus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
87	Salticidae	-	*Pancorius dentichelis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
88	Salticidae	-	*Phaeacius malayensis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
89	Salticidae	-	*Phintella bifurcilinea*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM + EA	Not Assessed	Not Assessed	-	-	-	-
90	Salticidae	-	*Phintella debilis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
91	Salticidae	-	*Phintella vittata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
92	Salticidae	-	*Portia labiata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
93	Salticidae	-	*Pseudamycus sp. CP*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
94	Salticidae	-	*Ptocasius weyersi*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
95	Salticidae	-	*Siler semiglaucus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
96	Salticidae	-	*Telamonia dimidiata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + Indonesia	Not Assessed	Not Assessed	-	-	-	-
97	Salticidae	-	*Telamonia festiva*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + Myanmar	Not Assessed	Not Assessed	-	-	-	-
98	Salticidae	-	*Thiania bhamoensis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + Myanmar	Not Assessed	Not Assessed	-	-	-	-
99	Salticidae	-	*Thorelliola ensifera*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Indonesia	Not Assessed	Not Assessed	-	-	-	-
100	Salticidae	-	*Viciria praemandibularis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
101	Salticidae	-	*Unidentified sp. BB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
102	Salticidae	-	*Unidentified sp. BF*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
103	Salticidae	-	*Unidentified sp. RS*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
104	Salticidae	-	*Unidentified sp. TC*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
105	Salticidae	-	*Unidentified sp. LP*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
106	Salticidae	-	*Unidentified sp. TB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
107	Scytodidae	-	*Unidentified sp. LL*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
108	Sparassidae	-	*Heteropoda tetrica*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
109	Sparassidae	-	*Heteropoda venatoria*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	South America	Not Assessed	Not Assessed	-	-	-	-
110	Sparassidae	-	*Pandercetes sp. CM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
111	Sparassidae	-	*Pandercetes cf. macilentis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
112	Sparassidae	-	*Thelcticopis sp. FM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
113	Sparassidae	-	*Unidentified sp. PU*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
114	Telemidae	-	*Telema fabata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Singapore	Not Assessed	Not Assessed	-	-	-	-
115	Tetrablemmide	-	*Brignoliella michaeli*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Myanmar	Not Assessed	Not Assessed	-	-	-	-
116	Tetragnathidae	-	*Leucauge argentina*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	SD + TM + PH	Not Assessed	Not Assessed	-	-	-	-
117	Tetragnathidae	-	*Leucauge decorata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IC + BO	Not Assessed	Not Assessed	-	-	-	-
118	Tetragnathidae	-	*Mesida sp. JB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
119	Tetragnathidae	-	*Opadometa fastigata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	PH	Not Assessed	Not Assessed	-	-	-	-
120	Tetragnathidae	-	*Tetragnatha chauliodus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
121	Tetragnathidae	-	*Tetragnatha hasselti*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + Mynamar	Not Assessed	Not Assessed	-	-	-	-
122	Tetragnathidae	-	*Tetragnatha mandibulata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
123	Tetragnathidae	-	*Tetragnatha sp. CM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
124	Tetragnathidae	-	*Tetragnatha sp. AM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
125	Tetragnathidae	-	*Tetragnatha sp. AZ*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
126	Tetragnathidae	-	*Tetragnatha sp. SJ*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-

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127	Tetragnathidae	-	*Tylorida striata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + IC	Not Assessed	Not Assessed	-	-	-	-
128	Tetragnathidae	-	*Tylorida ventralis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM + Oceania	Not Assessed	Not Assessed	-	-	-	-
129	Theridiidae	-	*Argyrodes fissifrons*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
130	Theridiidae	-	*Argyrodes flavescens*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
131	Theridiidae	-	*Argyrodes sp. ST*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
132	Theridiidae	-	*Ariamnes flagellum*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Indonesia	Not Assessed	Not Assessed	-	-	-	-
133	Theridiidae	-	*Chrysso sp. TT*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
134	Theridiidae	-	*Coleosoma blandum*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
135	Theridiidae	-	*Episinus sp. JB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
136	Theridiidae	-	*Janula triangularis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO	Not Assessed	Not Assessed	-	-	-	-
137	Theridiidae	-	*Janula sp. CP*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
138	Theridiidae	-	*Janula sp. MS*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
139	Theridiidae	-	*Janula sp. YF*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
140	Theridiidae	-	*Parasteatoda mundula*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM + EA + Oceania	Not Assessed	Not Assessed	-	-	-	-
141	Theridiidae	-	*Parasteatoda sp. 4S*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
142	Theridiidae	-	*Parasteatoda sp. BU*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
143	Theridiidae	-	*Rhomphaea labiata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	EA	Not Assessed	Not Assessed	-	-	-	-
144	Theridiidae	-	*Rhomphaea tanikawai*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	EA	Not Assessed	Not Assessed	-	-	-	-
145	Theridiidae	-	*Theridion t-notatum*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Myanmar	Not Assessed	Not Assessed	-	-	-	-
146	Theridiidae	-	*Theridion sp. AZ*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
147	Theridiidae	-	*Theridula gonygaster*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Europe + SEA	Not Assessed	Not Assessed	-	-	-	-
148	Theridiidae	-	*Thwaitesia sp. MA*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
149	Theridiidae	-	*Unidentified sp. 5S*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
150	Theridiidae	-	*Unidentified sp. B2*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
151	Theridiidae	-	*Unidentified sp. BK*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
152	Theridiidae	-	*Unidentified sp. GP*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
153	Theridiidae	-	*Unidentified sp. PR*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
154	Theridiidae	-	*Unidentified sp. T8*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
155	Theridiidae	-	*Unidentified sp. WP*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
156	Theridiosomatidae	-	*Theridiosoma fasciatum*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	SD	Not Assessed	Not Assessed	-	-	-	-
157	Thomisidae	-	*Angaeus rhombifer*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
158	Thomisidae	-	*Camaricus maugei*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not Assessed	Not Assessed	-	-	-	-
159	Thomisidae	-	*Monaeses aciculatus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	PH + EA	Not Assessed	Not Assessed	-	-	-	-
160	Thomisidae	-	*Phurta bimaculata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	TM + BO	Not Assessed	Not Assessed	-	-	-	-
161	Thomisidae	-	*Runcinia affinis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM + EA	Not Assessed	Not Assessed	-	-	-	-
162	Thomisidae	-	*Thomisus guangxicus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + China	Not Assessed	Not Assessed	-	-	-	-
163	Thomisidae	-	*Tmarus sp. SC*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
164	Thomisidae	-	*Unidentified sp. SB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
165	Uloboridae	-	*Miagrammopes sp. SB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
166	Zodariidae	-	*Asceua sp. CG*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
167	Zodariidae	-	*Asceua sp. AM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
168	Zodariidae	-	*Asceua sp. CE*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
169	Zodariidae	-	*Mallinella annulipes*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	SD + Myanmar	Not Assessed	Not Assessed	-	-	-	-
170	-	-	*Corinnomma serverum*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
171	-	-	*Tylorida ventralis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
172	-	-	*Herennia multipunctata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
173	-	-	*Thiania bhamoensis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
174	-	-	*Phurta bimaculata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not Assessed	Not Assessed	-	-	-	-
Hymenoptera													
1	Vespidae	Vespinae	*Vespa tropica*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
2	Vespidae	Vespinae	*Vespa analis*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
3	Vespidae	Polistinae	*Ropalidia "sp. 1"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-

Item	Family	Sub-Family	Genus species	English Name	Source	Presence*	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
4	Vespidae	Polistinae	*Ropalidia "sp. 2"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
5	Vespidae	Polistinae	*Ropalidia erythrospila*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
6	Vespidae	Polistinae	*Ropalidia marginata*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
7	Vespidae	Polistinae	*Polistes meadeanus*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
8	Vespidae	Polistinae	*Polistes stigma*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
9	Vespidae	Eumeninae	*Delta pyriforme*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
10	Vespidae	Eumeninae	*Phimenes sp.*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
11	Vespidae	Eumeninae	*Rhynchium haemorrhoidale*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
12	Vespidae	Eumeninae	*Eumenes "sp. 1"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
13	Vespidae	Eumeninae	*Eumenes "sp. 2"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
14	Vespidae	Eumeninae	*Eumenes "sp. 3"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
15	Vespidae	Eumeninae	*Eumenes "sp. 4"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
16	Vespidae	Eumeninae	*Eumenes "sp. 5"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
17	Vespidae	Eumeninae	*Eumenes "sp. 6"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
18	Vespidae	Eumeninae	*Eumenes "sp. 7"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
19	Vespidae	Eumeninae	*Allorhynchium argentatum*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
20	Vespidae	Stenogastrinae	*Eustenogaster "sp. 1"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
21	Vespidae	Stenogastrinae	*Eustenogaster "sp. 2"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
22	Vespidae	Stenogastrinae	*Liostenogaster sp.*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
23	Vespidae	Stenogastrinae	*Parischnogaster sp. nr. nigricans*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
24	Vespidae	Stenogastrinae	*Parischnogaster sp. nr. mellyi*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
25	Vespidae	Stenogastrinae	*Parischnogaster "sp. 2"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
26	Vespidae	Stenogastrinae	*Metischnogaster sp.*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
27	Sphecidae	Sphecinae	*Sphex sericeus*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
28	Sphecidae	Sphecinae	*Isodontia sp. nr. diodon*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
29	Sphecidae	Sphecinae	*Isodontia sp.*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-
30	Sphecidae	Sceliphrinae	*Sceliphron javanum*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not Assessed	Not Assessed	-	-	-	-

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31	Sphecidae	Sceliphrinae	*Sceliphron madraspatanum*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
32	Crabronidae	Larrinae	*Liris "sp. 1"*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
33	Crabronidae	Larrinae	*Liris "sp. 2"*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
34	Crabronidae	Larrinae	*Larrinae undet. (small)*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
35	Crabronidae	Crabroninae; Trypoxylii	*Trypoxylon "sp. 1"*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
36	Crabronidae	Crabroninae; Trypoxylii	*Trypoxylon "sp. 2"*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
37	Crabronidae	-	*Crabronidae undet.*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
38	Pompilidae	-	*Pompilidae "sp. 1"*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
39	Pompilidae	-	*Pompilidae "sp. 2"*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
40	Pompilidae	-	*Pompilidae "sp. 3"*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
41	Pompilidae	-	*Pompilidae "sp. 4"*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
42	Pompilidae	-	*Auplopus "sp. 1"*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
43	Pompilidae	-	*Pompilidae "sp. 5"*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
44	Pompilidae	-	*Pompilidae "sp. 6"*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
45	Pompilidae	-	*Pompilidae "sp. 7"*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
46	Pompilidae	-	*Tachypompilus analis*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
47	Apidae	Apinae; Apini	*Apis cerana*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
48	Apidae	Apinae; Meliponini	*Trigona cf laeviceps*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
49	Apidae	Apinae; Anthoporini	*Amegilla cf zonata*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
50	Apidae	Xylocopinae; Xylocopin	*Xylocopa latipes*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
51	Apidae	Xylocopinae; Ceratinini	*Ceratina unimaculata*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
52	Apidae	Xylocopinae; Ceratinini	*Ceratina "sp. 1"*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
53	Apidae	Xylocopinae; Ceratinini	*Ceratina "sp. 2"*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
54	Apidae	Xylocopinae; Ceratinini	*Ceratina "sp. 3"*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
55	Megachilidae	-	*Coelioxys sp. nr. confusus*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
56	Megachilidae	-	*Megachile disjuncta*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
57	Megachilidae	-	*Megachile subrixator*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-

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58	Megachilidae	-	*Megachile laticeps*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
59	Megachilidae	-	*Megachile sp.*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
60	Megachilidae	-	*Heriades sp.*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
61	Halictidae	-	*Nomia striata*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
62	Halictidae	-	*Nomia (Maculonomia) apicalis*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
63	Halictidae	-	*Nomia (Maculonomia) terminata*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
64	Halictidae	-	*Lipotriches ceratina*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
65	Halictidae	-	*Halictidae undet. 1*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
66	Halictidae	-	*Halictidae undet. 2*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
67	Colletidae	-	*Hylaeus sp.*	-	John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area	O	-	Not Assessed	Not Assessed	-	-	-	-
Orthoptera													
1	Acrididae	Acrididae	*Acrida willemsei*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
2	Acrididae	Acrididae	*Phlaeoba antennata*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
3	Acrididae	Acrididae	*Phlaeoba infumata*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
4	Acrididae	Catantopinae	*Acrida willemsei*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
5	Acrididae	Catantopinae	*Phlaeoba antennata*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
6	Acrididae	Catantopinae	*Phlaeoba infumata*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
7	Acrididae	Catantopinae	*Acrida willemsei*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
8	Acrididae	Catantopinae	*Phlaeoba antennata*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
9	Acrididae	Cyrtacanthacridinae	*Valanga nigricornis*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
10	Acrididae	Oedipodinae	*Trilophidia annulata*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
11	Acrididae	Oxyinae	*Oxya japonica japonica*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
12	Acrididae	Oxyinae	*Pseudoxya diminuta*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
13	Acrididae	Spathosterninae	*Spathosternum prasiniferum*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
14	Chorotypidae	Erianthinae	*Erianthus sp.*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-

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15	Chorotypidae	Mnesicleinae	*Mnesicles sp.*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
16	Pyrgomorphidae	Pyrgomorphinae	*Atractomorpha psittacina psittac*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
17	Pyrgomorphidae	Pyrgomorphinae	*Tagasta marginella*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
18	Tetrigidae	Scelimeninae	*Criotettix cf. robustus*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
19	Tetrigidae	Tetriginae	*Coptotettix spp.*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
20	Tetrigidae	Tetriginae	*Euparatettix variabilis*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
21	Tetrigidae	Tetriginae	*Euparatettix sp.*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
22	Tetrigidae	Tetriginae	*Phaesticus insularis*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
23	Gryllidae	Eneopterinae	*Cardiodactylus singapura*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
24	Gryllidae	Eneopterinae	*Nisitrus vittatus*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
25	Gryllidae	Euscyrtinae	*Beybienkoana trapeza*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
26	Gryllidae	Euscyrtinae	*Euscyrtus concinnus*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
27	Gryllidae	Euscyrtinae	*Euscyrtus cf. hemelytrus*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
28	Gryllidae	Euscyrtinae	*Patiscus malayanus*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
29	Gryllidae	Gryllinae	*Gymnogryllus sp.*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
30	Gryllidae	Gryllinae	*Teleogryllus sp.*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
31	Gryllidae	Gryllinae	*Velarifictorus aspersus*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
32	Gryllidae	Landrevinae	*Duolandrevus (Eulandrevus) sp*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
33	Gryllidae	Landrevinae	*Duolandrevus (Surdolandrevus)*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
34	Gryllidae	Landrevinae	*Landrevinae nymph*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
35	Gryllidae	Nemobiinae	*Pteronemobius sp. 1*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
36	Gryllidae	Nemobiinae	*Pteronemobius sp. 2*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
37	Gryllidae	Oecanthinae	*Oecanthus sp.*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-

Item	Family	Sub-Family	Genus species	English Name	Source	Presence*	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
38	Gryllidae	Podoscirtinae	*Aphonoides sp.*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
39	Gryllidae	Podoscirtinae	*Sonotrella (Megatrella) typica*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
40	Gryllidae	Sclerogryllinae	*Sclerogryllus sp. 1*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
41	Gryllidae	Sclerogryllinae	*Sclerogryllus sp. 2*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
42	Gryllidae	Trigonidiinae	*Amusurgus sp. 1*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
43	Gryllidae	Trigonidiinae	*Amusurgus sp. 2*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
44	Gryllidae	Trigonidiinae	*Amusurgus sp. 3*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
45	Gryllidae	Trigonidiinae	*Amusurgus sp. 4*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
46	Gryllidae	Trigonidiinae	*Amusurgus sp. 5*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
47	Gryllidae	Trigonidiinae	*Anaxipha sp.*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
48	Gryllidae	Trigonidiinae	*Homoeoxipha lycoides*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
49	Gryllidae	Trigonidiinae	*Metioche pallipes*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
50	Gryllidae	Trigonidiinae	*Natula longipennis*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
51	Gryllidae	Trigonidiinae	*Svistella sp.*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
52	Gryllidae	Trigonidiinae	*Trigonidiinae sp.*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
53	Gryllotalpidae	Gryllotalpinae	*Gryllotalpa nymphicus*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
54	Mogoplistidae	Mogoplistinae	*Apterornebius sp.*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
55	Mogoplistidae	Mogoplistinae	*Cycloptiloides cf. timah*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
56	Mogoplistidae	Mogoplistinae	*Ectatoderus angusticollis*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
57	Mogoplistidae	Mogoplistinae	*Micrornebius sp. 1*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
58	Mogoplistidae	Mogoplistinae	*Micrornebius sp. 2*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
59	Mogoplistidae	Mogoplistinae	*Ornebius albipalpus*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-
60	Mogoplistidae	Mogoplistinae	*Ornebius cf. pullus*	-	Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore	O	-	Not Assessed	Not Assessed	-	-	-	-

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61	Mogoplistidae	Mogoplistinae	*Ornebius sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
62	Rhaphidophoridae	Rhaphidophorinae	*Rhaphidophora sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
63	Gryllacrididae	Gryllacridinae	*Gryllacris sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
64	Tettigonidae	Conocephalinae	*Conocephalus longipennis*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
65	Tettigonidae	Conocephalinae	*Conocephalus maculatus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore http://www.iucnredlist.org/details/20633133/0*	O	Africa + Asia	LC	Least Concern ver 3.1	-	-	-	-
66	Tettigonidae	Conocephalinae	*Conocephalus melaenus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	This species is ubiquitous and probably found in all habitats which possess lowland grass, including roadside verges and pastures.
67	Tettigonidae	Conocephalinae	*Conocephalus sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
68	Tettigonidae	Conocephalinae	*Euconocephalus mucro*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
69	Tettigonidae	Conocephalinae	*Euconocephalus nasutus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
70	Tettigonidae	Conocephalinae	*Euconocephalus pallidus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
71	Tettigonidae	Conocephalinae	*Peracca macritchiensis*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
72	Tettigonidae	Conocephalinae	*Xestophrys horvathi*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
73	Tettigonidae	Conocephalinae	*Nahlaksia bidadari*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
74	Tettigonidae	Conocephalinae	*Oxylakis sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
75	Tettigonidae	Hexacentrinae	*Hexacentrus unicolor*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
76	Tettigonidae	Lipotactinae	*Lipotactes maculatus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
77	Tettigonidae	Listroscelidinae	*Carliphisis sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
78	Tettigonidae	Meconematinae	*Alloteratura sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
79	Tettigonidae	Mecopodinae	*Mecopoda elongata*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
80	Tettigonidae	Phaneropterinae	*Ducetia japonica*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
81	Tettigonidae	Phaneropterinae	*Elimaea*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
82	Tettigonidae	Phaneropterinae	*Phaneroptera brevis*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
83	Tettigonidae	Pseudophyllinae	*Chondroderella borneensis*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
Reduviidae													

Item	Family	Sub-Family	Genus species	English Name	Source	Presence#	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
1		Emesinae	*Gardena muscicapa*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
2		Emesinae	*Gardena melinarthrum*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
3		Emesinae	*Emesopsis sp.*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
4		Emesinae	*Empicoris sp.*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
5		Emesinae	*Tridemula cf. mixta*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
6		Harpactorinae	*Agyrius cf. podagricus*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
7		Harpactorinae	*Cosmolestes picticeps*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
8		Harpactorinae	*Euagoras plagiatus*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
9		Harpactorinae	*Sycanus sp. 1*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
10		Harpactorinae	*Sycanus sp. 2*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
11		Harpactorinae	*Red and black Harpactorine*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
12		Peiratinae	*Ectomocoris atrox*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
13		Reduviinae	*Acanthaspis inermis*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
14		Reduviinae	*Acanthaspis cf. quadriannulata*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
15		Reduviinae	*Acanthaspis signifera*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
16		Reduviinae	*Inara flavopicta*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
17		Saicinae	*Sp. 1*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
18		Salyavatinae	*Lisarda annularis*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
19		Salyavatinae	*Lisarda inornata*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
20		Stenopodainae	*Aulacogenia patalungae*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-
21		Stenopodainae	*Sastrapada sp.*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not Assessed	Not Assessed	-	-	-	-

* Endemicity definitions:
PH = Philippines only
BO = Borneo Island, which includes only Brunei, Sabah, Sarawak and Kalimantan
TM = Thai-Malay Peninsula, which includes only Myanmar, Thailand, Singapore and Peninsular Malaysia
IC = Indochinese Region, which includes only Cambodia, Laos, Vietnam, Myanmar, Thailand and Southern China
SD = Sundaland, which includes only Borneo, Peninsular Malaysia, Singapore and Indonesia
IM = Indomalaya Ecozone, which includes South Asian countries, Southeast Asian countries, Southern China and parts of East Asia
EA = East Asia region, which includes from Sakhalin to the north, Japan, Korean Peninsula, mainland China, and Taiwan

# Presence definitions:
O = Reportedly observed
O/A = Observed always
O/S = Observed sometimes
O/R = Rarely observed

Item	Family	Sub-Family	Genus species	English Name	Source	Presence*	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements

O/N = Never observed
PP = Potentially present

Item	Family	Genus species	English Name	Source	Presence[#]	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
1	Anabatidae	*Anabas testudineus*	Climbing Perch	*SFI EIA, 2002 http://www.iucnredlist.org/details/166543/0*	O	IM	DD	Data Deficient ver 3.1	-	-	-	Inhabits freshwaters, commonly found in rivers, canals, lakes, ponds, swamps and paddy fields
2	Bagridae	*Mystus nemurus*	Yellow Catfish	*SFI EIA, 2002 http://www.iucnredlist.org/details/180954/0*	O	SD	LC	Least Concern ver 3.1	-	-	-	Inhabits wide range of habitats, including rivers and streams, lakes, marshlands, and peat swamps
3	Channidae	*Channa striata*	Aruan or Common Snakehea	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai http://www.iucnredlist.org/details/166563/0*		IM + EA	LC	Least Concern ver 3.1			-	Inhabits swamps, freshwater ponds, streams and tanks in the plains; prefers stagnant muddy waters and grassy tanks.
4	Cichlidae	*Acarichthys heckelii*	Threadfin Acara	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai http://www.catalogueoflife.org/col/details/species/id/17990707*		South America	-	-			-	Freshwater
5	Clariidae	*Clarias batrachus*	Common Walking Catfish	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai http://www.iucnredlist.org/details/166613/0*		IM + EA	LC	Least Concern ver 3.1			-	Inhabits lowland fresh and brackish waters; rivers, lakes, ponds and reservoirs.
6	Cobitidae	*Acanthopsis choirorhynch*	Horseface Loach	*SFI EIA, 2002*	O	IM	NE	Not Evaluated	-	-	-	Inhabits wide range of habitats, including rivers and streams, lakes, marshlands, and peat swamps
7	Cyprinidae	*Garra borneensis*	Log Suckers	*SFI EIA, 2002*	O	IM	NE	Not Evaluated	-	-	-	Inhabits freshwaters, commonly found in rivers, canals, lakes, ponds, swamps and paddy fields
8	Cyprinidae	*Hampala macrolepidota*	Hampala Barb	*SFI EIA, 2002 http://www.iucnredlist.org/details/181255/0*	O	TM + SD	LC	Least Concern ver 3.1	-	-	-	Occurs mainly in clear rivers or streams with running water and sandy to muddy bottoms
9	Cyprinidae	*Leptobarbus hosii*	-	*SFI EIA, 2002 http://www.iucnredlist.org/details/169517/0*	O	BO	DD	Data Deficient ver 3.1	-	-	-	Inhabits freshwaters, this species can be found near or in the deepest part of a body of water
10	Cyprinidae	*Nematabramis borneensis*	-	*SFI EIA, 2002*	O	TM + SD	NE	Not Evaluated	-	-	-	Inhabits freshwaters, commonly found in rivers, canals, lakes, ponds, swamps and paddy fields
11	Cyprinidae	*Osteochilus microcephalus*	Pla Rong Mai Tub	*SFI EIA, 2002 http://www.iucnredlist.org/details/180653/0*	O	TM + SD	LC	Least Concern ver 3.1	-	-	-	Inhabits lowland freshwater wetlands, as well as canals and artificial habitats
12	Cyprinidae	*Barbodes sealei*	-	*SFI EIA, 2002*	O	BO	NE	Not Evaluated	-	-	-	Inhabits freshwaters, commonly found in rivers and streams
13	Cyprinidae	*Rasbora borapetensis*	Red-tailed Rasbora	*SFI EIA, 2002 http://www.iucnredlist.org/details/180947/0*	O	TM + SD	LC	Least Concern ver 3.1	-	-	-	Inhabits marshlands and shallow standing water bodies (including ponds, ditches, canals and reservoir margins)
14	Cyprinidae	*Rasbora einthovenii*	Einthoven's Rasbora	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai http://www.catalogueoflife.org/col/details/species/id/17968981*		SD	-	-			-	Freshwater
15	Cyprinidae	*Barbodes rhombeus*	Indochinese Spotted Barb	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai*		-	-	-			-	-
16	Cyprinidae	*Brachydanio albolineata*	Pearl Danio	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai*		-	-	-			-	-
17	Eleotridae	*Oxyeleotris marmorata*	Marbled Gudgeon	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai http://www.iucnredlist.org/details/181009/0*		IM + EA	LC	Least Concern ver 3.1			-	Occurs in various wetlands, including rivers, ponds, reservoirs, canals, swamps and flooded forests. It generally prefers areas of little or no water movement. Mainly found in freshwater but is also found in brackish environments.
18	Gastromyzontidae	*Gastromyzon borneensis*	-	*SFI EIA, 2002*	O	BO	NE	Not Evaluated	NA		-	Inhabits freshwaters, commonly found in rivers and streams
19	Gobionellidae	*Brachygobus sabanus*	Lesser Bumblebee Goby	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai*		-	-	-			-	-
20	Gobionellidae	*Eugnathogobius siamensis*	Siam Stream Goby	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai http://www.iucnredlist.org/details/181303/0*		TM + BO + EA	LC	Least Concern ver 3.1			-	Inhabits streams and lower reach rivers and estuaries.
21	Gobionellidae	*Gobiopterus brachypterus*	Greater Glass Goby	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai http://www.catalogueoflife.org/col/details/species/id/17987919*		IM + Oceania	-	-			-	Brackish,freshwater
22	Gobionellidae	*Rhinogobius giurinus*	Oriental River Goby	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai http://www.iucnredlist.org/details/166980/0*		IM + EA	LC	Least Concern ver 3.1			-	From large rivers to streams, found usually in shallow water over sandy bottom. Found both upstream and in estuaries and is carnivorous. Eggs are laid under stones in river shoals and the larvae travel in both river and the sea, and return to rivers
23	Osphronemidae	*Trichopsis vittata*	Croaking Gouramy	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai http://www.iucnredlist.org/details/187906/0*		SD + IC	LC	Least Concern ver 3.1			-	Locally common in all suitable habitats throughout its range.

Item	Family	Genus species	English Name	Source	Presence#	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
24	Poeciliidae	*Gambusia affinis*	Mosquito-fish	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai http://www.iucnredlist.org/details/166562/0*		Mexico + USA	LC	Least Concern ver 3.1			-	Habitat includes river channels, margins, backwaters; springs, marshes, and artificial habitats of all kinds. Often this species occurs in shallow, often stagnant, ponds and the shallow edges of lakes and streams where predatory fishes are largely absent and temperatures are high. It is most abundant in shallow water with thick vegetation. It also occurs in brackish sloughs and coastal saltwater habitats
25	Poeciliidae	*Poecilia reticulata*	Guppy	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai http://www.catalogueoflife.org/col/details/species/id/17971898*		West Indies, northern South America from Venezuela to Guyana *Nick Baker, Kelvin Lim (2012) Wild Animals of Singapore*	-	-			-	Brackish,freshwater
26	Zenarchopteridae	*Dermogenys collettei*	Sunda Pygmy Halfbeak	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai http://www.catalogueoflife.org/col/details/species/id/17942155*		Asia	-	-			-	Freshwater

* Endemicity definitions:
PH = Philippines only
BO = Borneo Island, which includes only Brunei, Sabah, Sarawak and Kalimantan
TM = Thai-Malay Peninsula, which includes only Myanmar, Thailand, Singapore and Peninsular Malaysia
IC = Indochinese Region, which includes only Cambodia, Laos, Vietnam, Myanmar, Thailand and Southern China
SD = Sundaland, which includes only Borneo, Peninsular Malaysia, Singapore and Indonesia
IM = Indomalaya Ecozone, which includes South Asian countries, Southeast Asian countries, Southern China and parts of East Asia
EA = East Asia region, which includes from Sakhalin to the north, Japan, Korean Peninsula, mainland China, and Taiwan

# Presence definitions:
O = Reportedly observed
O/A = Observed always
O/S = Observed sometimes
O/R = Rarely observed
O/N = Never observed
PP = Potentially present

Item	Family	Genus Species	English Name	Source	Presence*	Current endemicity listing^	IUCN Category	IUCN Status	Protected by Local Law	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
	-	*Chrysophlegma miniaceus*	Banded Woodpecker	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*		-	-	-	-	-	-	-
	-	*Aerodramus maximus*	Black-Nest Swiftlet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*		-	-	-	-	-	-	-
	-	*Callocalia fuciphaga*	Black-nest Swiftlet			-	-	-	-	-	-	-
	-	*Nisaetus limnaeetus*	Changeable Hawk-Eagle	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*		-	-	-	-	-	-	-
	-	*Megalaima haemacephala*	Coppersmith Barbet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*		-	-	-	Benefited from increase in number of habitat *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Secondary scrub, parkland, mangroves
	-	*Aerodramus germani*	Germain's Swiftlet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*		-	-	-		-	-	-
	-	*Callocalia brevirostris*	Himalayan Swiftlet			-	-	-		-	-	-
	-	*Megalaima lineata*	Lineated Barbet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*		-	-	-	Has adapted well to scrub *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Secondary forest, scrub, oldplantations, parkland
	-	*Cinnyris jugularis*	Olive-backed Sunbird	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)http://www.catalogueoflife.org/col/details/species/id/16991277*		-	-	-	-	-	-	Found in diverse habitats
	-	*Megalaima rafflesii*	Red-Crowned Barbet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*		-	NT	-	-	-	-	-
	-	*Halcyon capensis*	Stork-billed Kingfisher	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*		-	-	-		-	-	-
	-	*Leptocoma brasiliana*	Van Hasselt's Sunbird	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/16991230*		-	-	-	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Primary and secondary forests, old plantations, scrub, mangroves, parkland
	-	*Araneus*therra *chrysogenys*	Yellow-sured Spiderhunter			-	-	-	-	Critically Endangered (CR) *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	Forest dependent species (Subaraj, 2007)
	Psittacidae	*Loriculus galgulus*	Blue-crowned Hanging Parrot	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22685384/0*		IM	LC	Least Concern ver 3.1	-	Endangered (EN) *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-
	Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22725310/0*		Indonesia + Oceania	LC	Least Concern ver 3.1		-	-	-
	Sturnidae	*Acridotheres javanicus*	Javan Myna	*http://www.catalogueoflife.org/col/details/species/id/16989556*		-	-	-	Wild Animals and Birds Act *http://www.ava.gov.sg/docs/default-source/legislation/wild-animals-and-birds-act(584)e8_wildanimalsandbirdsact-p87-docx?*	-	-	Secondary forests, forest edge, scrub, old plantations, parkland, urban areas
	Irenidae	*Irena puella*	Asian Fairy-Bluebird	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22704933/0*		IM	LC	Least Concern ver 3.1	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Primary and secondary forests, adjacent scrub
	Accipitridae	*Haliastur indus*	Brahminy Kite	*SFI EIA, 2002 http://www.iucnredlist.org/details/22695094/0*	O	IM	LC	Least Concern ver 3.1	II	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	Commonly found on the coast and in inland wetlands
	Accipitridae	*Spizaetus cirrhatus*	Changeable Hawk-Eagle	*http://www.catalogueoflife.org/col/details/species/id/11931068 /rgnmnpm/11933041*		-	-	-		Endangered (EN) *Davidson et al (2008) The Singapore Red Data Book*	-	-
	Accipitridae	*Accipiter soloensis*	Chinese Goshawk	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22685850/0*		IM + EA	LC	Least Concern ver 3.1	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Primary and secondary forests, old plantations, scrub and parklands
	Accipitridae	*Ichthyophaga ichthyaetus*	Grey-headed Fish Eagle	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/11930148 /rgnmnpm/11933022*		Internationally Threatened				Critically Endangered (CR) *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	Forest dependent species
	Accipitridae	*Accipiter gularis*	Japannese Sparrowhawk	*WWF HCVF Assessment, 2011 http://www.iucnredlist.org/details/22695085/0*	O	IM	LC	Least Concern ver 3.1	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Commonly found in subtropical or tropical lowland rainforest
	Accipitridae	*Pernis ptilorhyncus*	Oriental Honey-Buzzard	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22694995/0*		IM + EA	LC	Least Concern ver 3.1	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Primary and secondary forest, forest edge, mangroves, oldplantations, scrub and parkland.
	Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22695097/0*		IM + EA + Oceania	LC	Least Concern ver 3.1	-	-	-	-
	Aegithinidae	*Aegithina tiphia*	Common Iora	*http://www.iucnredlist.org/details/22707433/0*		IM	LC	Least Concern ver 3.1	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	-
	Alcedinidae	*Ceyx erithaca*	Black-backed Kingfisher	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/61658565/0*		IM	LC	Least Concern ver 3.1	-	-	-	Primary and secondary forests, usually along streams or in swampy areas
	Alcedinidae	*Todiramphus chloris*	Collared Kingfisher	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22683398/0*		IM + EA	LC	Least Concern ver 3.1	Benefited from increase in number of habitat *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	-
	Alcedinidae	*Halcyon coromanda*	Ruddy Kingfisher	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22683234/0*		IM + EA	LC	Least Concern ver 3.1	-	Critically Endangered (CR) *Davidson et al (2008) The Singapore Red Data Book*	-	Secondary forests, scrub, old plantations, parklands
	Alcedinidae	*Halcyon smyrnensis*	White-throated Kingfisher	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22725846/0*		IM	LC	Least Concern ver 3.1	-	-	-	Secondary scrub, oldplantations, mudy fringged reservoirs, open playing fields and parkland
	Apodidae	*Aerodramus fuciphagus*	Edible-nest Swiftlet	*WWF HCVF Assessment, 2011 http://www.iucnredlist.org/details/22686614/0*	O	TM + SD + PH	LC	Least Concern ver 3.1	-	-	-	Covers a range of habitats from coastal areas to the montane forest, occurring up to 2,800 metres above sea-level
	Apodidae	*Aerodramus brevirostris*	Himalayan Swiftlet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/60824542/0*		IM	LC	Least Concern ver 3.1	-	-	-	-
	Apodidae	*Apus affinis*	House Swift	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22686856/0*		Asia, Africa, Spain	LC	Least Concern ver 3.1	-	-	-	-
	Ardeidae	*Nycticorax nycticorax*	Black-crowned Night Heron	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22697211/0*		IM + EA + others	LC	Least Concern ver 3.1	-	Critically Endangered *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	An uncommon resident of mangroves, ponds, mudflats, canals and well-vegetated reservoir fringes
	Ardeidae	*Bubulcus ibis*	Cattle Egret	*http://www.iucnredlist.org/details/22697109/0*		Asia + Africa + Europe + Oceania + United States	LC	Least Concern ver 3.1	-	-	-	Grassland dependent species

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1	Ardeidae	*Bubulcus coromandus*	Eastern Cattle Egret	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.catalogueoflife.org/col/details/browsed/id/19500099*		-	-	-	-	-	-	Grassland dependent species
2	Ardeidae	*Ardea cinerea*	Grey Heron	<IUCN> *Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.iucnredlist.org/details/22696993/0*		Asia + Africa + Europe	LC	Least Concern ver 3.1	-	Vulnerable (VU) *Davidson et.al (2008) The Singapore Red Data Book*	-	Sandy beaches, reefs, mangroves, coastal mudflats, freshwater marshes,wet grasslands and canals
3	Ardeidae	*Butorides striatus*	Little Heron	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/11927808 /summary/11932747*		-	-	-	-	-	-	-
4	Ardeidae	*Ardea purpurea*	Purple Heron	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.iucnredlist.org/details/22697031/0*		Asia + Africa + Europe	LC	Least Concern ver 3.1	-	Endangered (EN) *Davidson et.al (2008) The Singapore Red Data Book*	-	Mangroves, freshwater marshes, wet grasslands, water bodies with well-vegetated fringes
5	Ardeidae	*Ixobrychus sinensis*	Yellow Bittern	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22697303/0*		IM + EA + others	LC	Least Concern ver 3.1	No issues with conservation. *Yeng et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Mangroves, freshwater marshes and wet grasslands
6	Campephagidae	*Pericrocotus divaricatus*	Ashy Minivet	*http://www.iucnredlist.org/details/22706735/0*		IM + EA	LC	Least Concern ver 3.1	No issues with conservation. *Yeng et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	-
7	Campephagidae	*Lalage nigra*	Pied Triller	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22706651/0*		IM	LC	Least Concern ver 3.1	No issues with conservation. *Yeng et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Mangroves, parklands, urban areas, coastal scrub
8	Caprimulgidae	*Caprimulgus macrurus*	Large-tailed Nightjar	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22725708/0*		IM + EA + Oceania	LC	Least Concern ver 3.1	-	-	-	-
9	Chloropseidae	*Chloropsis cochinchinensis*	Blue-winged Leafbird	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22734235/0*		IM	LC	Least Concern ver 3.1	No issues with conservation. *Yeng et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Primary and secondary forests
10	Cisticolidae	*Prinia flaviventris*	Yellow-bellied Prinia	*http://www.iucnredlist.org/details/22713601/0*		IM + EA	LC	Least Concern ver 3.1	No issues with conservation. *Yeng et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Grassland dependent species
11	Columbidae	*Chalcophaps indica*	Emerald Dove	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22725538/0*		IM + EA	LC	Least Concern ver 3.1	-	-	-	-
12	Columbidae	*Treron vernans*	Pink-necked Green-Pigeon	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22691137/0*		IM	LC	Least Concern ver 3.1	-	-	-	-
13	Columbidae	*Streptopelia chinensis*	Spotted Dove	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/11910570*		-	-	-	-	-	-	-
14	Columbidae	*Treron curvirostra*	Thick-billed Green Pigeon	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22691160/0*		IM	LC	Least Concern ver 3.1	-	Endangered (EN) *Yeng et al (2013) A Naturalist Guide to the Birds of Singapore*	-	Forest dependent species
15	Columbidae	*Geopelia striata*	Zebra Dove	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22696708/0*		IM	LC	Least Concern ver 3.1	-		-	-
16	Coraciidae	*Eurystomus orientalis*	Dollarbird	*http://www.iucnredlist.org/details/22682920/0*		IM + EA + AS	LC	Least Concern ver 3.1	-	-	-	Secondary forests, forest edge, scrub,old plantations and parklands, mangroves
17	Corvidae	*Corvus splendens*	House Crow	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22705938/0*		IM	LC	Least Concern ver 3.1	Wild Animals and Birds Act *http://www.ava.gov.sg/docs/default-*	-	-	Old plantations, scrub, mangroves, parkland and urban areas
18	Corvidae	*Corvus macrorhynchos*	Large-billed Crow			-	-	-	No issues with conservation. *Yeng et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Secondary forests, mangroves, forest edge, scrub, old plantations, parkland, urban areas
19	Cuculidae	*Eudynamys scolopacea*	Asian Koel	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22684604/0*		IM + EA	LC	Least Concern ver 3.1	-	-	-	-
20	Cuculidae	*Caeomantis sonneratii*	Banded Bay Cuckoo	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22683917/0*		IM	LC	Least Concern ver 3.1	-	-	-	-
21	Cuculidae	*Phaenicophaeus sumatranus*	Chestnut-bellied Malkoha	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22684095/0*		SD + TM	NT	Near Threatened ver 3.1			-	Forest dependent species
22	Cuculidae	*Surniculus lugubris*	Drongo Cuckoo	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22728167/0*		IM	LC	Least Concern ver 3.1		Critically Endangered (CR) *Davidson et.al (2008) The Singapore Red Data Book*	-	-
23	Cuculidae	*Centropus sinensis*	Greater Coucal	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22684229/0*		IM	LC	Least Concern ver 3.1	-	-	-	-
24	Cuculidae	*Cuculus saturatus*	Himalayan Cuckoo	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/61450351/0*		IM + EA	LC	Least Concern ver 3.1	-	-	-	-
25	Cuculidae	*Cuculus micropterus*	Indian Cuckoo	*WWF HCVF Assessment, 2011 http://www.iucnredlist.org/details/22683870/0*	O	IM	LC	Least Concern ver 3.1	NA	-	-	Commonly found in forests and open woodland at up to 3,600 m
26	Cuculidae	*Centropus bengalensis*	Lesser Coucal	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22684254/0*		IM	LC	Least Concern ver 3.1	-	-	-	-
27	Cuculidae	*Caeomantis merulinus*	Plaintive Cuckoo	*WWF HCVF Assessment, 2011 http://www.iucnredlist.org/details/22683923/0*	O	IM	LC	Least Concern ver 3.1	NA	-	-	Commonly found in subtropical or tropical lowland rainforest
28	Cuculidae	*Chrysococcyx xanthorhynchus*	Violet Cuckoo	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22684003/0*		IM	LC	Least Concern ver 3.1	-	Endangered (EN) *Davidson et.al (2008) The Singapore Red Data Book*	-	-
29	Dicaeidae	*Ploceus philippinus*	Baya Weaver	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22719005/0*		IM + China	LC	Least Concern ver 3.1	-	-	-	Grassland dependent species
30	Dicaeidae	-	Chestnut-winged Babbler	*NSS Report on STB Project*		-	-	-	-	-	-	-
31	Dicaeidae	-	Greater Coucal	*NSS Report on STB Project*		-	-	-	-	-	-	-
32	Dicaeidae	*Dicaeum trigonostigma*	Orange-bellied Flowerpecker	*WWF HCVF Assessment, 2011 http://www.iucnredlist.org/details/22717519/0*	O	IM	LC	Least Concern ver 3.1	NA	-	-	Commonly found in subtropical or tropical lowland rainforests, subtropical or tropical mangrove forests, and subtropical or tropical montane rainforests; Forest dependent species (Subaraj, 2007)
33	Dicaeidae	-	Red-crowned Barbet	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*		-	-	-	-	-	-	-

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34	Dicaeidae	*Lonchura punctulata*	Scaly-breasted Munia	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22719821/0*		IM + China	LC	Least Concern ver 3.1	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Grassland dependent species
35	Dicaeidae	*Dicaeum cruentatum*	Scarlet-backed Flowerpecker	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22717584/0*		IM + China	LC	Least Concern ver 3.1	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Secondary forests, old plantations, mangroves, parklands, urban green spaces
36	Dicruridae	*Dicrurus paradiseus*	Greater Racket-tailed Drongo	*SFI EIA, 2002 http://www.iucnredlist.org/details/22707005/0*	O	IM	LC	Least Concern ver 3.1	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Commonly found in subtropical or tropical lowland rainforest
37	Estrildidae	*Lonchura atricapilla*	Chestnut Munia	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22729134/0*		IM	LC	Least Concern ver 3.1	-	-	-	Grassland, secondary scrub, parkland, gold courses
38	Gallirallus	*Rallus striatus*	Slaty-breasted Rail	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/11915661 #synonym/11931968*		-	-	-	-	-	-	Grassland dependent species
39	Heliornithidae	*Heliopais personata*	Masked Finfoot	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22692181/0*		IM	EN	Endangered A2cd+3cd+4cd; C2a(i) ver 3.1	-	Globally Endangered *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	Mangroves and secluded well-forested inlets of reservoirs.
40	Hemiprocnidae	*Hemiprocne longipennis*	Grey-rumped Treeswift	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22686894/0*		SD	LC	Least Concern ver 3.1	Population has declined in recent years *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	-
41	Hirundinidae	*Hirundo rustica*	Barn Swallow	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22712252/0*		Asia, Africa, Europe, Oceania, United States	LC	Least Concern ver 3.1	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Occurs over all habitats
42	Hirundinidae	*Hirundo tahitica*	Pacific Swallow	*http://www.iucnredlist.org/details/22712289/0*		BO + AS + IM	LC	Least Concern ver 3.1	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Occurs over all hibtats
43	Laniidae	*Lanius cristatus*	Brown shrike	*http://www.iucnredlist.org/details/22705011/0*		IM + EA	LC	Least Concern ver 3.1	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Grassland dependent species
44	Meropidae	*Merops philippinus*	Blue-tailed Bee-eater	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22683750/0*		IM	LC	Least Concern ver 3.1	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Secondary forest, forest edge, scrub, old plantations, parkland, urban gardens
45	Meropidae	*Merops viridis*	Blue-throated Bee-eater	*WRVF HCVF Assessment, 2011 http://www.iucnredlist.org/details/22683733/0*	O	TM + SD + PH	LC	Least Concern ver 3.1	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Commonly found in subtropical or tropical mangrove forest
46	Motacillidae	*Dendronanthus indicus*	Forest Wagtail	*http://www.iucnredlist.org/details/22718345/0*		IM + EA	LC	Least Concern ver 3.1	-	-	-	Primary and secondary forests, old plantations, mangroves, scrub
47	Motacillidae	*Anthus rufulus*	Paddyfield Pipit	*http://www.iucnredlist.org/details/22718477/0*		Asia	LC	Least Concern ver 3.1	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Grassland dependent species
48	Muscicapidae	*Muscicapa dauurica*	Asian Brown Flycatcher	*http://www.iucnredlist.org/details/22709203/0*		IM + EA + USA	LC	Least Concern ver 3.1	No issues with conservation. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Primary and secondary forests, mangroves, forest edge, scrub, old plantations, parkland, urban green spaces
49	Muscicapidae	*Cyanoptila cyanomelana*	Blue-and-White Flycatcher	*http://www.iucnredlist.org/details/22709422/0*		IM + EA	LC	Least Concern ver 3.1	-	-	-	-
50	Muscicapidae	*Copsychus saularis*	Oriental Magpie-Robin	*http://www.iucnredlist.org/details/22709088/0*		IM + China	LC	Least Concern ver 3.1	-	Endangered *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	Primary and secondary forests, mangroves, forest edge, scrub, parkland, urban areas
51	Muscicapidae	*Luscinia cyane*	Siberian Blue Robin	*http://www.iucnredlist.org/details/22709730/0*		IM + EA	LC	Least Concern ver 3.1	-	-	-	Primary and secondary forests, forest edge, old plantations, scrub
52	Muscicapidae	*Copsychus malabaricus*	White-rumped Shama	*http://www.iucnredlist.org/details/22734262/0*		IM + China	LC	Least Concern ver 3.1	-	Critically Endangered *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	This species inhabits lowland tropical moist forest, swamp forest, overgrown tree plantations, secondary jungle, mangroves and forest clearings, from sea-level to 1500 m in Thailand, but more usually to 500-600 m. It tends to prefer undergrowth and shady ravines
53	Nectariniidae	*Anthreptes malaccensis*	Brown-throated Sunbird	*WRVF HCVF Assessment, 2011 http://www.iucnredlist.org/details/22717614/0*	O	TM + SD + PH	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Commonly found in tropical lowland rainforest
54	Nectariniidae	*Aethopyga siparaja*	Crimson Sunbird	*WRVF HCVF Assessment, 2011 http://www.iucnredlist.org/details/22718093/0*	O	IM	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Commonly found in subtropical or tropical lowland rainforest
55	Nectariniidae	*Arachnothera longirostra*	Little Spiderhunter	*WRVF HCVF Assessment, 2011 http://www.iucnredlist.org/details/22718103/0*	O	IM	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Commonly found in subtropical or tropical lowland rainforest; Forest dependent species (Subaraj, 2007)
56	Nectariniidae	*Nectarinia sperata*	Purple-throated Sunbird	*http://www.iucnredlist.org/details/22717788/0*		SD + IC + PH	LC	Least Concern ver 3.1		-	-	Forest dependent species (Subaraj, 2007)
57	Oriolidae	*Oriolus chinensis*	Black-naped Oriole	*http://www.iucnredlist.org/details/22706394/0*		IM + EA	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Secondary forests, mangroves, old plantations, scrub, parkland, urban areas
58	Pandionidae	*Pandion haliaetus*	Osprey	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22694938/0*		IM + EA + others	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Mangroves, coastal mudflats, reservoirswith well-vegetated fringes
59	Picidae	*Picus miniaceus*	Banded Woodpecker	*http://www.iucnredlist.org/details/22683424/0*		BO + TM	LC	Least Concern ver 3.1		-	-	-
60	Picidae	*Dinopium javanense*	Common Flameback	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22727182/0*		IM	LC	Least Concern ver 3.1	Has colonoised secondary woodland and parklands *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Secondary forests, scrub, old plantations, mangroves, urban parks near woodlands
61	Picidae	*Picus vittatus*	Laced Woodpecker	*http://www.iucnredlist.org/details/22683450/0*		TM + China	LC	Least Concern ver 3.1	Has colonoised secondary woodland *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Secondary forests, scrub, old plantations,mangroves and urban forests
62	Picidae	*Celeus brachyurus*	Rufous Woodpecker	*http://www.iucnredlist.org/details/22683314/0*		IM + China	LC	Least Concern ver 3.1	-	-	-	-
63	Picidae	*Micropternus brachyurus*	Rufous Woodpecker	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22683314/0*		IM	LC	Least Concern ver 3.1	Has colonoised secondary scrub *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Old growth and secondary forests, scrub and old plantations
64	Psittacidae	*Psittacula longicauda*	Long-tailed Parakeet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/22685513/0*		IM	NT	Near Threatened ver 3.1	-	-	-	-

Item	Family	Genus Species	English Name	Source	Presence*	Current endemicity listing^	IUCN Category	IUCN Status	Protected by Local Law	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
65	Psittacidae	*Psittacula krameri*	Rose-ringed Parakeet	*Subaraj, R (2014) Vertebrate & Odonate Report (Manda) http://www.iucnredlist.org/details/22685441/0*		IM + EA + others	LC	Least Concern ver 3.1	-	-	-	-
66	Pycnonotidae	*Pycnonotus simplex*	Cream-vented Bulbul	*Subaraj, R (2014) Vertebrate & Odonate Report (Manda) http://www.iucnredlist.org/details/22732740/0*		TM + SD	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Primary and secondary forests, forest edge
67	Pycnonotidae	*Pycnonotus plumosus*	Olive-winged Bulbul	*WWF HCVF Assessment, 2011 http://www.iucnredlist.org/details/22732734/0*	O	TM + SD	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Commonly found in subtropical or tropical lowland rainforest
68	Pycnonotidae	*Pycnonotus jocosus*	Red-whiskered Bulbul	*http://www.iucnredlist.org/details/22732634/0*		AS + USA + Asia (Singapore, Saudi Arabia)	LC	Least Concern ver 3.1	Introduced, Naturalised Species in Singapore		-	Scrub, parklands, secondary forests
69	Pycnonotidae	*Pycnonotus zeylanicus*	Straw-headed Bulbul	*http://www.iucnredlist.org/details/22732603/0*		SD + Myanmar	VU	Vulnerable A2cd+3cd+4cd ver 3.1	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*	Endangered (EN) *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	CITES Appendix II	It occupies successional habitats bordering rivers, streams, marshes and other wet areas, where seasonal flooding prevents the establishment of climax communities
70	Pycnonotidae	*Pycnonotus goiavier*	Yellow-vented Bulbul	*WWF HCVF Assessment, 2011 http://www.iucnredlist.org/details/22732731/0*	O	TM + SD + PH	LC	Least Concern ver 3.1	-	-	-	Commonly found in a wide variety of open habitats, but not deep forest
71	Rallidae	*Rallina fasciata*	Red-legged Crake	*Subaraj, R (2014) Vertebrate & Odonate Report (Manda) http://www.iucnredlist.org/details/22692314/0*		IM	LC	Least Concern ver 3.1	-	Vulnerable (VU) *Davidson et.al (2008) The Singapore Red Data Book*	-	-
72	Rallidae	*Gallirallus striatus*	Slaty-breasted Rail	*Subaraj, R (2014) Vertebrate & Odonate Report (Manda) http://www.iucnredlist.org/details/22692463/0*		IM + EA	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Secondary scrub, marshes, wet grasslands, well wooded parkland
73	Rallidae	*Amaurornis phoenicurus*	White-breasted Waterhen	*Subaraj, R (2014) Vertebrate & Odonate Report (Manda) http://www.iucnredlist.org/details/22692644/0*		IM + EA	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Mangroves, secondary forests and scrub, marshes, ponds with well vegetated fringes, wet grassland and parkland
74	Rhipiduridae	*Rhipidura javanica*	Pied Fantail	*Subaraj, R (2014) Vertebrate & Odonate Report (Manda) http://www.iucnredlist.org/details/22708799/0*		IC + SD	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Mangroves, old plantations, forest edge, secondary scrub, parklands near waters
75	Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	*Subaraj, R (2014) Vertebrate & Odonate Report (Manda) http://www.iucnredlist.org/details/22693264/0*		IM + EA + others	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Sandy shores, coastal mudflats, freshwater marshes, wet grasslandsand concretised canals
76	Scolopacidae	*Gallinago gallinago*	Common Snipe	*Subaraj, R (2014) Vertebrate & Odonate Report (Manda) http://www.iucnredlist.org/details/22693097/0*		IM + EA + others	LC	Least Concern ver 3.1	Reduction in number of habitats *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Grassland dependent species
77	Strigidae	*Ninox scutulata*	Brown Hawk Owl	*Subaraj, R (2014) Vertebrate & Odonate Report (Manda) http://www.iucnredlist.org/details/22725643/0*		IM	LC	Least Concern ver 3.1	-	-	-	-
78	Strigidae	*Otus bakkamoena*	Collared Scops Owl	*Subaraj, R (2014) Vertebrate & Odonate Report (Manda) http://www.iucnredlist.org/details/61853263/0*		IM	LC	Least Concern ver 3.1	-	-	-	-
79	Sturnidae	*Aplonis panayensis*	Asian Glossy Starling	*http://www.iucnredlist.org/details/22730550/0*		PH + BO + TM + India	LC	Least Concern ver 3.1	Wild Animals and Birds Act *http://www.ava.gov.sg/docs/default-source/legislation/wild-animals-and-birds-act564aeb_wildanimalsandbirdsact.pdf?sfvrsn=2*	-	-	Secondary forests, forest edge, scrub, old plantations, parklands, urban areas
80	Sturnidae	*Gracula religiosa*	Hill Myna	*WWF HCVF Assessment, 2011 http://www.iucnredlist.org/details/22730993/0*	O	IM	LC	Least Concern ver 3.1	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*	-	CITES Appendix II	Commonly found in moist or semi-evergreen forest in lowlands, hills and mountains
81	Sturnidae	*Sturnus sturninus*	Purple-backed Starling	*http://www.iucnredlist.org/details/22731087/0*		IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act *http://www.ava.gov.sg/docs/default-source/legislation/wild-animals-and-birds-act564aeb_wildanimalsandbirdsact.pdf?sfvrsn=2*	-	-	-
82	Sylviidae	*Phylloscopus borealis*	Arctic Warbler	*http://www.iucnredlist.org/details/22715316/0*		IM + EA + Europe (Sweden, Finland) + USA	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Primary and secondary forests, forest edge, mangroves, old plantations, scrub, parkland and urban areas, small islands
83	Sylviidae	*Orthotomus sutorius*	Common Tailorbird	*http://www.iucnredlist.org/details/22734982/0*		IM + China	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Forest edge, old plantations, scrub, parkland, urban areas
84	Sylviidae	*Orthotomus atrogularis*	Dark-necked Tailorbird	*http://www.iucnredlist.org/details/22734985/0*		IM + China	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Primary and secondary forests, forest edge, old plantations, scrub, well-wooded areas.
85	Sylviidae	*Orthotomus sericeus*	Rufous-necked Tailorbird	*NSS Paper STB http://www.iucnredlist.org/details/22734987/0*		TM + PH + BO	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Primary and secondary forests, forest edge, scrub and old plantations, swampy forests
86	Timaliidae	*Malacocincla malaccensis*	Short-tailed Babbler	*Scoping Report http://www.iucnredlist.org/details/22715834/0*		SD + TM	NT	Near Threatened ver 3.1	-	Globally near threatened *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	This species occurs in lowland evergreen forest, including swamp forest, up to 1,000 m. Although it is most frequent in primary forest, it is also recorded from secondary growth, overgrown plantations, scrub and streamside thickets.
87	Timaliidae	*Malacocincla abbotti*	Abbott's Babbler	*Subaraj, R (2014) Vertebrate & Odonate Report (Manda) http://www.iucnredlist.org/details/22715814/0*		IM	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Secondary forests, forest edge, old plantations, scrub, mangroves
88	Timaliidae	*Macronous gularis*	Pin-striped Tit-Babbler	*Subaraj, R (2014) Vertebrate & Odonate Report (Manda) http://www.iucnredlist.org/details/22735162/0*		IM	LC	Least Concern ver 3.1	-	-	-	-
89	Timaliidae	*Malacocincla malaccensis*	Short-tailed Babbler	*Subaraj, R (2014) Vertebrate & Odonate Report (Manda) http://www.iucnredlist.org/details/22715834/0*		TM + SD	NT	Near Threatened ver 3.1	-	-	-	-
90	Timaliidae	*Garrulax leucolophus*	White-crested Laughingthrush	*Subaraj, R (2014) Vertebrate & Odonate Report (Manda) http://www.iucnredlist.org/details/22734757/0*		IM	LC	Least Concern ver 3.1	-	-	-	Secondary forests, forest edge, scrub, old plantations
91	Timaliidae	*Macronus gularis*	Striped Tit Babbler	*http://www.catalogueoflife.org/col/details/species/id/10189879*		-	-	-	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Primary and secondary forests, forest edge, scrub, old plantations, wooded gardens , mangroves
92	Zosteropidae	*Zosterops palpebrosus*	Oriental White-eye	*Subaraj, R (2014) Vertebrate & Odonate Report (Manda) http://www.iucnredlist.org/details/22734030/0*		IM	LC	Least Concern ver 3.1	No issues with conservation *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	Secondary forests, forest edge, old plantations, scrub, mangroves , parklands

^ Endemicity definitions:
PH = Philippines only
BO = Borneo Island, which includes only Brunei, Sabah, Sarawak and Kalimantan
TM = Thai-Malay Peninsula, which includes only Myanmar, Thailand, Singapore and Peninsular Malaysia
IC = Indochinese Region, which includes only Cambodia, Laos, Vietnam, Myanmar, Thailand and Southern China
SD = Sundaland, which includes only Borneo, Peninsular Malaysia, Singapore and Indonesia
IM = Indomalaya Ecozone, which includes South Asian countries, Southeast Asian countries, Southern China and parts of East Asia
EA = East Asia region, which includes from Sakhalin to the north, Japan, Korean Peninsula, mainland China, and Taiwan
AS = Australasia region, which includes Australia, New Zealand, New Guinea Island and neighbouring islands in Pacific Ocean

* Presence definitions:
O = Reportedly observed
O/A = Observed always
O/S = Observed sometimes
O/R = Rarely observed
O/N = Never observed
PP = Potentially present

Item	Family	Genus species	English Name	Source	Presence#	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
1	Ranidae	*Hylarana chalconota*	Schlegel's Frog (= To check	*WWF HCVF Assessment, 2011 http://www.iucnredlist.org/details/58568/0*	O	SD	LC	Least Concern ver 3.1	-	-	-	Generally seen on rocks and vegetation along small lowland forest streams
2	Rhacophoridae	*Polypedates leucomystax*	Four-lined Tree Frog (Comi	*WWF HCVF Assessment, 2011 http://www.iucnredlist.org/details/58953/0*	O	IM	LC	Least Concern ver 3.1	-	-	-	Can be found in subtropical or tropical lowland forest
3	Bufonidae	*Bufo melanostictus*	Asian Toad	*http://www.iucnredlist.org/details/54707/0*		IM + EA	LC	Least Concern ver 3.1		-	-	It is mainly a species of disturbed lowland habitats, from upper beaches and riverbanks to human-dominated agricultural and urban areas. It is uncommon in closed forests. It breeds in still and slow-flowing rivers and temporary and permanent ponds and pools. Adults are terrestrial and may be found under ground cover (eg. rocks, leaf-litter, logs), and are also associated with human habitations. The larvae are found in still and slow-moving waterbodies.
4	Dicroglossidae	*Fejervarya limnocharis*	Field Frog	*http://www.iucnredlist.org/details/58275/0*		IM + EA	LC	Least Concern ver 3.1		-	-	It inhabits most open wet habitat types, including river floodplains, wet agriculture areas such as rice fields, ditches, marshes, parks, gardens and other habitats and in closed-canopy forest (although this is rare in some regions).
5	-	*Kaloula pulchra*	Banded Bull Frog			-	-	-	Introduced, naturalised species in Singapore	-	-	-
6	Microhylidae	*Microhyla butleri*	Painted Chorus Frog	*http://www.iucnredlist.org/details/57878/0*		IM + EA	LC	Least Concern ver 3.1		-	-	A species of the forest edge, occasionally encountered on the forest floor of primary forest, but most often heard in massive choruses at forest edge puddles and pools. It is also known occasionally from plantations, tall shrublands and cultivated fields. It breeds in relatively permanent still waters, such as grassy pools, marshes, ponds and paddy fields in hilly areas.
7	Microhylidae	*Microhyla heymonsi*	Dark-sided Chorus Frog	*http://www.iucnredlist.org/details/57882/0*		IM + EA	LC	Least Concern ver 3.1		-	-	It inhabits disturbed areas such as riverbanks, gardens, fire-maintained grassy areas, paddy fields and savannah forest as well as secondary vegetation. It breeds in temporary rain puddles, paddy fields, ditches, marshes and slow-flowing streams.
8	-	-	*Copper Cheeked Frog Rana chalconota* is a forest-dependent species			-	-	-		-	-	
9	-	-	Black Eyed Litter Frog	*NSS Report on STB Project in Mandai*		-	-	-		-	-	
10	Bufonidae	*Duttaphrynus melanostict*	Asian Toad	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/54707/0*		IM	LC	Least Concern ver 3.1		-	-	Mainly a species of disturbed lowland habitats, from upper beaches and riverbanks to human-dominated agricultural and urban areas. It is uncommon in closed forests.
11	Megophyridae	*Leptobrachium nigrops*	Black-eyed Litter Frog	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/57557/0*		SD	LC	Least Concern ver 3.1		-	-	It inhabits lowland rainforest, including regenerating forest. Adults and juveniles range widely in swampy forest.
12	Dicroglossidae	*Limnonectes blythii*	Malayan Giant Frog	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/58329/0*		TM + IC	NT	Near Threatened ver 3.1		-	-	It inhabits streams with gravel and boulders in primary and secondary evergreen forest.
13	Ranidae	*Hylarana erythraea*	Common Greenback	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/58593/0*		IM	LC	Least Concern ver 3.1		-	-	It is characteristic of vegetated floodplain ponds and is also frequently associated with rice fields.
14	Ranidae	*Hylarana labialis*	Copper-cheeked Frog	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/7161177*		-	-	-		-	-	
15	Ranidae	*Hylarana baramica*	Golden-eared Rough-sided Frog	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/58558/0*		SD	LC	Least Concern ver 3.1		-	-	It is known from a variety of lowland floodplain situations, including peat swamp forest and swampy flatland primary forest at low elevations, usually in swampy areas
16	Ranidae	*Hylarana laterimaculata*	Masked Rough-sided Frog	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/58639/0*		IM	LC	Least Concern ver 3.1		-	-	The species is predominantly an inhabitant of lowland freshwater and peat swamp forests
17	Ranidae	*Lithobates catesbeianus*	American Bullfrog	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/58565/0*		IM + EA + others	LC	Least Concern ver 3.1		-	-	This species inhabits ponds, swamps, lakes, reservoirs, marshes, brackish ponds (in Hawaii), stream margins and irrigation ditches. It is sometimes found in temporary waters hundreds of metres from permanent water.
18	Microhylidae	*Kaloula pulchra*	Banded Bull Frog	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/57855/0*		IM + EA	LC	Least Concern ver 3.1		-	-	It is a species commensal with humans that rapidly colonizes urban habitats. It is quite adaptable and was presumably originally a wetland/riverbank/forest edge species that has adapted successfully to agricultural and residential landscapes, although it can still be found in dry forests

Item	Family	Genus species	English Name	Source	Presence#	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements

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Item	Family	Genus Species	English Name	Source	Presence#	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law (WCE, 1997)	Local Law Listing/ Status	CITES (I, II, III)	Habitat Requirements
1	Cercopithecidae	*Macaca fascicularis*	Long-tailed Macaque	*WWF HCVF Assessment, 2011 Mammals of Borneo http://www.iucnredlist.org/details/12551/0; Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O/A	TM + SD	LC	Least Concern ver 3.1	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*	-	CITES Appendix II	Extremely tolerant of a range of habitats, including mangrove and swamp forests, and can be found in agricultural areas near forest (secondary growth, secondary forest, and primary forest)
2	Cervidae	*Rusa unicolor*	Sambar Dear	*WWF HCVF Assessment, 2011 HCV 27/08/13, 04/02/14 L02, L10 Survey*	O/N	IM	VU	Vulnerable A2cd + 3cd + 4cd ver 3.1	III	-	-	Occurs in dense evergreen closed-canopy forest, highly tolerant of forest degradation; forest-dependent species (Subaraj, 2007)
3	Cynocephalidae	*Cynocephalus variegatus*	Sunda Flying Lemur/ Malayan	*SFI EIA, 2002 http://www.iucnredlist.org/details/41502/0*	O	TM + SD	LC	Least Concern ver 3.1	II	-	-	Forest-dependent species, but can be found in secondary habitats close to human populations
4	Cynocephalidae	*Galeopterus variegatus*	Malayan Colugo	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/41502/0*	O	IC + SD	LC	Least Concern ver 3.1	-	-	-	-
5	Manidae	*Manis javanica*	Malayan Pangolin/ Sunda Pang	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/12763/0*	O/N	IC + SD	EN	Endangered A2d + 3d + 4d ver 3.1	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*	-	CITES Appendix II	Found in primary and secondary forest, and is found in cultivated areas including gardens and plantations, including near human settlements.
6	Pteropodidae	*Cynopterus brachyotis*	Common Short-nosed Fruit Bat	*WWF HCVF Assessment, 2011 http://www.iucnredlist.org/details/61003/0*	O	IM	LC	Least Concern ver 3.1	-	-	-	Can be found from habitats ranging from orchards, gardens to forested tracts
7	Tupaiidae	*Tupaia glis*	Common Treeshrew	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai) http://www.iucnredlist.org/details/41494/0*		TM + SD	LC	Least Concern ver 3.1	-	-	-	-
8	Emballonuridae	*Taphozous saccolaimus*	Pouched Tomb Bat			-	-	-	-	-	-	-
9	Pteropodidae	*Myotis muricola*	Whiskered Myotis			-	-	-	-	-	-	-
10	Pteropodidae	*Pipistrellus sp.*	Pipistrelle			-	-	-	-	-	-	-
11	Pteropodidae	*Scotophilus kuhlii*	Asiatic Lesser Yellow House Bat			-	-	-	-	-	-	-
12	Pteropodidae	*Callosciurus notatus*	Plantain Squirrel			-	-	-	-	-	-	-
13	Pteropodidae	*Sundasciurus tenuis*	Slender Squirrel	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*		-	-	-	-	-	-	Forest-dependent species
14	Pteropodidae	*Eonycteris spelaea*	Cave Nectar Bat	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/7787/0*		IM	LC	Least Concern ver 3.1	-	-	-	-
15	Tragulidae	*Tragulus kanchil*	Lesser Mouse Deer	*http://www.iucnredlist.org/details/136297/0; NSS report on STB Project in Mandai*	O/N	TM + SD	LC	Least Concern ver 3.1	III	-	-	Generally found in lowland/foothill primary and secondary forests
16	Tragulidae	-	Blyth's Horsehoe Bat	*NSS report on STB Project in Mandai*		-	-	-	-	-	-	-
17	Felidae	*Prionailurus bengalensis*	Leopard Cat	*WWF HCVF Assessment, 2011 http://www.iucnredlist.org/details/18146/0; NSS report on STB Project in Mandai*	O/N	IM	LC	Least Concern ver 3.1	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*	-	CITES Appendix II	Occurs in a broad spectrum of habitats, from tropical rainforest to temperate broadleaf and, marginally, coniferous forest, as well as shrub forest and successional grasslands
18	Rhinolophidae	*Rhinolophus lepidus*	Blyth's Horseshoe Bat	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/19547/0*		IM	LC	Least Concern ver 3.1	-	-	-	This species can be found in both dry and moist forest and fringe areas
19	Emballonuridae	*Saccolaimus saccolaimus*	Pouched Tomb Bat	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/19802/0*		IM	LC	Least Concern ver 3.1	-	-	-	Dense forests, swampy areas and plantations.
20	Vespertilionidae	*Pipistrellus javanicus*	Javan Pipistrelle	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/17344/0*		IM	LC	Least Concern ver 3.1	-	-	-	This species is found in varied habitat types from primary and secondary forested regions, agricultural landscapes (including rubber plantations) to urban areas
21	Muridae	*Rattus annandalei*	Singapore Rat	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/19321/0*		SD	LC	Least Concern ver 3.1	-	-	-	It has been collected from lowland secondary forest, and in rubber estates whenever traps were set low in trees. Several specimens were also taken on the ground.
22	Viverridae	*Paradoxurus hermaphrodit*	Common Palm Civet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/41693/0*		IM + EA	LC	Least Concern ver 3.1	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*	-	CITES Appendix III	This species has been found in a wide range of habitats including evergreen and deciduous forest (primary and secondary), plantations and near humans, in habitats up to 2,400 m
23	Suidae	*Sus scrofa*	Wild Boar	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/41775/0*		IM + EA + others	LC	Least Concern ver 3.1	-	-	-	The Eurasian wild pig occupies a wide variety of temperate and tropical habitats, from semi-desert to tropical rain forests, temperate woodlands, grasslands and reed jungles; often venturing onto agricultural land to forage. It is found in a variety of habitats.
24	-	*Pyeropus vampyrus*	Malayan Flying Fox	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*		-	-	-	-	-	-	-
25	-	*Myotis hasselti*	Grey Large-footed Myotis	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*		-	-	-	-	-	-	-
26	-	*Tylonycteris sp.*	Bamboo Bat	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*		-	-	-	-	-	-	-
27	-	*Rasa unicolor*	Sambar Deer	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*		-	-	-	-	-	-	-

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1	Geomydidae	*Notochelys platynota*	Malayan Flat-shelled Turtle	*WWF HCVF Assessment, 2011 http://www.iucnredlist.org/details/14856/0*	O	TM + SD	VU	Vulnerable A1cd + 2cd ver 2.3	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*	Endangered *Davidson et.al (2008) The Singapore Red Data Book*	CITES Appendix II	Inhabits freshwater, especially mangroves and low lying peat swamp forests
2	Pythonidae	*Python reticulatus*	Reticulated Python	*WWF HCVF Assessment, 2011*	O	IM	NE	Not Evaluated	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*	-	CITES Appendix II	Generally found rainforests, woodlands, and nearby grasslands associated with rivers
3	Scincidae	*Eutropis multifisciata*	Common Sun Skink	*WWF HCVF Assessment, 2011*	O	IM	NE	Not Evaluated	-	-	-	Generally found in forest and forested areas
4	Varanidae	*Varanus salvator*	Common Water Monitor Lizar	*WWF HCVF Assessment, 2011 http://www.iucnredlist.org/details/178214/0*	O	IM	LC	Least Concern ver 3.1	-	-	-	Semi-aquatic and opportunistic, inhabits a variety of natural habitats, such as primary forests and mangrove swamps
5	Colubridae	*Ahaetulla prasina*	Oriental Whip Snake	*http://www.iucnredlist.org/details/176329/0*		IM + China	LC	Least Concern ver 3.1	-	-	-	This species inhabits both primary lowland and montane moist forests, secondary forests, dry and open forests, scrublands, plantations, gardens, monsoon forest, cultivated land, roadsides, and city gardens
6	Colubridae	*Dendrelaphis pictus*	Painted Bronzeback	*http://www.catalogueoflife.org/col/details/species/id/13207132*		-	-	-	-	-	-	-
7	Agamidae	*Draco sumatranus*	Common Malayan Flying Dra	*http://www.catalogueoflife.org/col/details/species/id/13200188*		-	-	-	-	-	-	-
8	-	*Calotes versicolor*	Changeable Lizard			-	-	-	Introduced, naturalised in Singapore		-	-
9	Emydidae	*Trachemys scripta*	Red-eared Slider	http://www.iucnredlist.org/details/22028/0		America	LC	Least Concern ver 3.1	Introduced, naturalised in Singapore		-	In its native range, *Trachemys scripta* is an inhabitant of a wide variety of waterbodies, and is most abundant in soft-bottomed shallow habitats with minimal flow, abundant access to sunlight and extensive vegetation. In Mexico, it is primarily a riverine species. In Europe, the species is an opportunistic inhabitant of freshwater habitats, generally in close proximity to human habitation and/or recreation centres.
10	Geoemydida	*Cuora amboinensis*	Malayan Box Terrapin	http://www.iucnredlist.org/details/5958/0		IM	VU	ulnerable A1d+2d ver 2	-	-	-	Juveniles fully aquatic (marshes, swamps, ponds, pools, rice paddies); adults semi-aquatic.
11	-	-	Marbled Forest Gecko	*NSS Report on STB Project*	O	-	-	-	-		-	-
12	Colubridae	*Boiga dendrophila*	Gold-ringed Cat Snake	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/172682/0*	O	IM	DD	Data Deficient ver 3.1	-	-	-	This nocturnal species is found in undisturbed tropical moist forests, and snakes have been seen on the forest floor near freshwater bodies
13	Colubridae	*Dendrelaphis kopsteini*	Red-necked Bronzeback	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/192015/0*	O	SD + TM	LC	Least Concern ver 3.1	-	-	-	In common with some other species in the genus, this snake is commonly found in primary and secondary lowland forest but can also be encountered in gardens in villages
14	Natricidae	*Macropisthodon rhodomela*	Blue-necked Keelback	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/192056/0*	O	SD + TM	LC	Least Concern ver 3.1	-	-	-	This species is only known from lowland forest near riparian areas. In Peninsular Malaysia it is found in low-lying wet areas up to 200 m asl.
15	Gekkonidae	*Cyrtodactylus majulah*	Singapore Bent-toed Gecko	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/13199917*	O	-	-	-	-	-	-	-
16	Gekkonidae	*Gekko monarchus*	Spotted House Gecko	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/13207568*	O	-	-	-	-	-	-	-
17	Gekkonidae	*Hemidactylus frenatus*	Spiny-tailed House Gecko	Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/176130/0	O	IM + EA	LC	Least Concern ver 3.1	-	-	-	This nocturnal species is found on boulders, beneath rocks or rotting logs, and on trees, however, it most commonly found on buildings. This species is found in both villages and large urban areas, it is usually found close to electric lights at dusk. In addition, this species also occurs in a diverse range of habitats, including rain forests, savannas, and deserts.
18	Geoemydida	*Siebenrockiella crassicollis*	Black Marsh Terrapin	Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.iucnredlist.org/details/39616/0	O	IM	VU	Vulnerable A1cd+2cd ver 2.3	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*	-	CITES Appendix II	-
19	Pythonidae	*Broghammerus reticulatus*	Reticulated Python	Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) http://www.catalogueoflife.org/col/details/species/id/13206537	O	-	-	-	-	-	-	-
20	-	*Eutropis multifisciatus*	Common Sun Skink	Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)	O	-	-	-	-	-	-	-

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IM = Indomalaya Ecozone, which includes South Asian countries, Southeast Asian countries, Southern
AS = Australasia region, which includes Australia, New Zealand, New Guinea Island and neighbouring

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Annex B

Scoping Matrix

Title Mandai Project Scoping Matrix
Version 003
Reference 0272180
Date Monday, February 16, 2015

Key

- No interaction
- An interaction with the environment or receptor that is not expected to be significant
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- Denotes a positive interaction

Note: Definition of Existing WRS Operations includes visitor experience and Zoo animals

	ACTIVITIES	ENVIRONMENT & RECEPTORS																	COMMENTS	IN-PLACE CONTROLS
		Physical							Biological					Human						
	Project Activities	**Ambient Air Quality/ Dust**	**Global Climate**	**Noise and Vibration**	**Groundwater quality & Hydrogeology**	**Surface water**	**Soil Quaity and structure**	**Topography, Landscape & Visual Character**	**Terrestrial Habitats**	**Terrestrial Flora & Fauna**	**Aquatic Habitats (Freshwater)**	**Aquatic Flora & Fauna (Freshwater)**	**Protected Areas**	**Public Health & Safety**	**Military**	**Road Traffic & Transportation**	**Public Utilities**	**Existing WRS Operations**		
A	**Pre-Construction**																			
	Geotechnical investigation																		-Significance of impacts depends on location and extent of investigations (ie number of drilling rigs)	
	Establishment of workers quarter/site office (include temporary facilities such as toilets)																		-Study of cultural heritage planned for 2015 - Reported that the site is the former location of a church, historical road etc	
	Transportation and storage of materials, manpower and equipment to and from the site																		- Applies for both preconstruction and construction	
	Street closures and traffic diversions																		-Impacts are related to potential bottlenecks in traffic as a result of diversion works - Transportation study will be undertaken in 2015 in parallel with the EIA	
	Road demolition																		- Need for road demolition activities to be reviewed during IA based on outcome of transport study	
	Temporary power generation (preconstruction and construction)																		-Diesel running generators	
	Land clearance, excavation and grading (for project footprint equipment laydown area, construction of temporary drains etc)																		-Loss of buffer of protected area - Unintended access to nature reserve by third parties may occur	

Title	Mandai Project Scoping Matrix
Version	003
Reference	0272180
Date	Monday, February 16, 2015

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	ACTIVITIES	ENVIRONMENT & RECEPTORS																	COMMENTS	IN-PLACE CONTROLS
		Physical							Biological					Human						
	Project Activities	**Ambient Air Quality/ Dust**	**Global Climate**	**Noise and Vibration**	**Groundwater quality & Hydrogeology**	**Surface water**	**Soil Quaity and structure**	**Topography, Landscape & Visual Character**	**Terrestrial Habitats**	**Terrestrial Flora & Fauna**	**Aquatic Habitats (Freshwater)**	**Aquatic Flora & Fauna (Freshwater)**	**Protected Areas**	**Public Health & Safety**	**Military**	**Road Traffic & Transportation**	**Public Utilities**	**Existing WRS Operations**		
B	**Construction**																			
	Slope protection																		- Likely to be required along Mandai Lake Road and periphery of Upper Seletar Reservoir adjacent to the proposed Arrival Plaza, and potentially along the unnamed road parallel to the Project western boundary.	-Proper embankment
	Demolition of existing facilities																		- Carparks will be submerged - Machinery will need to be mobilized off track in some areas	
	Construction of aboveground and underground structures (eg eco-link,arrival plaza, new quarantine area and nursery, surface and underground car parks)																			
	Modifications to Mandai Lake Road																		- Nature of modifications to be determined through separate transport study in 2015. Potential impacts to be evaluated in the IA.	
	Modifications to existing surface water drain at the Zoo																		- Details of modifications not known at this stage. Recommendations around options, timing considerations etc for this activity to be provided in the IA.	
	Construction of boardwalk																			
	Planting of vegetation in Rainforest Safari site, bird park and other areas																		-Impacts to terrestrial habitats and species need to be studied in the IA to determine significance of impact, whether positive or negative. However, given the Projects commitments to sustainability etc. revegetation must be done in a way to ensure a positive outcome for biodiversity.	
	Establishing water features (fountains, lakes) within the Rainforest Safari and Arrival Plaza																		- Activities assumed to include concreting, bringing in water from external source, landscaping -Features will be likely to provide some positive new biodiversity resource for aquatic species.	
	Installation of features to enhance thermal comfort																		-Assumed to consist mainly of air conditioning and construction of some above ground features (fans, shelters, rest areas etc)	
	Construction of new sewer line along Mandai Lake Road to connect to public sewer line (partially to be built by PUB and MPH, to be determined when design of road is firmed)																		- PUB will provide connection to main sewer. Considered an associated facility as this is taking place as a result of the Project.	

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		Physical							Biological					Human						
	Project Activities	**Ambient Air Quality/ Dust**	**Global Climate**	**Noise and Vibration**	**Groundwater quality & Hydrogeology**	**Surface water**	**Soil Quaity and structure**	**Topography, Landscape & Visual Character**	**Terrestrial Habitats**	**Terrestrial Flora & Fauna**	**Aquatic Habitats (Freshwater)**	**Aquatic Flora & Fauna (Freshwater)**	**Protected Areas**	**Public Health & Safety**	**Military**	**Road Traffic & Transportation**	**Public Utilities**	**Existing WRS Operations**		
C	**Operations**																			
	Employment of additional personnel/ increase in visitorship																		- People walking off path -Secondary impact due to fumigation - Opportunity for enhancement in the form of GHG management plan	
	Transportation of visitors to and from the zoo																		- We recognize that the increased visitorship may necessitate additional transport capacity. We are currently studying the transport requirements. Any development on this front would be subject to further feasibility studies and environment impact analysis	
	Maintenance activities																			
	Waste collection and disposal																		- Enhancement opportunities such as biogas generation, composting can be considered in Project design - Will require management of fauna species such as long-tailed macaque to ensure waste is not littered everywhere.	
	Handling and storage of fertilizer, pesticides, other chemicals																		-For biodiversity most issues likely to arise from unplanned events. However, spraying for mosquitos will have an impact on species directly or indirectly	
	Supply of power and water to facilities																			
	Lighting of facilities																			
	Fencing between Project sites and CCNR																		-No hard fencing to be constructed. Exact design not confirmed, will be evaluated in the IA. -Need to consider how measures to prevent potentially aggressive wildlife (e.g. macaques) from disturbing visitors may be put in place without restricting the movement of other wildlife.	
D	**Unplanned Events**																			
	Outbreak of communicable diseases (eg bird flu)																			
	Animal escapees and invasive species (flora and fauna)																		Also during transportation/relocation of bird park	
	Leakage and failure of machinery																			- Ensure legal compliance by installing measures such as bunding, drip trays etc

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Annex 2.3

Scoping Matrix

	ACTIVITIES	ENVIRONMENT & RECEPTORS																				COMMENTS
		Physical							Biological					Human								
	Project Activities	**Ambient Air Quality/ Dust**	**Global Climate**	**Noise and Vibration**	**Groundwater quality & Hydrogeology**	**Surface water**	**Soil Quaity and Structure**	**Topography, Landscape & Visual Char**	**Terrestrial Habitats**	**Terrestrial Flora & Fauna**	**Aquatic Habitats (Freshwater)**	**Aquatic Flora & Fauna (Freshwater)**	**Protected Areas**	**Public Health & Safety**	**Military**	**Road Traffic & Transportation**	**Cultural Resources, History and Archa**	**Public Utilities**	**Existing WRS Operations**		
A	**Pre-Construction**																				
	Geotechnical investigation (predominantly impacts associated with geotechnical borehole)																				-Significance of impacts depends on location and extent of investigations (ie number of drilling rigs). - May be associated with major structures such as eco-lodge, eco-link, carparks. Typically short duration, small number required, and small borehole size (eg less than 100 mm diameter).
	Land clearance and grading for preparation of construction work areas																				- Loss of existing habitats within Project areas north and south of Mandai Lake Road, and near the multi storey carpark. - Encroachment of CCNR for grading of eco-link. - Understand from MPH that vegetation clearance will be carried out in phases.
	Slope protection																				- Likely to be required along Mandai Lake Road and periphery of Upper Seletar Reservoir adjacent to the proposed Arrival Plaza, and potentially along the Project western boundary
	Wildlife relocation																				- Erection of temporary hoardings around construction work areas. - Relocation of wildlife within Project areas north and south of Mandai Lake Road will be undertaken in phases.
	Establishment of site office (include temporary facilities such as toilets), laydown and storage area																				- Key activities include moving in and setting up prefabricated container site office as well as placing other temporary facilities (eg laydown areas, warehouse, fabrication shops). - There will be no workers' quarters or concrete batching plants on site.
	Transportation and storage of materials, manpower and equipment to and from the site																				- Applies for both preconstruction and construction. - Increase in volume of heavy vehicles, which will in turn increase the possibility of roadkill. - Estimated peak manpower is 6,000, requiring up to 240 trucks for daily transport of workers to and from the site.
	Street closures and traffic diversions																				- Impacts are related to potential bottlenecks in traffic as a result of diversion works. - May be required along Mandai Lake Road but unlikely to inhibit traffic flow. May just result in minor delay. - Transportation study is being undertaken in parallel with the EIA.

	ACTIVITIES	ENVIRONMENT & RECEPTORS																				COMMENTS
		Physical							Biological					Human								
	Project Activities	**Ambient Air Quality/ Dust**	**Global Climate**	**Noise and Vibration**	**Groundwater quality & Hydrogeology**	**Surface water**	**Soil Quaity and Structure**	**Topography, Landscape & Visual Char**	**Terrestrial Habitats**	**Terrestrial Flora & Fauna**	**Aquatic Habitats (Freshwater)**	**Aquatic Flora & Fauna (Freshwater)**	**Protected Areas**	**Public Health & Safety**	**Military**	**Road Traffic & Transportation**	**Cultural Resources, History and Archa**	**Public Utilities**	**Existing WRS Operations**		
	Diversion of underground telecommunications, gas, electricity lines (exclude existing drainage and sewer line)	■		▒		▒												▒	▒		- Modification to existing drainage and sewer line covered under Construction phase. - Excavation may be required. - Possible disruption to utility supply and result in impacts to their users such as WRS.
	Temporary power generation	▒		▒																	- Applies for both preconstruction and construction. - Air and noise emissions due to diesel generators. Assume only generators that meet the emission standards outlined within the *Environmental Protection and Management (off-Road Diesel Engine Emission) Regulations* will be used.
B	**Construction**																				
	Demolition of existing facilities	■		■	■	■			■	■	■	■	■	▒						■	- Structures that will be demolished include: existing multi storey carpark, staff quarters, wastewater treatment plant etc. - Wastetwater treatement plant will b demolished and relocated to the parcel of land south of Mandai Lake Road - Impacts on ecological receptors due to noise generation and emissions to air and nearby surface water bodies such as the Upper Seletar Reservoir. - The Upper Seletar Reservoir is considered as part of the CCNR and is therefore a protected area.
	Generation of sanitary and domestic waste	▒							■												- Odour generated from waste storage areas and portable toilets at construction worksites. - Alteration of wildlife behavior due to attraction to food waste.
	Storage of fuel, chemicals, construction waste and stockpiling of spoil	▒				■	■		▒	▒	■	■									- Dust emissions from stockpiles of soil & demolition waste. - Odour emissions from waste storage areas. - Unplanned event such as leakage could lead to secondary impact to aquatic flora and fauna if leakage/spillage is washed off to nearby surface water bodies during rain. - Wildlife attracted to waste storage areas.
	Installation of groundwater recharge wells	▒		▒	▒	▒	▒		▒	▒											- Wells assumed to be installed around underground excavations for carparks at West and East Arrival Nodes, to monitor groundwater levels during construction. - Well installation involve operation of rotary boring rigs, similar to those used for geotechnical investigations.

	ACTIVITIES	ENVIRONMENT & RECEPTORS																			COMMENTS
		Physical							Biological					Human							
	Project Activities	Ambient Air Quality/ Dust	Global Climate	Noise and Vibration	Groundwater quality & Hydrogeology	Surface water	Soil Quaity and Structure	Topography, Landscape & Visual Char	Terrestrial Habitats	Terrestrial Flora & Fauna	Aquatic Habitats (Freshwater)	Aquatic Flora & Fauna (Freshwater)	Protected Areas	Public Health & Safety	Military	Road Traffic & Transportation	Cultural Resources, History and Archa	Public Utilities	Existing WRS Operations	
	Excavation of underground structures	■		■	■	■		■			■	■	■								- Dust emissions due to excavation and transportation of spoil within the site. - Noise emissions from machinery such as excavators, dump trucks etc. - Groundwater drawdown due to deep excavation. - Exacavtion of basement carparks at West Arrival Node in close proximity to the unnamed stream parallel to the Project western boundary. - Proximity of underground excavation to Upper Seletar Reservoir may impact hydrogeology due to potential hydraulic continuity between groundwater resources in the Project Area and the reservoir.
	Construction of aboveground and underground structures (eg eco-link,arrival plaza, new quarantine area and nursery, new wastewater treatment plant, surface and underground car parks)	■		■		■			■	■	■	■	■		▒					■	-The construction of eco-link will involve piling etc within the CCNR fragments. - Increased sediment loading of nearby surface water bodies due to runoff from Project worksites (exposed ground). - Impacts on ecological receptors due to noise generated from piling activities and operation of machinery, air emissions from machinery and emissions to nearby surface water bodies. - Impacts on human receptors within the existing WRS site due to air and noise emissions, in particular at nearby construction worksites for the East Arrival Node and eco-lodge. - A configuration of eco-link will require removal of the existing PUB discharge point.
	Modifications to Mandai Lake Road	▒		▒					■	■						■				■	- Existing Mandai Lake Road to be retained as mush as possible but there will be some road widening works. - Minor excavation / demolition - Road modification works might have temporary impacts to animals crossing between the two CCNR fragments via Mandai Lake Road.
	Modifications to existing surface water drain at the Project area	▒		▒		■			■	■	■	■	■							■	- Existing drainages along Mandai Lake Road and Mandai Road to be retained as much as possible. - Addition of vegetated swales will increase ecological value to terrestrial and aquatic habitats.

	ACTIVITIES	ENVIRONMENT & RECEPTORS																			COMMENTS
		Physical							Biological					Human							
	Project Activities	**Ambient Air Quality/ Dust**	**Global Climate**	**Noise and Vibration**	**Groundwater quality & Hydrogeology**	**Surface water**	**Soil Quaity and Structure**	**Topography, Landscape & Visual Char**	**Terrestrial Habitats**	**Terrestrial Flora & Fauna**	**Aquatic Habitats (Freshwater)**	**Aquatic Flora & Fauna (Freshwater)**	**Protected Areas**	**Public Health & Safety**	**Military**	**Road Traffic & Transportation**	**Cultural Resources, History and Archa**	**Public Utilities**	**Existing WRS Operations**	
	Construction of new boardwalk and upgrade of existing boardwalk			■		■					■	■	■						■	- Include forested boardwalk, boardwalk along swale, boardwalk on reservoir and floating boardwalk. - Noise emissions from piling of steel support structures. - Clearance of existing vegetation along shore.
	Planting of vegetation in Rainforest Park, Bird Park and other areas		■				■		■	■										-Forest restoration framework currently being developed. Landscaping and planting will prioritise native species as far as possible.
	Establishing water features (fountains, lakes) within the Rainforest Park and Arrival Plaza			■							■	■								- Activities assumed to include concreting, bringing in water from external source, landscaping -Features will be likely to provide some positive new biodiversity resource for aquatic species.
	Construction of new sewer line along Mandai Lake Road to connect to public sewer line (partially to be built by PUB and MPH, to be determined when design of road is firmed)			■														■	■	- PUB will provide connection to main sewer. Considered an associated facility as this is taking place as a result of the Project.
	Construction of a perimeter security fence and netting over the Bird Park aviaries.			■					■	■			■							- Fencing along the edge of CCNR is required, thus personnel access into CCNR might be required. - It is assumed that no further vegetation clearance or establishment of equipment laydown areas within the CCNR. - Noise emissions during installation of fence posts (assumed to be via piling).
	Lighting of construction site							■	■	■			■		■				■	- Edge effect associated with differences in light intensity between CCNR and the construction site. - Lights at the worksites to the north and south of Mandai Lake Road might increase luminance levels at the nearby Night Safari and at Mandai Camp.

	ACTIVITIES	ENVIRONMENT & RECEPTORS																			COMMENTS
		Physical							Biological					Human							
	Project Activities	**Ambient Air Quality/ Dust**	**Global Climate**	**Noise and Vibration**	**Groundwater quality & Hydrogeology**	**Surface water**	**Soil Quaity and Structure**	**Topography, Landscape & Visual Char**	**Terrestrial Habitats**	**Terrestrial Flora & Fauna**	**Aquatic Habitats (Freshwater)**	**Aquatic Flora & Fauna (Freshwater)**	**Protected Areas**	**Public Health & Safety**	**Military**	**Road Traffic & Transportation**	**Cultural Resources, History and Archa**	**Public Utilities**	**Existing WRS Operations**	
C	**Operations**																				
	Employment of additional personnel/ increase in visitorship to Project gated and non-gated areas																				- Impacts on ecological receptors within the CCNR due to increased human presence (noise emissions) in particular within the Rainforest Park and Bird Park. - Littering to the Upper Seletar Reservoir from visitors using boardwalk.
	Transportation of visitors to and from the zoo																				- Significance of vehicular emission depending on the volume of traffic. - Depending on the traffic plan, there could be an opportunity for enhancement in the form of GHG management plan if public transportation is encouraged
	Operation of Project gated attractions (eg shows, guided tours, F&B outlets and shops)																				- Impacts to ecological receptors within the CCNR due to noise generated from attractions in the Rainforest Park, Bird Park and East Arrival Node.
	Operation of eco-link																				- Completion of eco-link will enable safe passage of terrestrial fauna between the CCNR fragments north and south of Mandai Lake Road.
	Waste generation, collection and disposal																				- Enhancement opportunities such as biogas generation, composting can be considered in Project design. - Will require management to ensure wildlife such as long-tailed macaque are not attracted to waste disposal areas.
	Usage, handling and storage of fertilizer, pesticides, other chemicals																				- Periodic fumigation for mosquitos will have an impact on species within the CCNR directly or indirectly.
	Supply of power and water to facilities																				
	Lighting of facilities in the night																				- Rainforest Park and Bird Park will be operational during the day. Assume minimal lighting within these areas during the night. - Increased luminance levels at areas near the Eco-lodge.
	Fencing between Project sites and CCNR																				- Fencing will be erected between Project sites and the CCNR boundary to prevent human access to the CCNR. - Fencing will be designed to allow access of small animals. - Presence of fencing will prohibit movement of larger terrestrial fauna.

	ACTIVITIES	ENVIRONMENT & RECEPTORS																				COMMENTS
		Physical							Biological					Human								
	Project Activities	**Ambient Air Quality/ Dust**	**Global Climate**	**Noise and Vibration**	**Groundwater quality & Hydrogeology**	**Surface water**	**Soil Quaity and Structure**	**Topography, Landscape & Visual Char**	**Terrestrial Habitats**	**Terrestrial Flora & Fauna**	**Aquatic Habitats (Freshwater)**	**Aquatic Flora & Fauna (Freshwater)**	**Protected Areas**	**Public Health & Safety**	**Military**	**Road Traffic & Transportation**	**Cultural Resources, History and Archa**	**Public Utilities**	**Existing WRS Operations**		
D	**Unplanned Events**																					
	Outbreak of communicable diseases (eg bird flu)/ Animal dealth									■				■						■		
	Animal escapees and invasive species (flora and fauna)								■	■	■	■	■								■	- Accounts for unplanned escapes during transportation/relocation of bird park, as well as operation of the Project
	Leakage/spillage of chemicals/fertilizers/waste materials etc stored during construction and operation				■	■	■		■	■	■	■	■									- Potential impacts to terrestrial / aquatic habitats during unplanned events such as leakage/spillage of chemicals/fertilizers/waste stored on site during construction and operation.
	Overflow of surface runoff from surface water drainage within the Project area due to a major rainfall event (ie 1 in 100 year)/ failure of Sewerage Treatment Plant (STP)					■			■	■	■	■										- Potential contamination of Upper Seletar Reservoir due to surface runoff from the Project containing pathogens, animal waste etc.
	Fire outbreak					■			■	■	■	■		■						■		- Impact to air quality screened out due to many variables such as location of fire, amount of emissions etc.

Annex 3.0

Baseline Method Statement











Environmental Impact Assessment for Mandai Development

Baseline Method Statement

May 2015

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Environmental Impact Assessment for Mandai Development

Baseline Method Statement

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Client	Project No
Mandai Park Holdings	0292668
Project Summary Environmental Resources Management (S) Pte Ltd (ERM) was commissioned by Mandai Park Holdings to prepare an Environmental Impact Assessment (EIA) for the proposed development at Mandai ('the Project'). This document presents the methodology, legislative framework, locations and schedule for the biodiversity and physical baseline surveys to be carried out in support of the EIA.	Date 04 May 2015 Approved by  **Piers Touzel** *Partner, Asia Pacific*

Revision	Description	By	Checked	Approved	Date
0	Baseline Method Statement	EY/ SM	AJ/ DN	PT	01.05.15

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CONTENTS

1 INTRODUCTION

1.1 OVERVIEW

The Singapore Tourism Board (STB) intends to develop two plots of land along Mandai Lake Road into a nature-themed attraction (hereafter referred to as 'the Project'). Temasek Holdings was invited in 2010 to submit a concept proposal for the Project and subsequently Mandai Park Holdings (MPH) was established.

Environmental Resources Management (S) Pte Ltd (ERM) was commissioned by MPH to carry out an Impact Assessment (IA) Scoping Study *(ERM, February 2015)* for the Project. The outcome of this study was an IA Scoping Report, which was reviewed and approved by the Technical Agencies (TAs). The TAs are comprised of the National Parks Board (NParks), Urban Redevelopment Authority (URA), PUB, National Environment Agency (NEA), Agri-Food & Veterinary Authority (AVA) as well as the Ministry of National Development (MND).

Subsequently, ERM was commissioned by MPH to prepare an EIA for the Project. The scope of the EIA includes studying the existing environment through a series of primary baseline surveys supplemented by secondary data collection. This document is the Baseline Method Statement for the Project. It presents the objectives, legislative framework and methods for the baseline surveys. The following environmental aspects will be studied through the baseline surveys:

- Terrestrial and aquatic flora, fauna and habitats;
- Soil and groundwater;
- Surface water quality;
- Ambient air quality; and
- Noise.

1.2 OBJECTIVES

The overall objective of this Method Statement is to develop surveys that are effective and fit the purpose of the EIA. The findings of the surveys will be used to establish the physical and biological conditions that prevail in the absence of the Project, ie establishing the Baseline.

1.3 HEALTH AND SAFETY

ERM is dedicated to the care and protection of its personnel, including subcontractors. In accordance with our Global Health & Safety Policy (*Annex A*), at the outset of any field surveys or visit, a Health and Safety Plan (HASP) will be prepared incorporating detailed action plans for specific activities. The HASP is a 'live' document and will be updated

throughout the field activities, reflecting the range of tasks and their associated risks. It is based on detailed risk assessment and risk mitigation and management for each survey.

1.4 STRUCTURE OF THIS DOCUMENT

The background, legislative outlines and methodology of the field survey for each key environmental aspect are split into the following *Sections*:

- *Section 2*: Biodiversity Baseline Surveys;
- *Section 3*: Shallow Soil Sampling Survey;
- *Section 4*: Surface Water Sampling;
- *Section 5*: Ambient Air Quality Survey; and
- *Section 6*: Acoustics Survey.

Each section also presents a summary of the differences between the Scoping Report and the proposed methods.

The main report is supported by the following Annex:

- *Annex A:* ERM Global Health & Safety Policy

2 BIODIVERSITY BASELINE SURVEYS

2.1 OBJECTIVES

The Project site comprises mainly forested areas which are contiguous with the Central Catchment Nature Reserve, a gazetted nature reserve in Singapore. Rapid biodiversity surveys were conducted in 2007 and 2014 to provide a preliminary understanding of the biodiversity baseline at the Project site. These surveys found a variety of habitat types within the Project site and recorded a number of species that have been categorized as threatened (Critically Endangered, Endangered, and Vulnerable) in the Singapore Red Data Book and by the International Union for Conservation of Nature.

In 2015, the Project called for additional biodiversity surveys to be carried out to validate and supplement surveys from previous years, as well as to fill gaps identified from a desktop review of secondary literature. In summary, this round of biodiversity surveys aims to:

- Characterize the major species groups that utilize the area of influence and/or the study area;
- Determine the presence and/or absence of species of conservation significance;
- Determine the quality and spatial distribution of important habitats; and
- Determine the presence of invasive species.

2.1.1 *Analysis of Results*

The survey findings will contribute towards the design of the Project and development of management plans to minimize potential impacts to ecology and biodiversity. Examples of data types that will be collected from the surveys include, but are not limited to:

- Spatial data (eg coordinates of locations of breeding grounds, sensitive habitats);
- Species lists, that will be correlated with spatial data; and
- If presence of species of conservation significance is established, population and distribution data.

The importance of species and their habitats will be determined by undertaking a screening exercise that will:

- Analyze the species and habitats present;
- Rank species and habitats based on their conservation significance using their "extinction risk" status (IUCN Redlist and Singapore Red Book);
- Determine the distribution and significance of the species globally, regionally and locally;
- Determine the importance of the site to the species' lifecycle; and

- Determine the relative importance of surrounding areas of habitats to the site.

This exercise will be undertaken using spreadsheets and GIS to spatially represent the distribution and abundance of the species and habitats to enable comparison and analysis of the proportion of impacts.

Regarding the analysis of results, the following will be produced:

- Maps showing the distribution, utilisation and importance of the site for species of conservation significance;
- Maps of the distribution of important habitat values;
- Table analyzing the results of the screening assessment;
- Species profiles for species of conservation significance.

Note that this exercise is separate to the impact assessment where ERM will apply the approach as outlined in the ERM Biodiversity Standard. This Standard is based on the assessment criteria as outlined under the International Finance Corporation's (IFC) Performance Standard (PS) 6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources.

2.2 *LEGISLATIVE FRAMEWORK*

The Project is required to operate within the context of national legislation, guidelines and administrative requirements pertaining to the protection of the biotic environment. The legislative and administrative framework is presented in *Table 2.1.*

Table 2.1 Regulations and Administrative Requirements

Legislation/ Regulations/ Guidelines	Relevance	Responsible Agency
• Parks and Trees Act 2006 • Parks and Trees Regulations 2006 • Parks and Trees (Preservation of Trees) Order 1998	Restricts activities surrounding a Tree Conservation Area, Nature Reserve/Park, and Public Park; and requires approval to be sought prior to conducting restricted activities in nature reserves and national parks. Surveys will need to obtain the necessary permits prior to commencement.	NParks
• Public Utilities Act 2002 • Public Utilities (Reservoirs, Catchment Areas and Waterways) Regulations 2006	Requires approval to be sought prior to conducting activities that involve the collection of flora or fauna specimens from Central Water Catchment Area and Catchment Area Parks, or release of animals into waterways. Similarly, surveys will need to obtain the necessary permits prior to commencement.	PUB

Legislation/ Regulations/ Guidelines	Relevance	Responsible Agency
	It is noted that this does not apply to any part of the Central Water Catchment Area or a Catchment Area Park that is occupied by the Singapore Zoological Gardens or the Night Safari.	
Wild Animals and Birds Act, 2000	A license is required for the killing or keeping of wild animals or birds; there are penalties for the capture, taking and killing of any wild animal or bird.	AVA
URA Development Control Handbook: Design Guidelines for Developments Adjacent to Reservoirs and Stormwater Collection Ponds	States that vegetation at reservoirs should be saved and conserved if possible The biodiversity survey findings will inform the Project design and management plans that will support adherence to this series of legislation.	URA
• Animals and Birds Act, 2002 • Animals and Birds (Pet Shop and Exhibition) Rules, 2004 • Animals and Birds (Licensing of Farms) Rules, 2004 • Animals and Birds (Care and Use of Animals for Scientific Purposes) Rules, 2007 • Animals and Birds (Disease) Notification, 2004 • Animals and Birds (Importation) Order, 2009 • Animals and Birds (Live Fish) Rules, 2011 • Endangered Species (Import and Export) Act, 2008	Prevention of introduction and spread of diseases associated with animals, birds or fish; control of import and export of animals, birds or fish; and prevention of cruelty to animals, birds or fish. The biodiversity survey findings will inform the management plans that will support adherence to this series of legislation.	AVA
• Control of Plants Act, 2000 • Control of Plants (Import and Transhipment of Fresh Fruits and Vegetables) Rules, 2006 • Control of Plants (Cultivation of Plants) (Licensing and Certification) Rules, 2000 • Control of Plants (Plant Importation) Rules, 2000	Protection of plants and plant products against pests and diseases; and control of activities related to the import and export of plants and plant products. The biodiversity survey findings will inform the management plans that will support adherence to this series of legislation.	AVA

2.3 *SURVEY METHODOLOGY*

Surveys of the following groups of organisms will be undertaken:

- Flora
- Aquatic fauna (ie fish and decapod crustaceans);
- Terrestrial vertebrates including:

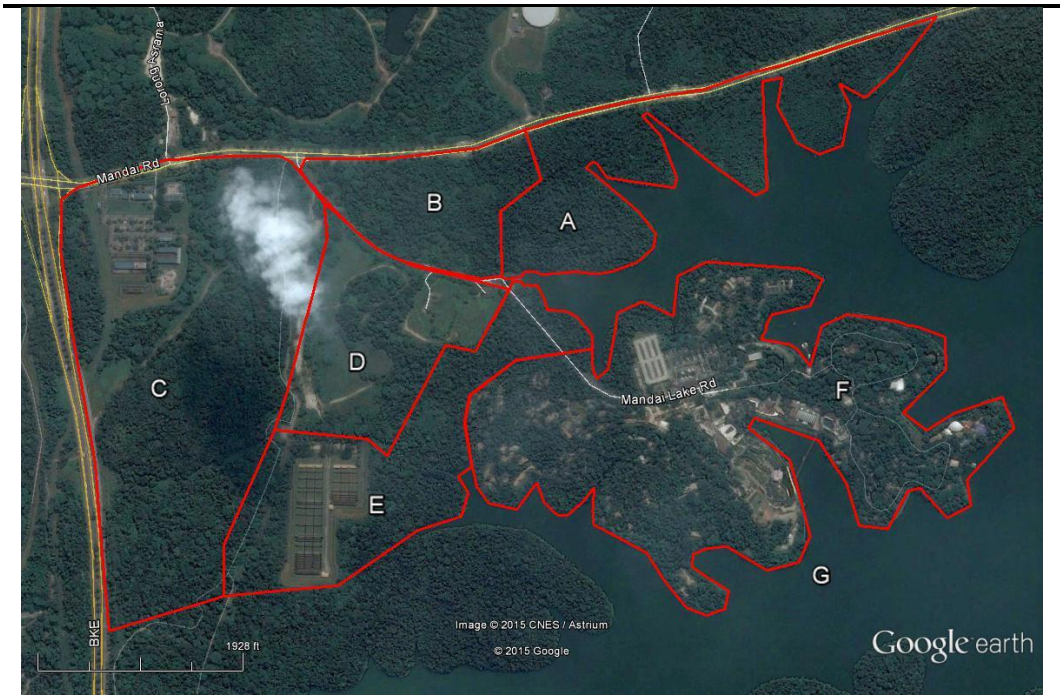
- Birds;
- Herpetofauna; and
- Mammals

- Invertebrates including:
  - Odonates (ie dragonflies and damselflies);
  - Butterflies;
  - Hymenoptera;
  - Orthoptera; and
  - Reduviidae.

These groups of organisms were selected based on results from previous studies and provide a representative coverage of the biodiversity at the Project site. This round of additional surveys will offer full coverage of the Project area and capture seasonal changes in organisms (eg due to monsoon seasons and/or breeding seasons). Some organisms like the Odonates, Orthoptera and Reduviidae serve as bioindicators and their diversities can be used to assess the quality of a habitat.

Six biodiversity survey zones (A, B, C, D, E and F) have been established at the Project site as presented in *Figure 2.1*.

Figure 2.1 Biodiversity Survey Zones at the Project area



The surveys will involve a variety of survey techniques that have been adopted according to the types of organisms under study. These are discussed in greater detail in the following subsections.

2.3.1 Terrestrial Vertebrates

The diversity, distribution and population densities of terrestrial vertebrates (ie mammals, birds and herpetofauna) will be studied as per methods outlined in the following subsections. Actual survey locations will be presented at a later stage upon commencement of the survey.

2.3.1.1 Mammals

Mammals will be surveyed using a combination of transect surveys; point counts and spot sampling; mist-netting and harp trapping; and camera trapping.

Transect surveys for mammals will be undertaken in the day and night in the survey zones (*Figure 2.1*). Mist-netting and harp trapping will be carried out at night for bats. Point counts and spot sampling will be undertaken in the day and night to cover gaps from transect surveys, offer greater coverage to specific habitats and observe certain faunal groups during their optimum times. These surveys will proceed from May to October 2015.

Camera trapping will be undertaken to detect the presence and distribution of ground dwelling mammals. The forested part of the survey area will be divided into 250 m by 250 m square plots and one camera trap will be positioned in the middle of each square (± 50 m) to monitor camera trails. Camera trap units will be mounted about 30 cm above the ground and set to be active 24 hours each day. 11 camera trap sites will be identified and the camera trapping effort will involve at least 40 camera trap nights per camera trap site. The camera trap surveys will be conducted from May to June 2015 and August to September 2015.

2.3.1.2 Birds

Birds will be surveyed using transect surveys, point counts and spot sampling. Bird species will be identified based on both visual and acoustic recognition. The surveys will be conducted in the early morning when most bird species are active to maximize chances of recording data that is representative of the bird community at the Project area.

The survey will be conducted from May to October 2015 and coincides with the breeding season for most bird species (mid-March to July).

2.3.1.3 Herpetofauna

Herpetofauna will be surveyed using transect surveys, and point counts and spot sampling. These surveys will be conducted primarily in the afternoon.

The survey will be conducted from May to October 2015.

2.3.1.4 *Survey Effort*

The survey effort for terrestrial vertebrates is estimated as follows:

- Seven transects per month in the morning. Each transect will bisect each of the biodiversity survey zones;
- Two transects per month in the afternoon for herpetofauna. The transects will rotate through the biodiversity survey zones; and
- One nocturnal survey for terrestrial vertebrates. This will involve mist-netting, nocturnal transects, spot sampling and conducted at a different zone each time.

2.3.2 Flora

Floristic surveys will seek to assess the presence, distribution and abundance of terrestrial flora through two methods: survey walks and vegetation plots.

A series of survey walks will be conducted in the six zones to characterize the vegetation, record the presence of vascular plant species, abundance of mature native trees and located plants that are nationally threatened. GPS locations will be recorded for nationally threatened plants encountered on the survey walks; all large native trees in Zones B and D with diameter at breast height (DBH) of ≥ 30 cm will be tagged and GPS locations marked. Voucher specimens for all nationally threatened species observed will be collected and deposited in the Herbarium, Lee Kong Chian Natural History Museum at the National University of Singapore (NUS) for future reference. The survey walks will also record the presence and estimate the abundances of invasive, introduced species encountered.

Permanent 20 m by 20 m vegetation plots will be established to investigate the abundance of plants of different size classes and for future monitoring to assess the long term effects of the Project on surrounding native plant-dominated forest. The four corners of the plots will be marked with PVC pipes that will be hammered into the ground. The presence of all plant species found within each plot will be recorded; all stems ≥ 5 cm DBH will be tagged, measured and identified. Voucher specimens will be collected and deposited in the Herbarium, Lee Kong Chian Natural History Museum at the National University of Singapore (NUS) for future reference.

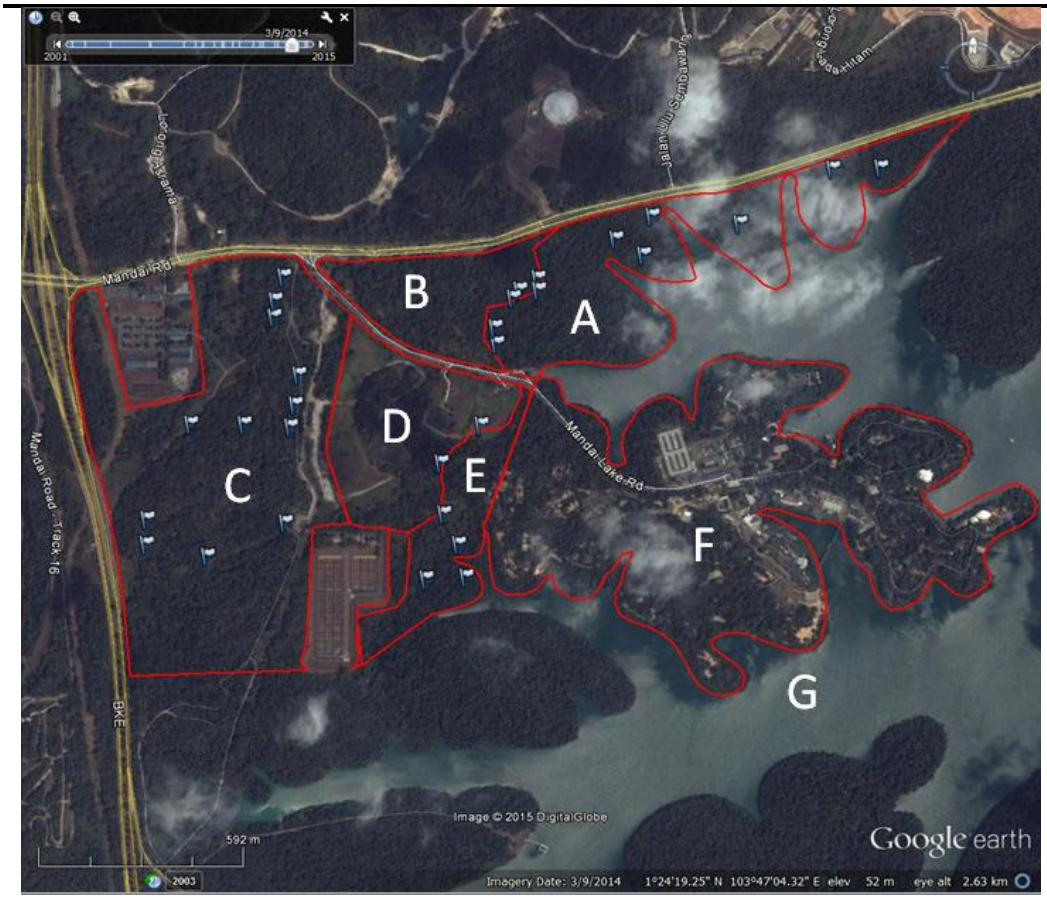
The plots will tentatively be distributed as follows:

- 15 plots in the buffer around Zones B and D (between Zones A and B, Zones D and C, and Zones E and D)
- 15 plots in total in the secondary forest in Zones A, C, and E.

Proposed locations of vegetation plots are presented in *Figure 2.2* (plots have been marked). The survey walks will aim to cover all zones as extensively as possible, and the routes walked will be presented at a later stage. Both the

survey walks and vegetation plots will be conducted from May to October 2015.

Figure 2.2 ***Proposed Locations of Vegetation Plots***



2.3.3 Aquatic Fauna

The aquatic fauna surveys aim to document the diversity of fish and decapod crustaceans present in the survey area and the preliminary biomass of these species. Quantitative and qualitative data will be derived from these series of surveys.

A variety of methods involving push netting, scoop netting, cast netting, trapping and visual census will be employed. The netting methods will be deployed in consideration of the width of the water body and depth of water. Push netting and scoop netting will mainly be conducted at streams and cast netting will be deployed in deeper waters. Baited trapping will be used to capture nocturnally active and cryptic organisms which are normally missed using diurnal methods. A visual census will be conducted where the water level is too deep or when the organism is too large.

All fish and decapod crustaceans obtained will be identified to species level, enumerated and released. Parameters of captured organisms will be recorded and enumerated (eg size, gender, location of capture). The estimated abundance of these species will be generated from the data.

Voucher specimens will be retained to facilitate accurate identification and for future historical reference. These specimens will be deposited in the Zoological Reference Collection of the Lee Kong Chian Natural History Museum, in NUS.

The aquatic fauna surveys will cover up to seven stream lines and each stream line will be assessed twice. Some streamlines outside the study area may be surveyed to provide comparative data if necessary. There may be limitations on the future use of this data based on the relatively short duration of the survey and limited sampling. Final sampling locations will be presented after completion of surveys.

The surveys will be carried out from May to October 2015.

2.3.4 Invertebrates

2.3.4.1 Hymenoptera

Surveys of aculeate hymenoptera (ie bees and wasps) will be conducted to record the number of species, population densities and fluctuations over the seasons. The relationships between different species of aculeate hymenoptera and plants will also be studied.

Most of the surveys will be conducted in the day primarily through visual sightings. Specimens will be identified in the field to the surveyor's best ability and photographed. In cases where further study is required for accurate identification, specimens will be collected using a net and subsequently deposited at the Lee Kong Chian Natural History Museum. Nocturnal surveys will be undertaken to determine the presence of rare nocturnal species, although this effort will not be as intensive as the daytime surveys. A minimum of 24 surveys will be conducted from May to October 2015 and each zone will be surveyed once a month. Two nocturnal surveys will be carried out. Finalized sampling locations will be presented at completion of surveys.

2.3.4.2 Odonates

Odonate diversity and distribution in the study area will be surveyed primarily using transect surveys. These surveys will be conducted in the late morning across the survey zones demarcated in the study area and species will be identified via visual recognition. Point counts and spot sampling will be carried out to cover gaps from transects.

The Odonate survey will proceed concurrently with the terrestrial vertebrate survey in the biodiversity survey zones (*Figure 2.1*). Surveys will be conducted from May to October 2015.

2.3.4.3 Orthoptera

Grasshoppers, crickets and katydids are part of the Order Orthoptera and are important components of terrestrial habitats as primary consumers and prey to terrestrial predators.

For the purposes of this survey, each biodiversity survey zone will be demarcated into four habitat types namely old and disturbed secondary forest; secondary swamp forest; bamboo patch; and grassy and shrubby plots. Two 50 m long line transects will be set up in each habitat type and two habitat types will be sampled in each round of survey. Each habitat type will be sampled ten times over the survey duration; sampling will be designed to begin each time at alternating survey transects to account for human error due to sampling fatigue and time differences.

Once the transects have been demarcated, opportunistic sampling with a net will be undertaken for 30 minutes. The sampling area will be restricted to vegetation located up to 5m away on either side of each transect and up to 2 m above the ground. Sampling will involve searching vegetation, sweeping vegetation, breaking off branches and examining their interior, and locating calls. Captured specimens will be identified, counted and released. Specimens that cannot be identified in the field will be euthanized for closer examination. These specimens will subsequently be deposited in the Zoological Reference Collection of the Lee Kong Chian Natural History Museum at NUS.

The surveys will be undertaken primarily in the day, with nocturnal surveys between 1930-2230 hours conducted approximately once a week. The finalized habitat zones and survey transects for the Orthoptera study will be presented at completion of the survey. The survey will be conducted over the course of May to October 2015.

2.3.4.4 Reduviidae

Assassin bugs (Hemiptera: Reduviidae) play important roles in the ecosystem as secondary consumers. They can be considered as bioindicators because their presence offers potential insights into prey and microhabitat types at a particular location.

The survey will adopt the same sampling methods as the Orthoptera survey and occur along the same transects concurrently. The survey will be conducted over the course of May to October 2015.

2.3.4.5 Butterflies

Butterflies will be surveyed across the different zones to assess their distribution and densities across the study area. They will be conducted using visual sightings and no samples are expected to require collection.

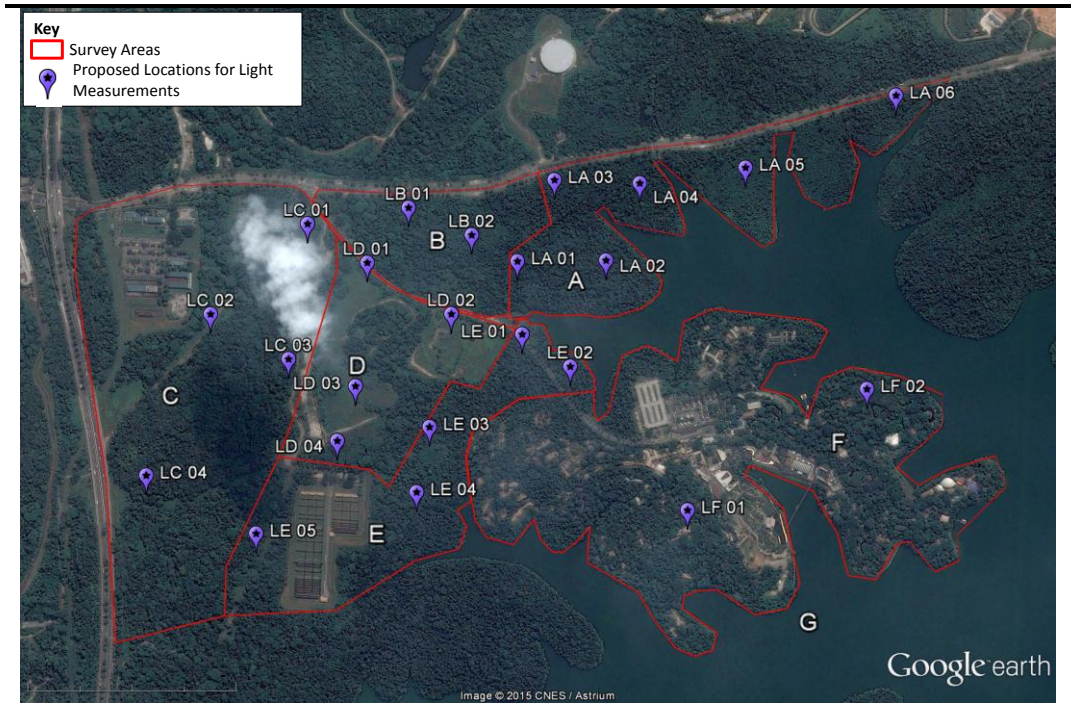
Two butterfly surveys a month will be carried out at each biodiversity survey zone. The survey will be conducted over the course of May to October 2015.

2.3.5 *Light*

Lighting of facilities during the construction and operation phases may impact the species within the CCNR as well as animals housed in the Singapore Zoo.

Light measurements will be taken on site using a handheld light meter (EXTECH EA30). The locations for the measurement have been selected based on the possibility of the area being affected by future Project lighting during construction and operation, and to develop a baseline that best represents existing light levels at the study area. These locations are presented in *Figure 2.3* and a total of 22 points are proposed; it should be noted that these are subject to changes based on site conditions, accessibility and finalized locations of key Project facilities. Measurements will be taken at forest edges, interiors, site boundaries of proposed developments and Mandai Lake Road; measurements will aim to capture illumination differences due to natural occurrences (eg moon phase, weather conditions). A finalized map will be provided after completion of the survey.

Figure 2.3 Tentative Locations for the Light Survey



A light source map will be produced that will identify current illuminated areas and highlight the intensity of sources. Sensitive receptors important for biodiversity will also be identified including important habitats, sensitive locations for species, wildlife corridors and species susceptible to light. A baseline of current light sources, illumination, intensity and spectral range

within the study area will be established. It will serve as a means of comparison against light modelling results to assess the extent of change in illumination during Project construction and operation.

The baseline and light modelling conducted in later stages of the study will help to guide design and management plans in reducing the impacts of increased illumination to identified receptors.

Light measurements will be taken between May and October 2015.

2.4 *SCHEDULE*

The schedule and details of biodiversity baseline surveys are presented in *Table 2.2*.

Table 2.2 Details of biodiversity baseline surveys

Survey Organism	Method/ Techniques	Time	Survey Effort	Duration
Terrestrial vertebrates	Transect, visual survey	Day, Night	7 morning surveys & 2 afternoon surveys per month	May to October 2015
	Point counts and sampling	Day, Night	7 surveys per month	May to October 2015
	Mist netting and harp trapping	Night	1 survey per month	May to October 2015
	Camera trapping	24 hours	40 camera trap nights per camera trap site; 11 camera traps	May to June 2015 August to September 2015
Flora	Survey walks	Day	Aim to cover all zones	May to October 2015
	Vegetation plots	Day	15 plots in buffer zones & 15 plots in Zones A, C & E	May to October 2015
Invertebrates				
Odonates	Transect Point counts and spot sampling	Day	7 morning surveys per month per zone	May to October 2015
Butterflies	Transect surveys	Day	2 afternoon	May to October 2015
Hymenoptera	Visual census	Day, Night	Minimum of 24 surveys, 2 night surveys. 1 survey per zone per month	May to October 2015
Orthoptera	Transect, active sampling	Day, Night	10 surveys per habitat type per month, 1 night survey per week	May to October 2015
Reduviidae	Transect, active sampling	Day, Night		May to October 2015
Aquatic Survey				

Survey Organism	Method/ Techniques	Time	Survey Effort	Duration
Aquatic fauna	Netting, trapping	Day, Night	7 stream lines, 2 surveys each line	May to October 2015
Others				
Light	Targeted sampling with light meter	Night	22 points in study area	May to October 2015

3 SOIL AND GROUNDWAtER SURVEYS

3.1 OBJECTIVES

3.1.1 Shallow Soil Sampling

The Project Site is mainly forested area where topsoil will be directly exposed once vegetation is removed. Construction activities that involve the storage and handling of chemicals and waste have the potential to impact the quality of soil. Further, the site to the south of Mandai Lake Road was formerly an orchid farm which the soil property could have been altered by the application of fertilizer.

The shallow soil sampling aims to understand the existing soil conditions of the Project site through the advancement of boreholes using hand augers. This less intrusive method of sampling has been selected for the initial phase of the EIA baseline considering the sensitivity of the surrounding ecology.

3.1.2 Groundwater Monitoring

The concept design includes two underground structures, an underground carpark in the site to the south of Mandai Lake Road and the other at the proposed location of the arrival plaza near the Upper Seletar Reservoir. Based on the design information available at the time of writing, dewatering is likely to be needed to construct these two structures. To understand the groundwater flow and potential connectivity to the Upper Seletar Reservoir, groundwater monitoring will be required. This will necessitate the use of boring around the proposed underground installations.

3.2 LEGISLATIVE FRAMEWORK

Soil sampling will be undertaken following the *Singapore Land Authority (SLA) Environmental Site Assessment Guidelines for State Land* and *JTC Guideline on Environmental Baseline Study, 2010 Edition*.

The *SLA Environmental Site Assessment Guidelines* presents the approach for the assessment and management of contaminated sites. The approach is risk-based which is flexible and allows decision making to be tailored to site specific conditions and hazards.

The soil sampling results will be compared against the Intervention Value and Target Value stipulated in the *JTC Guideline on Environmental Baseline Study, 2010 Edition*. The guideline makes reference to the *Environmental Quality Objectives in the Netherlands* issued by the Dutch Ministry of Housing, Physical Planning and the Environment in 2000. The Target Value presents the background value, where risks of adverse effects to human health are considered to be negligible. The Intervention Value indicates the

environmental quality level above which the maximum allowable risks of adverse effects on humans and the environment are considered unacceptable.

3.3 SURVEY METHODOLOGY

Subsurface clearance surveys will be conducted to identify any underground utilities that could be present in the survey area prior to intrusive sampling. A cable avoidance tool will be operated by a licensed cable detection worker (LCDW) to perform the scanning. The scanning will be supplemented by a review of the utility plans purchased from relevant authority (eg Singtel, SP Powergrid, Powergas). Subsequent to this is the unexploded ordnance (UXO) investigation which will be undertaken using an electromagnetic scanner.

3.3.1 Shallow Soil Sampling

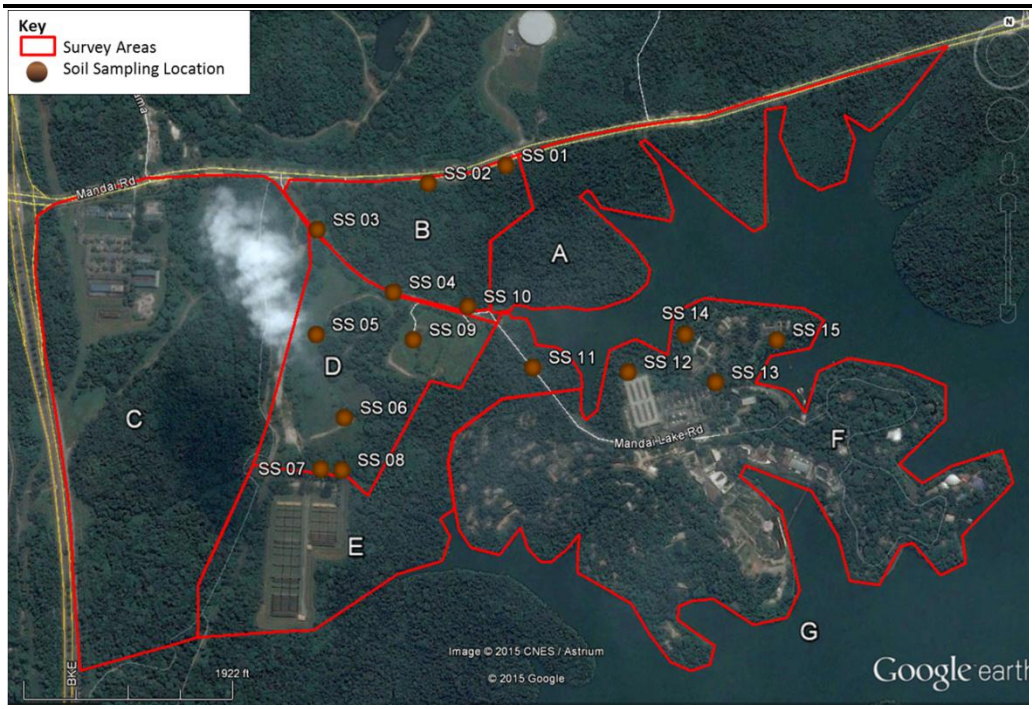
Once the Project site is confirmed to be free of UXO, the shallow soil sampling survey will be conducted. Hand augers will be manually rotated to penetrate the ground, and then withdrawn to remove excavated material. The procedure will be repeated until the required depth is reached (ie 3 m below ground level (m bgl)).

A total of 15 locations will be selected for the shallow soil sampling survey based on the historical uses of the site and future site planning. Two soil samples will be collected from each borehole location. The samples will be sent for analysis by a SINGLAS accredited laboratory for the following parameters:

- pH;
- Heavy metals (antimony, arsenic, barium, cadmium, chromium (total), cobalt, copper, lead, mercury, molybdenum, nickel and zinc);
- Inorganic compounds (including cyanide);
- Aromatic compounds (including benzene, ethylbenzene, toluene, xylene);
- Polycyclic aromatic hydrocarbons (including vinylchloride, chlorobenzene);
- Pesticides (including Aldrin, dieldrin, endrin);
- Other pollutants (cyclohexanone, phthalates (sum), mineral oil, pyridine, tribromomethane, tetrahydrofuran and tetrahydrothiophene);
- Total petroleum hydrocabons;
- Volatile organic compounds (VOCs);
- Semi-volatile organic compounds (SVOCs);
- Fecal coliform;
- Macroelements (including nitrogen, phosphorus, potassium, calcium, sulfur and magnesium); and
- Micronutrients/ trace elements (including chlorine, iron, boron and manganese).

The sampling locations are shown in *Figure 3.1*.

Figure 3.1 Shallow Soil Sampling Locations



3.3.2 *Soil and Groundwater Baseline Investigation Using Machine Boring*

Once the location and dimensions of the underground installations is confirmed, ERM will identify up to eight locations in total in the vicinity of the installations for the advancement of boreholes using machine boring. Each borehole will be advanced to a depth of 6 to 7 m bgl.

During drilling, soil samples will be collected at 1 m intervals for inspection and logging, and three soil samples will be selected from each borehole for laboratory analysis. The three samples will include shallow soil (0.3 m to 0.5 m bgl); soil from the top of groundwater interface; and a sample with the highest Photo-Ionization Detector reading.

Groundwater from each borehole will be sampled and analysed for the following parameters: water level, environmental parameters as per the JTC Guidelines for Environmental Baseline Studies (EBS), ie heavy metals, inorganic compounds, aromatic compounds, polycyclic aromatic hydrocarbons, chlorinated hydrocarbons, pesticides, total petroleum hydrocarbons and volatile organic compounds. All samples will be analysed by ALS, a SINGLAS-accredited laboratory. In addition, sieve sampling will be undertaken of borehole cuttings in order to assist in determination of the permeability of the underlying geology. Water level will be measured twice, once in the monsoon period and once in the inter-monsoon period to account for potential variability. One groundwater sample will be collected per monitoring well for laboratory analysis.

The specifics of the machine boring installation programme will be shared with the Client and the Technical Agencies after confirmation of the design of underground structures.

3.4 DIFFERENCES FROM SCOPING REPORT

Section 6.2.5.3 of the IA Scoping Report proposes the use of minimally intrusive methods for soil sampling, in view of the sensitive ecological receptors. In view of the potential for underground structures near the Upper Seletar Reservoir, however, it was determined that limited machine boring may be necessary in these locations to understand hydraulic connectivity with the reservoir and potential impacts associated with dewatering.

3.5 SCHEDULE

The shallow soil sampling survey is anticipated to be undertaken between May and July 2015.

Based on the current timeline of the Project design, it is expected that the machine boring will take place after June 2015. Groundwater monitoring will take place during two seasons, ie southwest monsoon and the intermonsoon period.

4 SURFACE WATER SAMPLING

4.1 OBJECTIVES

The Project site is located in close proximity to the Upper Seletar Reservoir which is part of the Central Catchment Nature Reserve (CCNR). The site to the south of Mandai Lake Road consists of a stream that runs parallel to Track 15. This stream belongs to the Sungei Mandai Water Catchment Area. Surface water quality and the hydrology of these waterbodies may be impacted as a result of the construction activities. In addition, the existing perimeter surface water drainage abutting Upper Seletar Reservoir of the Zoo, River Safari and the Night Safari, which serves as a cut-off drain to collect storm water runoff from the three WRS operated areas to be discharged outside water catchment areas, will also be modified as part of the design. .

Understanding the existing water quality of surface waterbodies in the vicinity of the Project site will facilitate the evaluation of receptor sensitivity. The Upper Seletar Reservoir is especially sensitive as it is a drinking water reservoir.

4.2 LEGISLATIVE FRAMEWORK

Key legislations governing surface water quality in Singapore include the following:

- The *Environmental Protection and Management (Trade Effluent) Regulations, 2008*. This regulation includes trade effluent discharge standards to controlled waters for parameters including total suspended solids (TSS), grease and oil, biological oxygen demand (BOD), chemical oxygen demand (COD) and heavy metals. Wastewater generated during the construction and operation of the Project will be considered as "trade effluent" based on the definition under the *Environmental Protection and Management Act, 2002*;

- The *Code of Practice on Surface Water Drainage, December, 2011 (Addendum No.1 June 2013)* and *Sewerage and Drainage (Surface Water Drainage) Regulations, 2007.* Stipulate Earth Control Measures that must be employed at construction sites, such as control of stockpiled material; setting earth slopes outside drainage reserves; and require runoff discharged into storm water drains to contain less than 50 milligrams per litre (mg/l) TSS; and

- Water within the Upper Seletar Reservoir is monitored and maintained to meet the PUB internal *Raw Water Quality Standard* for treatment system requirement. The *Environmental Public Health (Quality Piped Drinking Water) Regulations, 2008* were developed with reference to the *World Health*

4.3 SURVEY METHODOLOGY

A stream mapping survey will be carried out prior to the sampling to identify any additional surface waterbody of concern and for delineation of watershed. Following this, the baseline water sampling will be undertaken.

The baseline water sampling will comprise of both in-situ and ex-situ methodologies, both following the *National Field Manual for the Collection of Water Quality Data* published by the United States Geological Survey (USGS).

During the in-situ sampling, the probe of a multiparameter meter will be lowered to the surface water bodies for in-situ measurements of pH and temperature. The probe of the multiparameter will be rinsed prior to taking readings at each location. The ex-situ sampling will involve the use of a bailer for collection of water samples. For shallow water bodies such the stream near Track 15, water samples will be collected from the bank. Monitoring data from the PUB will be requested to understand the water quality of the Upper Seletar Reservoir. In the case where the PUB monitoring results are not available, sampling at the Upper Seletar Reservoir will be required. Field personnel will be ferried by a boat arranged with the consent of PUB. Sampling at varying depths will be required since the reservoir is expected to be more than 2 m deep. Up to 10 sampling locations will be selected from the aforementioned water bodies and depending on the findings of the stream mapping.

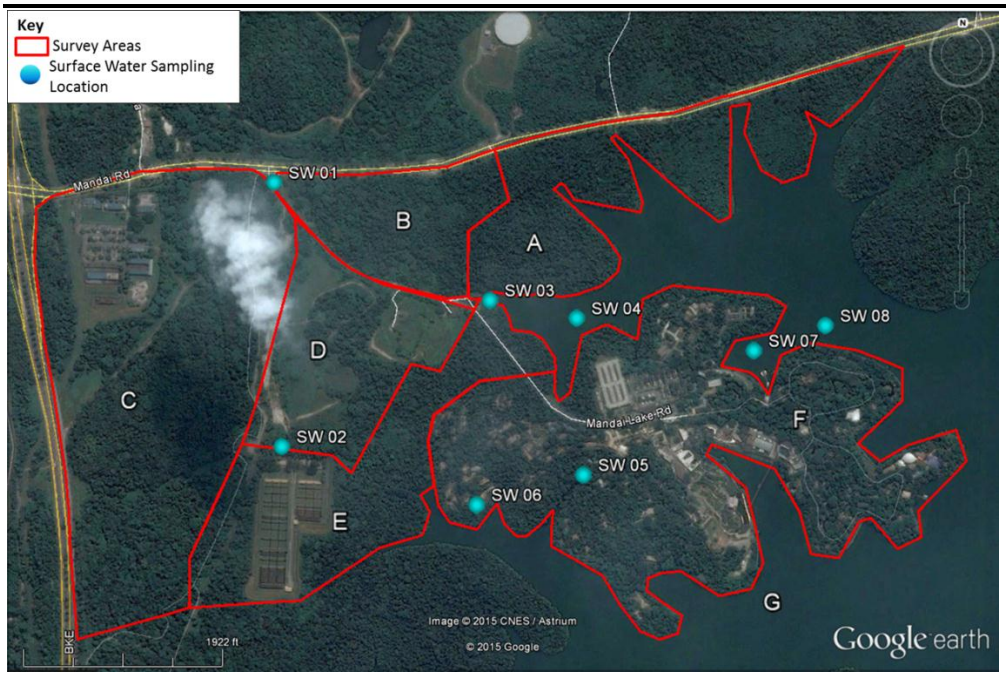
Water samples contained in the bailer will be equally poured into the laboratory bottles until full. The water samples collected will be properly preserved, individually sealed and sent directly to the laboratory for analysis of the following parameters:

- TSS;
- Oil and grease;
- Dissolved oxygen (DO);
- COD;
- BOD;
- Total dissolved solids (TDS);
- Nutrients (ie total phosphorus and total nitrogen);
- Chlorophyll-a; and
- *E.Coli*.

At the laboratory, standard methods stipulated in American Public Health Association (APHA) Standard Methods for the Examination of Water and Wastewater or American Society for Testing and Materials (ASTM) Annual Book of American Society for the Testing and Materials Standards will be adopted for analysis of water samples. A SINGLAS accredited laboratory with appropriate quality assurance and quality control (QAQC) procedures will complete the laboratory analysis.

The surface water sampling locations are shown in *Figure 4.1*.

Figure 4.1 Surface Water Sampling Locations



Note that the sampling locations SW04 and SW08 are 200- 300 m from the banks of the Upper Seletar Reservoir; sampling will be undertaken at these locations only if long-term historical data from the PUB is not available to inform the EIA.

4.4 SCHEDULE

Two rounds of sampling will be carried out during two monsoon seasons to cover the water quality under different weather conditions. The target is to carry out one round of sampling in May to capture the ongoing intermonsoon period and the other in June/ July in the southwest monsoon.

5 AMBIENT AIR QUALITY SURVEY

5.1 OBJECTIVES

The baseline air quality parameters were selected in view of the typical air emissions associated with the construction of the proposed development. Demolition works and earth works would generate large particulates, and may result in nuisance or ecological impacts due to dust deposition in the surrounding areas.

Receptor sensitivity is one of the key factors to be considered when selecting survey locations. Air sensitive receptors identified in the IA Scoping Study are outlined in *Table 5.1*.

Table 5.1 Potential ASRs

Name	Landuse Type	Approximate Distance
Upper Seletar Reservoir	Ecological	0 m (adjacent)
Nature Reserve	Ecological	0 m (adjacent)
Visitors and personnel within the Singapore Zoo	Recreational	0 m (adjacent)
Mandai Camp II (Military)	Residential	100 m
Mandai Camp	Residential	1 km
Segar Grove, Segar Garden	Residential	1.8 km
HDBs, Woodlands St 41	Residential	2 km
Century Grove	Residential	2 km
Singapore Turf Club	Recreational	1.7 km
Singapore American School	Educational	1.9 km
Singapore Sports School	Educational	1.9 km

Source: ERM, February 2015

Dust generated from the construction activities is typically re-deposited within 350 m of the source *(Institute of Air Quality Management, 2014)*. However as most of the ASRs are located more than 350 m from the Project site, the air quality survey will focus on the Project site (areas B, D and F in *Figure 2.1*) and up to six survey locations will be selected.

5.2 LEGISLATIVE FRAMEWORK

Singapore has adopted air quality targets based largely on the World Health Organisation (WHO) Air Quality Guidelines for $PM_{2.5}$, PM_{10}, NO_2 and CO *(NEA, 2012)*. The ambient air quality targets that are of relevance for the Project are outlined in *Table 5.1*.

Table 5.2 Singapore Ambient Air Quality Targets

Species	Averaging Time	Singapore Air Quality Target by 2020 (µg/m³)	Long-Term Target (µg/m³)
PM_{10}	24 hour	50	50
PM_{10}	Annual	20	20
$PM_{2.5}$	24 hour	37.5	25
$PM_{2.5}$	Annual	12	10

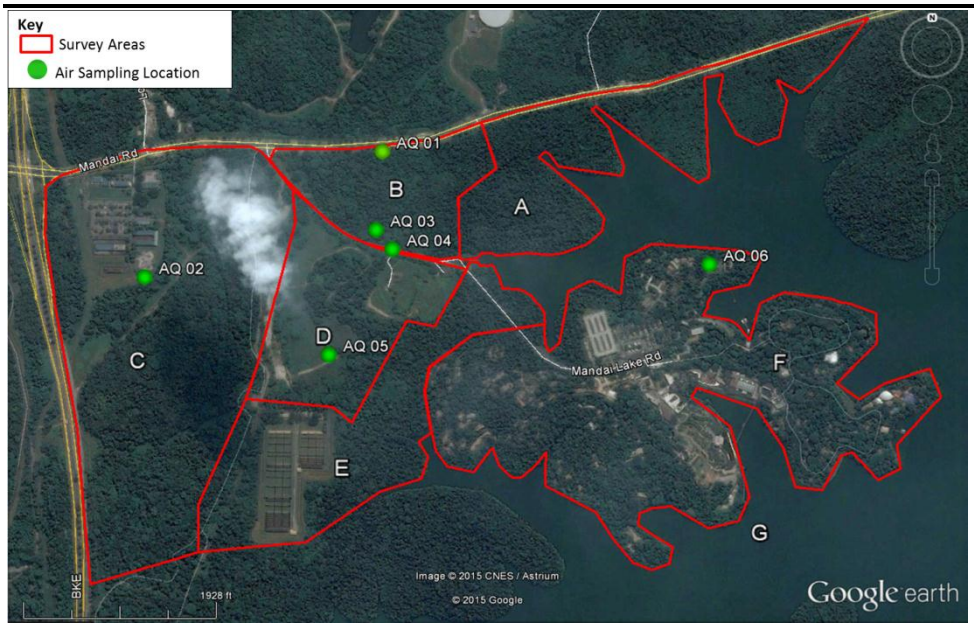
Source: NEA, 2012

5.3 SURVEY METHODOLOGY

Portable light scattering dust meters will be employed for the short-term air quality survey. The portable meter will be placed at locations that are selected in consideration of sensitivity, proximity to the Project site and accessibility.

The measurement of PM10 will be undertaken at the six locations shown in *Figure 5.1.*

Figure 5.1 Ambient Air Quality Measurement Locations



The survey locations may include a co-location at a nearby permanent station operated by the NEA as a reference method to help interpretation of the long-term results that will be requested from the NEA. Approval to place the meter will be sought from the NEA prior to the commencement of the survey.

The findings will be representative of short-term air quality over the specified duration at each location. As mentioned above, long term air quality monitoring data from the NEA's nearby monitoring stations will be requested to supplement the field survey. The baseline air quality status will be referenced against the Singapore Air Quality Targets presented in *Table 5.1*

5.4 DIFFERENCES FROM SCOPING REPORT

As discussed in *Section 6.2.2* of the IA Scoping Report, dust from construction is expected to be the main source of impacts to air quality from the Project. This will primarily occur in the form of PM_{10} and larger particles. The ambient air quality survey will therefore focus on these particles of concern, ie

the survey will be carried out at six locations within the Project sites and at the nearest sensitive receptor (Mandai Camp II) for PM_{10}.

5.5 SCHEDULE

Two rounds of sampling will be carried out. The first round of sampling will commence in June (southwest monsoon) while the second round will be undertaken in October (intermonsoon period).

6 ACOUSTICS SURVEY

6.1 OBJECTIVES

The ambient noise levels at the Project site could be impacted as a result of the operation of construction equipment during pre-construction and construction stages. The acoustic survey will establish baseline noise environment at areas that could be affected by the Project. The IA Scoping Study has identified numerous noise sensitive receptors (NSRs) and these are presented in *Table 6.1*.

Table 6.1 Potential NSRs

Name	Landuse Type	Approximate Distance
Upper Seletar Reservoir	Ecological	0 m (adjacent)
Nature Reserve	Ecological	0 m (adjacent)
Visitors and personnel within the Singapore Zoo	Recreational	0 m (adjacent)
Mandai Camp II (Military)	Residential	100 m
Mandai Camp	Residential	1 km
Segar Grove, Segar Garden	Residential	1.8 km
HDBs, Woodlands St 41	Residential	2 km
Century Grove	Residential	2 km
Singapore Turf Club	Recreational	1.7 km
Singapore American School	Educational	1.9 km
Singapore Sports School	Educational	1.9 km

Source: ERM, February 2015

The impact of construction noise will be localized. The area of influence is likely to extend approximately 500 m from the Project site boundary. However since most of NSRs are located more than 500 m from the Project site, the survey will mainly be undertaken at areas B, D and F in *Figure 2.1* and up to 10 survey locations will be selected.

6.2 LEGISLATIVE FRAMEWORK

Noise requirements in Singapore are specified under the *Section VIII* of the *Environmental Protection and Management Act, 2002*. The Project construction activities will be required to comply with the noise limits stipulated under the *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011*. The Project site is away from sensitive receptors such as schools and hospitals, however as Mandai Camp II located 100 m to the north is also used for residential purposes, the relevant affected premises fall under the categories of *Residential Buildings* and *Other Buildings*. The maximum permissible noise levels that the Project is required to comply with are provided in *Table 6.2* to *Table 6.4*.

Table 6.2 Maximum Permissible Noise Levels- (Part I, Period Limits 12 hours)

Type of Affected Building	Maximum permissible noise level for construction sites[1] in decibels (dB(A))	
	Day	Evening / Night
	7 am — 7 pm	7 pm — 7 am
Residential buildings located less than 150 m from the construction site where the noise is being emitted	75	-
Other Buildings [2]	75	65

Notes:

(1) Reckoned as an equivalent continuous noise level over a period of 12 hours

(2) Buildings other than residential premises, and noise sensitive receptors (schools, hospitals, home of the aged sick etc) classified under the *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011*.

Source: Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011

Table 6.3 Maximum Permissible Noise Levels- (Part II, Period Limits 1 hour)

Type of Affected Building	Maximum permissible noise level for construction sites[1] in decibels (dB(A))		
	Day	Evening	Night
	7 am — 7 pm	7 pm — 10 pm	10 pm — 7 am
Residential buildings located less than 150m from the construction site where the noise is being emitted	-	65	55
Buildings (other than those in above)	-	-	-

Notes:

(1) Reckoned as an equivalent continuous noise level over a period of 1 hour period from Mondays to Saturdays

(2) Noise Sensitive: Hospitals, schools, institutions of higher learning, homes for the aged sick, etc

Source: Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011

Table 6.4 Maximum Permissible Noise Levels- (Part I, Period Limits 5 mins)

Type of Affected Building	Maximum permissible noise level for construction sites[1] in decibels (dB(A))		
	Day	Evening	Night
	7 am – 7 pm	7 pm – 10 pm	10 pm – 7 am
Residential buildings located less than 150m from the construction site where the noise is being emitted-			
• Mondays to Saturdays	90	70	55
On Sundays and Public Holidays	75	55	55
Buildings (other than those in above)	90	70	70

Notes:

(1) Reckoned as an equivalent continuous noise level over a period of 5 mins

(2) Buildings other than residential premises, and noise sensitive receptors (schools, hospitals, home of the aged sick etc) classified under the *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011*.

Source: Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011

The Third Schedule of the *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations* states that the maximum permissible noise levels for construction sites shall be adjusted by the addition of a correction factor, to account for the existing background noise levels in the area. The correction factor corresponds to the difference between the applicable permissible level, and the background noise level, and is presented in *Table 6.5*.

Table 6.5 Correction Factor

Difference between Permissible and Background Noise Levels dB(A)	Correction Factor dB(A)
Below 2	3
2 to less than 4	2
4 to less than 10	1
10 and above	0

Note:

The correction factor is added to the higher of the 2 noise levels (ie baseline noise and permissible noise)

Source: Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011

Sensitive ecological receptors will be considered both in survey design and during the impact assessment. Spatial distribution of the species and habitats of conservation significance detected will be used to target the survey to identify the current background noise levels in these areas. The impact assessment will consider the noise levels obtained during the baseline surveys to recommend avoidance and mitigation measures for areas of ecological significance and sensitivity. Reference will also be made to the applicable WHO Guidelines on Community Noise.

6.3 SURVEY METHODOLOGY

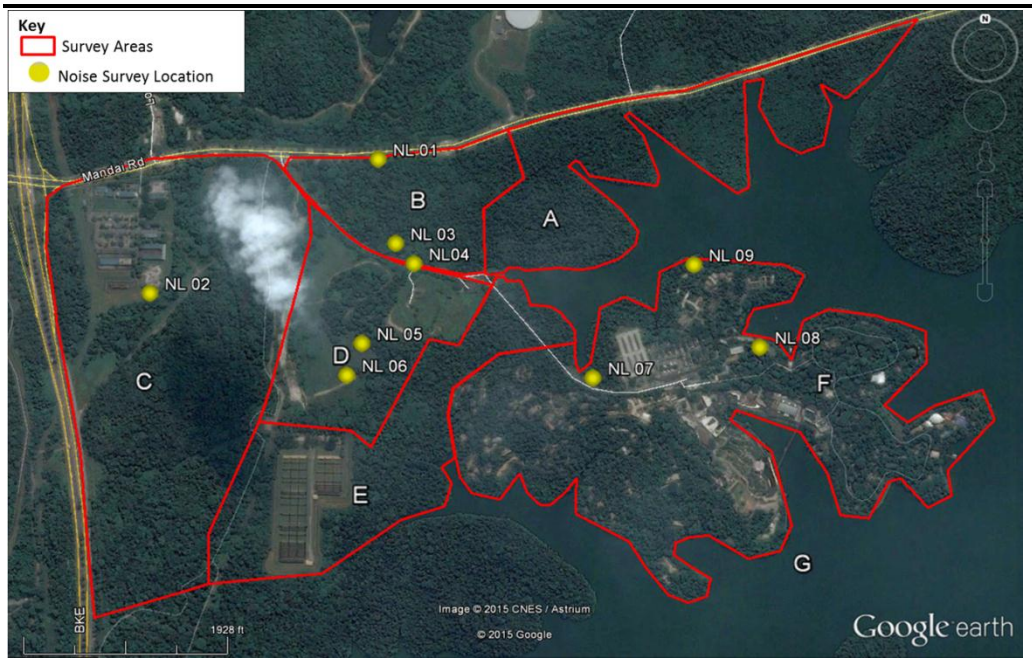
Noise levels will be measured using a Type I sound level meter and will be reported in terms of $L_{Aeq,12hr}$, $L_{Aeq,1hr}$ and $L_{Aeq,5min}$. Other parameters such as L_{max}, L_{10} and L_{90} will also be recorded to facilitate the analysis of baseline noise levels.

The measured levels will be compared against the *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011*.

Sensitive ecological receptors will be considered during the assessment phase. Information obtained during the biodiversity surveys will be used to provide additional information for survey points. Noise will be a considering factor during the ecological impact assessment.

The selected noise monitoring locations are presented in *Figure 6.1*.

Figure 6.1 Noise Monitoring Locations



6.4 SCHEDULE

Two rounds of sampling will be carried out. The first round of sampling will be undertaken in June while the second round will be undertaken in October.

7 *DELIVERABLES*

ERM will submit the following outputs from the baseline survey effort:

- 1st Interim Baseline Results – July 2015;
- 2nd Interim Baseline Results – September 2015;
- Final Baseline Findings – November 2015;
- Raw and processed baseline data as they become available; and
- Ongoing refinement of sensitivities map based on results of baseline surveys.

These reports will document the methodology for the surveys, their findings and the dates and timing of monitoring.

APHA	American Public Health Association
ASTM	American Society for Testing and Materials
ASR	Air Sensitive Receptor
AVA	Agri-Food & Veterinary
bgl	below ground level
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
CCNR	Central Catchment Nature Reserve
DO	Dissolved Oxygen
ERM	Environmental Resources Management
GIS	Geographic Information System
IA	Impact Assessment
JTC	Jurong Town Corporation
TA	Technical Agency
TSS	Total Suspended Solids
URA	Urban Redevelopment Authority Ministry
MND	of National Development
MPH	Mandai Park Holdings
NEA	National Environment Agency
NParks	National Parks Board
NSR	Noise Sensitive Receptor
QAQC	Quality assurance and quality control
STB	Singapore Tourism Board
SVOC	Semi-volatile organic compound
USGS	United States Geological Survey
VOC	Volatile organic compound
WHO	World Health Organization

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Annex A

ERM's Health and Safety Policy

ERM's Global Health and Safety System

May 2013

Ensuring the health, safety and security of our people at work is one of ERM's Core Values.

This vision is realized through our Global Health & Safety System and our safety culture, which is embodied by the phrase: *"You See It. You Own It. And Share It."*

It means that our people have the responsibility and authority to be proactive and to resolve safety, health and security concerns before they turn into bigger problems.

It also means that we strive to share lessons learned from small things and use those lessons to help ERM prevent bigger issues and become an even safer place to work.

ERM's people express their commitment to health & safety by being active participants in our safety culture – embodied by the phrase **"You See It. You Own It. And Share It."**

Inside this culture, the operations of our business implement a Health & Safety Program designed to drive our safety performance toward a level of "Zero Incidents". Our system incorporates OHSAS 18001-based elements and emphasizes risk assessment and control, strong communications, training, self-assessment, positive reinforcement of safe behaviors and, of course, continuous improvement. Where required, ERM also implements client-mandated health & safety programs and procedures (above and beyond our own) on projects.

ERM Business Units (BUs) have health & safety performance goals integrated into their operational plans. ERM employees – from the CEO on down – have personal safety goals incorporated into their performance and professional development plans.

The sustainable path to world-class safety performance is one where safe behaviors are engrained in the actions and decisions of our people. It's more than ensuring simple compliance with rules and procedures, though we do that. It's more than putting in place systems or policies, though we have those. It's making the notion of "You See It. You Own It. And Share It." part of the way we do things as ERM every day.

Global Safety & Health Organization

ERM's senior management is directly accountable for the implementation of ERM's Health and Safety Program and for leading by example. They are supported by a formally structured global safety & health organization that touches all levels and regions of the company.

Global Core H&S Team

ERM's Core H&S Team is comprised of a Global Health and Safety Director, Regional H&S Directors, Sector H&S Advisors and systems specialists, and is overseen by ERM's Global Programs Director. Each of ERM's Regions has a dedicated Regional H&S Director/Advisor who reports to the respective Regional CEO and is part of the Core H&S Team. Within each BU, there are local H&S Coordinators that work closely with our operational teams. The Core Global H&S Team helps to facilitate & deliver the broader H&S strategy within the company.

Local Reach

The Business Unit H&S Advisors work interactively with the Global Core H&S Team and local management to ensure consistency with global programs and to serve as a resource for local operations. This network organization helps to bring expertise and support to bear where it is most needed – at the front line of the business.

Safety Performance

ERM's safety performance and the pulse of our safety culture are continuously monitored through our **Event Communication System (ECS)**. The ECS allows any employee to "communicate" the occurrence of a health, safety, environmental and security event. Its use is encouraged as part of everyday life in the company. ECS information is used in real-time for sharing lessons learned around the globe and refining ERM's base procedures for safe work.

ERM's 2012 total recordable incident rate was 0.48, compared to an industry average of 1.2

2012 Injury & Illness (Lagging) Performance Indicators

In calendar year 2012, our overall global operations experienced a total recordable incident rate (TRIR) of 0.48, which compares favorably to the most recently reported rate for our industry of 1.2. ERM's lost workday incident rate (LWIR) was 0.15, less than our industry's average of 0.3 Recordable injuries and illnesses were in a broad range of categories including ergonomic-related injuries, contusions, and incidents related to outdoor/tropical exposures.

*2012 Global Recordable*Injury & Illness Data Summary*

Injury and Illness Parameter	ERM Global Rate	Total Number of Incidents/Cases
TRIR	0.48	20
LWIR	0.15	6

* Global Recordable per US OSHA recordkeeping guidelines. Data as of Jan 24, 2013

Key Components of ERM's Health & Safety Program

ERM's Health & Safety Program provides training, tools and processes that span the careers of our people and the lifecycles of our projects. These include the following:

- H&S Policy, Planning, Annual Objectives;
- Roles, Responsibilities and Accountability;
- H&S planning as integral part of the ERM Project Cycle;
- Behavior-Based Safety: The Observation & Feedback Program (OFP);
- Health & Safety Training;
- Subcontractor Pre-Qualification & Safety;
- Incident Investigations; and
- Health & Safety Internal Auditing.

H&S Policy, Planning, Objectives

Senior management defines and authorizes ERM's H&S policy to include a commitment to prevention of injury and illnesses, continual improvement in H&S management and performance; and ensuring a framework for setting and reviewing H&S goals/objectives. This policy is documented and communicated to all ERMers.

Global H&S objectives are developed annually by senior management, in consultation with the organization. All

employees have H&S objectives as part of their balanced score cards and annual goals.

H&S Roles, Responsibilities, Accountabilities
Senior management takes ultimate responsibility for H&S and the H&S management system. ERM demonstrates this commitment by ensuring the availability of resources essential to establish, implement, maintain and improve the H&S management system; and by defining roles, allocating responsibilities and accountabilities, and delegating authorities, to facilitate effective OH&S management;

H&S in the ERM Project Cycle
Health and safety is at the core of the ERM project cycle and is part of everything we do. This means that H&S is an integral part of every step of the process, from the proposal through the project planning, implementation, feedback and closure phase of every project. Risks of work activities including travel, auditing, working on undeveloped sites, intrusive work, offshore work, and remediation are formally assessed, and communicated with documentation in the form of Health & Safety Plans (HASPs) and Job Hazard Analyses (JHAs).

Behavior-Based Safety: Observation & Feedback Program (OFP)
At ERM, we believe that leaders' behaviors (that is, their thoughts and actions) create a body of behaviors within the men and women on the front line, which ultimately lead to our business outcomes. In terms of safety, our leader's behavior can mitigate risks or accidents.

OFP seeks to unlock the safety leadership potential in our people to drive enhanced safety performance. It helps them to realize for themselves the criticality of changing the way they think and act about safety for the sake of their colleagues and their livelihood. This requires embracing a simple set of principles to achieve that goal:

You See It. You Own It. And Share It.

These principles, in practice, embody a set safety related thinking and actions for leaders up and down the line.

- **Seeing:** Being better able to rapidly identify the hazards and degree to which they are (or are not) controlled, which give rise to Near Misses or Unsafe Actions and / or Conditions in the workplace.
- **Owning:** Doing what you are capable of about the things that you See" – from immediate abatement to interpersonal intervention and coaching – to ensure that the outcome from those things are safe. Through our behavior based programme each ERMer is authorized to stop work perceived to be unsafe.
- **Sharing:** Working inside a zero blame culture to learn big lessons from the big and especially small things that are "Seen" and "Owned" every day. This is accomplished through our ECS software.

Health and Safety Training
Beginning with new employee Health and Safety Orientation, H&S training is an ongoing activity through an employee's career. Employees' training needs are assessed upon hire or transfer based on their foreseen work activities. They are provided with a tailored and highly interactive training regime to help prepare them for the health & safety risks inherent in their work. ERM utilizes a combination of e-learning technology, instructor lead training sessions and 3rd party training specialists. ERM recently invested in a global learning management system (LMS) to assist with the ongoing management of training records and training needs.

Subcontractor Pre-Qualification and Safety
Ensuring the health and safety of our subcontractors in our shared work environment is a top priority for ERM.

This starts by identifying subcontractors that meet our safety & healthy requirements, insurance requirements, specific legal requirements as well as those of our clients. ERM utilizes a Contractor / Supplier Evaluation Questionnaire to gather information on subcontractor's past performance and current programs. ERM evaluates

this as part of a pre-approval process. Re-evaluations are performed annually. This commitment to safety continues on-site during project execution. ERM's health and safety expectations are taken to the site through HASPs and JHAs.

In Q4 2011, ERM partnered with Pacific Industrial Contractor Screening (PICS) to rollout a global standardized process for subcontractor prequalification. Implementation has taken place in the US/Canada and will be moving to other international geographies throughout 2013.

Incident Investigations

ERM has established, implemented and maintains a process to record, investigate and analyze incidents in order to:

- Determine underlying H&S deficiencies and other factors that may be causing or contributing to the occurrence of incidents;
- Identify the need for corrective action;
- Identify opportunities for preventive action;
- Identify opportunities for continual improvement; and
- Communicate the results of such investigations.

Health and Safety Internal Auditing

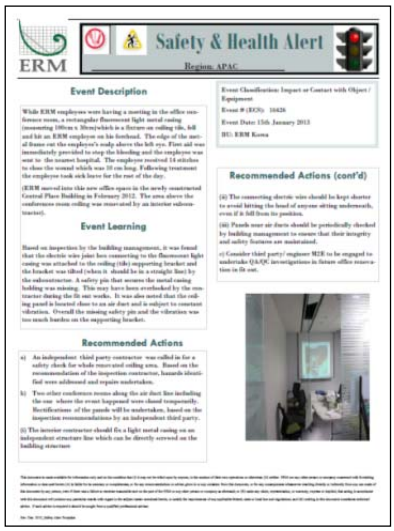
An important aspect of a health and safety management system is the audit process. This occurs at the project and system levels. ERM conducts system audits and inspections of fieldwork, assessing whether on-site activities meet the requirements of the site HASP. ERM does not tolerate known violations of safe work practice and has dismissed both employees and subcontractors for safety & health violations and preventable incidents.

Health and Safety Communications and Information Sharing

ERM utilizes several communication channels to help keep our staff and clients appraised of safety-related issues and trends affecting our operations.

Safety Alerts & Lessons Learned

ERM has developed a Safety Alert & Lessons Learned process that is used for communication of safety-critical learnings to any employee in the world and has become an integral part of our continuing education and injury protection program. At a minimum, Safety Alerts are prepared for high potential near misses, subsurface clearance intercepts and recordable injuries/illnesses.


ERM

Safety & Health Alert

Region: APAC

Event Description

Event Classification: Impact or Contact with Object / Equipment

Event Date: 15th January 2013

BU: ERM Korea

Recommended Actions (cont'd)

Event Learning

Recommended Actions

Safety Moment

It is most common for ERM to begin business, staff, and client meetings with a "safety minute" – a simple review of a useful safety topic. These Safety Minutes are used to maintain high levels of safety awareness at every level in the company. Depending on topic and timing, these "minutes" can constitute a tangible and important part of our meetings.

Minerva – ERMs Intranet System

ERM leverages its *Minerva* intranet platform to facilitate on-line discussions and interaction regarding safety topics with our staff around the world. Topics include trends and issues identified from the ECS, Safety Alerts, recent news and similar communications from our clients. The headlines for these topics – our "Safety Moments" – are one of the first things visible when ERM staff turns on their computers each day.

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Annex 4.0

Light Survey

A4 LIGHT SURVEY

A4.1 Scope and Method

The scope and methodology of the light survey can be found in the *Baseline Method Statement (Annex 3.0)*, *Section 2.3.5.*

A4.1.1 LIGHT MEASUREMENT POINTS

Measurement of light levels was undertaken at selected points within each survey zone. The locations for the measurement have been selected based on the possibility of the area being affected by future Project lighting during construction and operation, and to develop a baseline that best represents existing light levels at the study area. Detailed rationale for the selection and description of each location is presented in *Table A4.1*. Readings from a total of 25 points have taken and the locations of these points are presented in *Figure A4.1*.

A4.1.2 LIGHT MEASUREMENT FINDINGS

The results of the light survey are presented in *Table A4.*2.

Table A4.1: Rationale for Selection and Description of Survey Points

Zone	Point	Justification	Description		
			Location	Extent of Visible Sky	Canopy Height
A	LA 01	Slightly on edge of development in Zone B, to capture any differences in light on nature reserve edge due to construction/development in B.	Located within the forest in Zone A, on a trail.	~ 15%	~10 m to 15 m
	LA 02	Capture differences in light on nature reserve edge from construction of hotel lodge.	Located within the forest in Zone A, on a trail.	~ 50%	Low lying shrub vegetation
	LA 03	Obtain baseline information on light levels in the forest interior. Can be used to assess how far light from development has penetrated forest/altered baseline conditions within forest.	Located within the forest in Zone A, on a trail.	Almost fully obscured	~10 m to 15 m
	LA 04	Measure light levels within a forest patch at a distance away from the project areas.	Point was shifted to the forest edge due to access constraints.	~25%	~ 6 m to 7 m
B	LB 01	Light levels at interface with road, park connector and forested edge.	In a clearing behind the WRS billboard.	~100%	~ 5 m to 10 m
	LB 02	Light levels within forest at zone B.	In a small forest clearing approximately 8 m away from Mandai Lake Road.	~40 %	High canopy but relatively closed
	LB 03	Light levels within forest at zone B.	Located within the Zone B forest, approximately 138 m away from Mandai Road.	Almost fully obscured	~ 5 m to 10 m

Zone	Point	Justification	Description		
			Location	Extent of Visible Sky	Canopy Height
D	LD01	Measure light levels at the road to compare against light levels due to increased traffic/enhanced lighting after development is complete.	Point is located along Mandai Lake Road.	~100%	Reading taken in open space along Mandai Lake Road
	LD02	Measure light levels at one of the points of lowest elevation in Zone D.	Point is located in a clearing.	~100%	Reading taken in open space
	LD03	Measure light levels at open area at zone D.	Point located in a clearing, along the edge of the forest patch in Zone D.	~100%	Reading taken in open space
	LD04	Measure light levels at fringe of the MINDEF firing range.	Overlooking the MINDEF firing range.	~ 80%	~10 m to 20 m
	LD 05	Measure light levels at one of the points of highest elevation in Zone D.	On a plateau within the Mandai Orchid Farm.	~100%	Reading taken in open space
E	LE01	Existing light levels along Mandai Lake Road experienced by CCNR forest.	Point located within the forest approximately 5 m away from Mandai Lake Road.	Almost fully obscured	~ 10 m
	LE02	On edge of development in Zone D, to capture any differences in light on nature reserve edge due to construction or development in D.	Within CCNR forest.	100% (new moon survey) 85% (full moon survey)	~5 m mostly but some tall trees at 15 m

Zone	Point	Justification	Description		
			Location	Extent of Visible Sky	Canopy Height
	LE03	Obtain baseline information on light levels in the forest interior. Can be used to assess how far light from development has penetrated forest/altered baseline conditions within forest in Zone E.	Within CCNR forest.	< 30%	~8-10 m
	LE04	Obtain baseline information on light levels in the forest interior. Can be used to assess how far light from development has penetrated forest/altered baseline conditions within forest in Zone E.	Within CCNR forest.	0% - 20%	8-12 m
	LE05	Obtain baseline information on light levels in the forest interior. Can be used to assess how far light from development has penetrated forest/altered baseline conditions within forest in Zone E.	Within CCNR forest.	0%	10-13 m
F	LF 01	Obtain understanding of existing light levels within a similar development.	This point is located at the entrance of the Tree Top Trail in the Singapore Zoo, opposite the otters.	~50 %	
	LF 02	To obtain an understanding of existing light levels within a similar development, under forest canopy.	This point is located on an unlit tram road in the Night Safari.	70 %	

Zone	Point	Justification	Description		
			Location	Extent of Visible Sky	Canopy Height
	LF 03	To obtain an understanding of existing light levels at a lit area within a similar development.	This point is located along Wallaby Trail at Night Safari.	~25%	~5 m to 10 m
	LF 04	To have more baseline data within the zoo/night safari at eventual built up areas.	This point is at the coach bay located opposite the Night Safari visitor plaza.	100%	None
	LF 05	To have more baseline data within the zoo/night safari at eventual built up areas.	This point is located beside the multi-storey carpark within WRS.	100%	
	LF 06	To have more baseline data within the zoo/night safari at eventual built up areas.	This point is located in side access road into the Singapore Zoo.	50%	~10 m – 15 m
	LF 07	To have more baseline data within the zoo/night safari at eventual built up areas.	This point is located on a dock in the middle of Upper Seletar Reservoir.	~100%	Reading taken in open space
	LF 08	To have more baseline data within the zoo/night safari at eventual built up areas.	This point is located near the WRS staff quarters.	~100%	

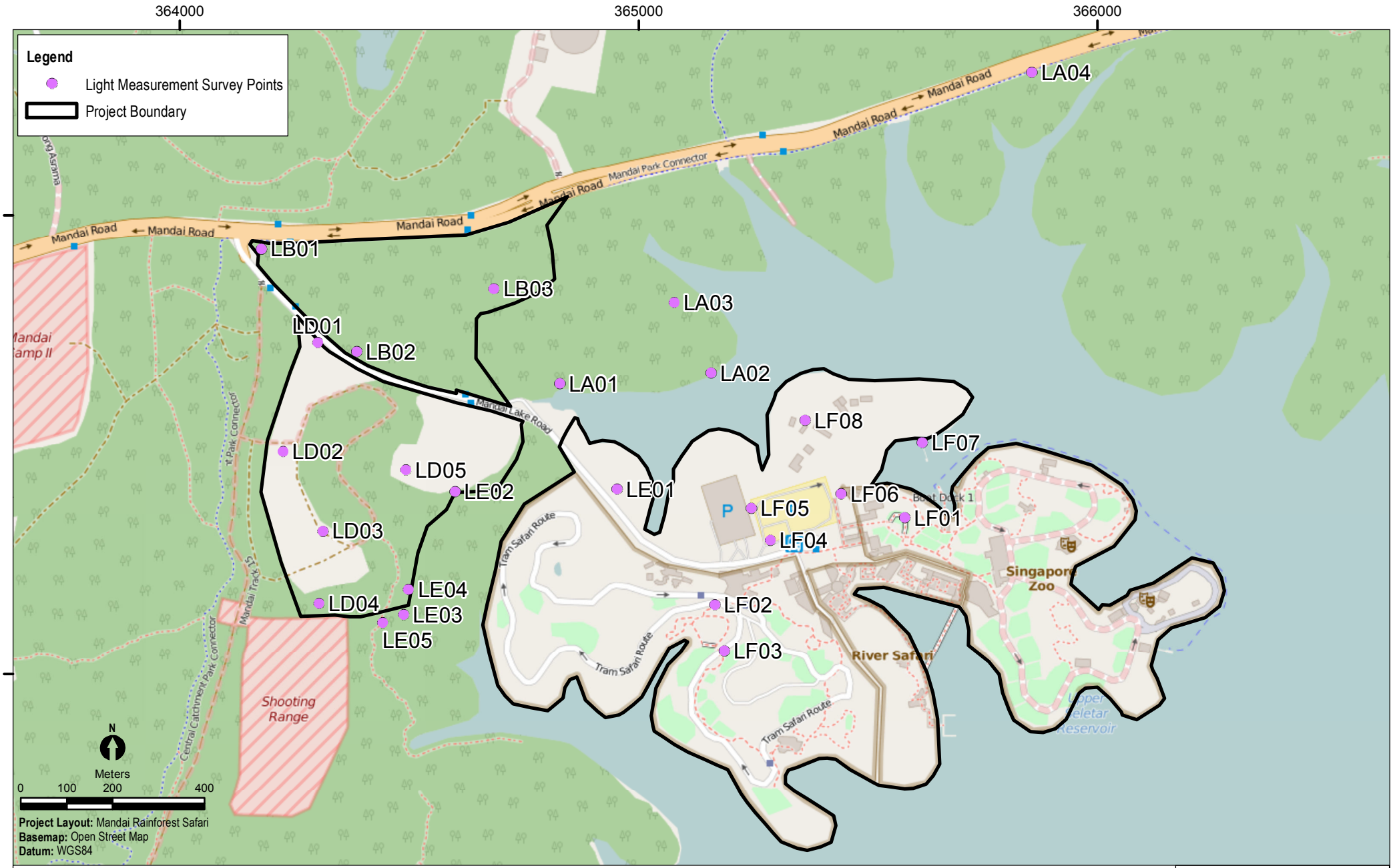


Figure A.1 Light Survey Locations

Service Layer Credits: OpenStreetMap (and) contributors, CC-BY-SA

Environmental Resources Management

ERM

Table A4.2: Light Survey Results

New Moon								Full Moon							
Baseline Survey Zone	ID	Average (Lux)			Okta [1]	Moon Fraction	Date	Zone	ID	Average (Lux)			Okta	Moon Fraction	Date
		First	Max	Min						First	Max	Min			
A	LA 01	0.00	0.00	0.00	7	0.00	16-Jul-15	A	LA 01	0.00	0.10	0.00	2	0.99	30-Jul-15
	LA 02	0.02	0.06	0.00	7	0.00	16-Jul-15		LA 02	0.05	0.34	0.03	2	0.99	30-Jul-15
	LA 03	0.00	0.01	0.00	4	0.00	16-Jul-15		LA 03	0.02	0.09	0.00	2	0.99	30-Jul-15
	LA 04	0.07	0.17	0.03	9	0.00	17-Jul-15		LA 04	0.06	0.16	0.04	9	0.99	30-Jul-15
B	LB 01	0.12	0.1	0.09	7	0.04	20-May-15	B	LB 01	0.74	0.82	0.62	5-6	0.99	2-Jun-15
	LB 02	0.03	0.00	0.00	7	0.04	20-May-15		LB 02	0.01	0.05	0.00	5	0.99	2-Jun-15
	LB 03	0.00	0.01	0.00	9	0.00	17-Jul-15		LB 03	0.01	0.26	0.00	9	0.99	30-Jul-15
D	LD 01	9.28	9.51	9.21	7	0.04	20-May-15	D	LD 01	14.41	14.56	14.14	4-5	0.99	2-Jun-15
	LD 02	0.02	0.02	0.00	8	0.04	15-Oct-15		LD 02	0.28	0.3	0.26	5	0.99	2-Jun-15
	LD 03	0.04	0.03	0.02	4	0.04	20-May-15		LD 03	0.24	0.24	0.21	5	0.99	2-Jun-15
	LD 04	0.04	0.04	0.00	2	0.00	17-Jul-15		LD 04	0.22	0.24	0.22	5	0.99	2-Jun-15
	LD 05	0.02	0.04	0.00	2	0.00	16-Jul-15		LD 05	0.18	0.25	0.16	2	0.99	30-Jul-15
E	LE 01	0.01	0.00	0.00	9	0.00	16-Jul-15	E	LE 01	0.07	0.07	0.00	8	0.99	30-Jul-15
	LE 02 [2]	0.01	0.03	0.00	0	0.04	15-Oct-15		LE 02	0.02	0.04	0.00	7	0.95	28-Aug-15
	LE 03	0.00	0.01	0.00	9	0.04	15-Oct-15		LE 03	0.01	0.06	0.00	2	0.95	28-Aug-15
	LE 04	0.00	0.00	0.00	9	0.04	15-Oct-15		LE 04	0.01	0.01	0.00	2	0.95	28-Aug-15
	LE 05	0.00	0.02	0.00	9	0.04	15-Oct-15		LE 05	0.03	0.03	0.00	8	0.95	28-Aug-15
F	LF 01	0.03	0.03	0.00	3	0.14	20-Jul-15	F	LF 01	0.02	0.05	0.01	7	0.91	3-Aug-15
	LF 02	0.05	0.06	0.05	7	0.17	22-May-15		LF 02	0.00	0.09	0.00	8	0.91	3-Aug-15
	LF 03	2.25	2.44	2.29	7	0.17	22-May-15		LF 03	0.01	0.03	0.00	8	0.91	3-Aug-15
	LF 04	1.94	2.24	1.87	0	0.04	15-Oct-15		LF 04	2.88	3.29	2.34	0	0.95	28-Aug-15
	LF 05	1.49	1.61	0.8	3	0.14	20-Jul-15		LF 05	1.18	1.19	1.16	7	0.91	3-Aug-15
	LF 06	0.02	0.03	0.03	3	0.14	20-Jul-15		LF 06	0.05	0.05	0.04	7	0.91	3-Aug-15
	LF 07	0.00	0.01	0.00	4	0.14	20-Jul-15		LF 07	0.25	0.11	0.09	7	0.91	3-Aug-15
	LF 08	0.00	0.02	0.00	3	0.14	20-Jul-15		LF 08	0.03	0.04	0.02	7	0.91	3-Aug-15

Notes:

[1] Measurement of cloud cover. The measurement values range from 0 to 8 oktas and can be broadly described as the following:

0 okta: Clear sky
1 – 2 oktas: Mostly clear
3 – 4oktas: Partly clear/ Scattered
5 – 6 oktas: Mostly cloudy
8 oktas: Cloudy/ Overcast

(2) Point LE 02 was shifted slightly on the day of the new moon survey as the original location was inaccessible due to tree fall.

Annex 4.1

Field Sheet

Point: LF 03

Weather
Cloudy

Date	3 Aug 2015
GPS	1° 24.148'N
	103° 47.292'E
Time	21:51

Moon Fraction	0.91

Okta (1-8)	8

Direction	**First**	**Max**	**Min**
Facing no entry sign	0.00	0.02	0.00
Facing exit	0.00	1.75	0.00
Facing exit (2nd reading)	0.00	0.33	0.00
Tram entrance	0	0	0
Exhibit	0	0.01	0

Observable Light Sources

- Sky 25% visible
- 2 orange short lamps by path
- 1 tall white street lamp (but covered by the canopy, ~10 m)
- Very cloudy, no moon visible although orange glow in sky visible

Point: LF 02

Weather
Cloudy

Date	3 Aug 2015
GPS	1° 24.203'N
	103° 47.280'E
Time	22:07

Moon Fraction	0.91

Okta (1-8)	8

Direction	**First**	**Max**	**Min**
Tram road	0.00	0.03	0.00
White tiger	0.02	0.02	0.00
Man zoo	0.01	0.03	0.00
Wallaby trail	0.00	0.02	0.00

Observable Light Sources

- White light filtering in through bushes
- Green map board filtering through
- Sky approx. 70% visible

Point: LF 01

Weather
Cloudy

Date	3 Aug 2015
GPS	1° 24.306'N
	103°47.504'E
Time	22:29

Moon Fraction	0.91

Direction	First	Max	Min
Zoo	0.03	0.09	0.01
Otter	0.02	0.04	0.01
Buggy	0.02	0.03	0.01
TTW	0.02	0.05	0.02

Okta (1-8)	7

Observable Light Sources
• Faint light from walkway sheltered • Orange glow in sky

Point: LF 07

Weather
Cloudy

Date	3 Aug 2015
GPS	1° 24.395'N
	103° 7.524'E
Time	22:40

Moon Fraction	0.91

Okta (1-8)	7

Direction	**First**	**Max**	**Min**
Hut	0.09	0.11	0.10
Reservoir	0.12	0.10	0.08
Back	0.10	0.10	0.09
Railing	0.09	0.11	0.08

Observable Light Sources

- Orange glow in sky
- Some lighting from service road, approx. 200 m away

Point: LF 06

Weather
Cloudy

Date	3 Aug 2015
GPS	1° 24.334'N
	103° 7.429'E
Time	22:47

Moon Fraction	0.91

Okta (1-8)	7

Direction	**First**	**Max**	**Min**
Taxi	0.06	0.06	0.04
Office	0.05	0.05	0.04
Back of house	0.01	0.02	0.01
Bamboo	0.07	0.07	0.06

Observable Light Sources

- Sky approx. 50% obstructed by approx. 10 m tall trees
- Intermittent headlight (4x) from vehicle
- Lights from carpark office
- Orange glow in sky

Point: LF 08

Weather
Cloudy

Date	3 Aug 2015
GPS	1° 4.421'N
	103° 7.386'E
Time	22:54

Moon Fraction	0.91

Okta (1-8)	7

Direction	**First**	**Max**	**Min**
Where buggy came from	0.02	0.03	0.02
Facing away from shed	0.04	0.05	0.02
Buggy parking	0.04	0.05	0.03
Shed	0.02	0.03	0.01

Observable Light Sources
• Orange glow • Short orange light x3 • Tall white light x2

Point: LF 05

Weather
Cloudy

Date	3 Aug 2015
GPS	1° 24.317'N
	103° 47.323'E
Time	22:59

Moon Fraction	0.91

Direction	First	Max	Min
Carpark	0.81	0.68	0.67
Back of house	1.9	1.97	1.96
Multi storey carpark	1.06	1.11	1.07
Night Safari entrance	0.94	1.01	0.95

Okta (1-8)	7

Observable Light Sources
• Artificial lighting – many street lamps and intermittent headlights • Orange glow in sky

Point: LE 01

Weather
Fair

Date	30 Jul 2015
GPS	1° 4.339'N
	103° 7.166'E
Time	22:00

Moon Fraction	99.0

Direction	First	Max	Min
Facing away from zoo	0.00	0.00	0.00
MLR	0.00	0.00	0.00
Zoo	0.07	0.17	0.00
Forest	0.19	0.10	0.00

Okta (1-8)	8

Observable Light Sources
• Street lamps filtering in • Some moonlight but sky was mostly obscured by trees, approx. 10 m tall

Point: LA 03

Weather
Fair

Date	30 Jul 2015
GPS	1° 4.560'N
	103° 7.233'E
Time	22:30

Moon Fraction	99.0

Okta (1-8)	2

Direction	**First**	**Max**	**Min**
Zoo	0.00	0.11	0.00
Away from zoo	0.00	0.04	0.00
Forest	0.07	0.16	0.00
MLR	0.00	0.04	0.00

Observable Light Sources

- Canopy approx. 10-15 m tall
- Moonlight filtering through forest
- Starlight

Point: LA 02

Weather
Fair

Date	30 Jul 2015
GPS	1° 24.477'N
	103° 47.276'E
Time	22:40

Moon Fraction	99.0

Direction	First	Max	Min
Zoo	0.12	5.43	0.00
Zoo (2nd reading)	0.11	0.44	0.12
Away from MLR	0.00	0.12	0.00
Away from zoo	0.00	0.56	0.00
MLR	0.09	0.23	0.00

Okta	2
(1-8)	

Observable Light Sources
• Moonlight directly visible, very bright • Some starlight but not significant

Point: LA 01

Weather
Fair

Date	30 Jul 2015
GPS	1° 4.465'N
	103° 7.098'E
Time	23:05

Moon Fraction	99.0

Direction	First	Max	Min
Zoo	0.00	1.09	0.00
Zoo (2nd reading)	0.00	0.17	0.00
Away from MLR	0.01	0.04	0.00
Away from zoo	0.00	0.02	0.00
MLR	0.00	0.18	0.00

Okta	2
(1-8)	

Observable Light Sources
• Sky obscured partially, 85% • Standing in patch of forest where moonlight is filtering in • Canopy high, approx. 10-15 m

Point: LD 05

Weather
Fair

Date	30 Jul 2015
GPS	1° 4.362'N
	103°46.917'E
Time	23:20

Moon Fraction	99.0

Direction	First	Max	Min
MLR	0.19	0.26	0.19
Durian camp	0.13	0.21	0.07
FR	0.20	0.24	0.19
Zone E	0.20	0.29	0.18

Okta (1-8)	2

Observable Light Sources
• Moonlight, sky was unobstructed by any trees • Starlight. Some street lighting (orange) from MLR, but moon had veil of clouds in front of it

Point: LB 03

Weather
Fair

Date	30 Jul 2015
GPS	1° 24.577'N
	103° 47.021'E
Time	23:50

Moon Fraction	99.0

Direction	First	Max	Min
MR	0.04	0.00	0.00
MR (2nd reading)	0.00	0.35	0.00
MR (3rd reading)	0.03	0.37	0.00
CCK	0.00	0.50	0.00
Away from MR	0.00	0.10	0.00
Yishun	0.00	0.08	0.00

Okta	Obstructed
(1-8)	

Observable Light Sources
• Moonlight filtering through gaps in canopy • Mousedeer x2 at original spot

Point: LA 04

Weather
Fair

Date	30 Jul 2015
GPS	1° 24.833'N
	103° 47.653'E
Time	00:30

Moon Fraction	99.0

Direction	First	Max	Min
MLR	0.00	0.06	0.00
CCK	0.00	0.18	0.00
Away from MLR	0.08	0.03	0.00
Yishun	0.14	0.36	0.17

Okta (1-8)	2

Observable Light Sources
• Approx. 25% of sky visible; canopy • Streetlamps from MLR (orange) filtering in • Moonlight (slight) • Wild boar on pavement

Point: LF 08

Weather
Fair

Date	20 Jul 2015
GPS	1° 24.421'N
	103° 47.386'E
Time	21:50

Moon Fraction	0.14

Okta (1-8)	3

Direction	**First**	**Max**	**Min**
Forest	0.00	0.00	0.00
Facing white light	0.00	0.06	0.00
Facing low orange light	0.00	0.01	0.00
Facing white light	0.00	0.01	0.00

Observable Light Sources

- Soft white street lamp approx. 3 m tall (x2)
- Low orange light (x4) some hidden within vegetation, light is angled downward.
- Starlight

Point: LF 05

Weather
Fair

Date	20 Jul 2015
GPS	1° 24.317'N
	103° 47.323'E
Time	22:10

Moon Fraction	0.14

Direction	**First**	**Max**	**Min**
NS	2.03 (1.37 – 2nd reading)	1.36	1.29
CP	0.92	1.33	0.36
Back	1.48	2.01	0.80
Zoo	1.54	1.74	0.74

Okta (1-8)	3

Observable Light Sources
• Street lighting (white light) • Intermittent car headlights • Carpark orange lighting • Night safari lights

Point: LF 06

Weather
Fair

Date	20 Jul 2015
GPS	1° 24.334'N
	103° 47.429'E
Time	22:14

Moon Fraction	0.14

Direction	First	Max	Min
Forest	0	0	0
CO	0.02	0.02	0.02
Taxi	0.02	0.02	0.01
Bamboo	0.03	0.06	0.08

Okta (1-8)	3

Observable Light Sources
• Faint light from corporate office. • Sky partially obscured by trees ~15m high.

Point: LF 07

Weather
Fair

Date	20 Jul 2015
GPS	1° 24.395'N
	103° 47.524'E
Time	22:23

Moon Fraction	0.14

Direction	First	Max	Min
Dock	0.01	0.02	0.00
Forest	0	0	0
WWT	0	0	0
Reservoir	0	0	0

Okta (1-8)	4

Observable Light Sources

- Starlight, faint but numerous.
- Some streetlights across reservoir but more than 200 m away.

Point: LF 01

Weather
Fair

Date	20 Jul 2015
GPS	1° 24.306'N
	103° 47.504'E
Time	22:30

Moon Fraction	0.14

Okta (1-8)	3

Direction	**First**	**Max**	**Min**
Treetop walk	0	0.03	0
Forest signboard	0.05	0.00	0.00
Linkway	0.05	0.02	0.00
Zoo entrance	0.00	0.07	0.00

Observable Light Sources

- Faint light at the shrubbery
- Lighting from linkway although more than 15 m away (white)
- Retail lighting at zoo entrance

Point: LD 04

Weather
Fair

Date	17 Jul 2015
GPS	1° 24.204'N
	103° 46.815'E
Time	00:05

Moon Fraction	0.00

Direction	First	Max	Min
Forest	0.08	0.03	0.00
Forest (2nd reading)	0.00	0.04	0.00
FR	0.03	0.04	0.00
Zone C	0.03	0.05	0.00
Away from FR	0.00	0.04	0.00

Okta	2
(1-8)	

Observable Light Sources
• Starlight dim, but numerous • Streetlight from FR, 5 visible

Point: LB 03

Weather
Fair

Date	17 Jul 2015
GPS	1° 24.577'N
	103° 47.021'E
Time	00:50

Moon Fraction	0.00

Direction	**First**	**Max**	**Min**
Zone A end	0.00	0.04	0.00
Away from MR	0.00	0.04	0.00
Entrance	0.00	0.04	0.00
MR	0.00	0.01	0.00

Okta (1-8)	

Obscured by canopy ~5-10 m tall

Observable Light Sources

Point: LA 04

Weather
Fair

Date	17 Jul 2015
GPS	1° 24.833'N
	103° 47.653'E
Time	01:20

Moon Fraction	0.00

Direction	First	Max	Min
Dune	0	0	0
MLR	0	0.35	0.00
MR	0.27	0.29	0.12
Yishun	0.02	0.03	0.00

Okta (1-8)	-

Sky obscured by canopy ~6-7m

Observable Light Sources
• Streetlamp – orange (MLR) • ~5m away from streetlamps

Point: LE 01

Weather
Fair Rained ~2hrs prior

Date	16 Jul 2015
GPS	1° 4.339'N
	103° 7.166'E
Time	22:10

Moon Fraction	0.00

Okta (1-8)	4

Sky obstructed by trees ~10m

Direction	First	Max	Min
Away from MLR	0.01	0.00	0.00
Zoo	0.00	0.00	0.00
MLR	0.00	0.00	0.00
MR	0.02	0.00	0.00

Observable Light Sources

- Starlight
- Streetlamps from Mandai Lake Road
- Intermittent headlamps from passing vehicles
- Light from road filters through trees up to distance of ~7m

Point: LA 03

Weather
Fair Rained ~2hrs prior

Date	16 Jul 2015
GPS	1° 4.560'N
	103° 7.233'E
Time	22:40

Moon Fraction	0.00

Okta (1-8)	4

Sky obstructed by trees ~10-15 m

Direction	First	Max	Min
Zoo	0.00	0.02	0.00
Away from MLR	0.00	0.00	0.00
Away from Zoo	0.00	0.02	0.00
MLR	0.00	0.01	0.00

Observable Light Sources
• None

Point: LA 02

Weather
Cloudy

Date	16 Jul 2015
GPS	1° 24.477'N
	103° 47.276'E
Time	22:57

Moon Fraction	0.00

Direction	First	Max	Min
Zoo	0.00	0.07	0.00
MLR	0.06	0.04	0.00
Away from zoo	0.00	0.07	0.00
Away from MLR	0.00	0.06	0.00

Okta (1-8)	7

Sky ~50% obscured by low lying vegetation

Observable Light Sources
• At reservoir's edge, zoo glow visible • Sky cloudy, no starlight

Point: LA 01

Weather

Date	16 Jul 2015
GPS	1° 4.465'N
	103° 7.098'E
Time	23:20

Moon Fraction	0.00

Direction	First	Max	Min
MLR	0.00	0.00	0.00
Entrance to A	0.00	0.00	0.00
Away from MLR	0.00	0.00	0.00
Forest	0.00	0.00	0.00

Okta (1-8)	7

Sky obstructed by tall canopy ~20m

Observable Light Sources
• Streetlamps from MLR barely visible through vegetation

Point: LD 05

Weather

Date	16 Jul 2015
GPS	1° 4.362'N
	103°46.917'E
Time	23:40

Moon Fraction	0.00

Okta (1-8)	2

Unobstructed sky. Not cloudy

Direction	First	Max	Min
MLR	0.03	0.05	0.00
Zone E	0.04	0.05	0.00
Away from MLR	0.00	0.02	0.00
Durian camp	0.00	0.03	0.00

Observable Light Sources

- Streetlight – very little and dim
- Streetlamps visible from MLR
- Orange glow in sky towards durian camp and away from MLR
- Orange glow from top of plateau

Point: LD 04

Weather
Partially cloudy

Date	2 June 2015
GPS	1° 24.204'N
	103° 46.815'E
Time	22:40

Moon Fraction	0.99

Okta (1-8)	5

Clear, open space. Some partial vegetation approx. 10-20m tall obstructing sky by 20%

Direction	First	Max	Min
FR	0.23	0.25	0.22
Forest	0.28	0.27	0.25
PCN	0.23	0.23	0.20
Face away	0.20	0.20	0.19

Observable Light Sources
• Moonlight • Streetlamps

Point: LD 03

Weather
Partially cloudy

Date	2 June 2015
GPS	1° 24.289'N
	103° 46.820'E
Time	22:55

Moon Fraction	0.99

Direction	First	Max	Min
FR	0.27	0.27	0.20
Forest	0.22	0.25	0.23
PCN	0.24	0.22	0.21
Face away	0.22	0.23	0.21

Okta (1-8)	5

Open space, clear. Sky unobscured.

Observable Light Sources
• Moonlight • Streetlamps

Point: LB 01

Weather
Partially cloudy

Date	2 June 2015
GPS	1° 24.624'N
	103° 46.747'E
Time	23:34

Moon Fraction	0.99

Okta (1-8)	5-6

Direction	**First**	**Max**	**Min**
MLR	0.75	0.82	0.50
MR (away from CCK)	0.52	0.57	0.46
PCN	0.74	0.82	0.74
MR (CCK)	0.95	1.06	0.79 (may be getting street light)

Observable Light Sources

- Moon observed by clouds
- White PCN light ~10m away
- Orange streetlamps lining MLR and MR
- Some vegetation (low level, 5-10m tall) obscuring lights

Point: LD 01

Weather
Partially cloudy

Date	2 June 2015
GPS	1° 24.513'N
	103° 46.814'E
Time	23:20

Moon Fraction	0.99

Direction	First	Max	Min
MLR	16.3	16.42	15.37
Mandai Road	13.95	14.33	13.98
Zone D	13.70	13.54	13.19
Zoo	13.67	13.83	13.71

Okta (1-8)	4-5

By the road side. Overhead streetlamps and tall trees lining the road

Observable Light Sources
• Moonlight • Streetlamps • Intermittent headlights of vehicles

Point: LB 02

Weather
Partially cloudy

Date	2 June 2015
GPS	1° 24.502'N
	103° 46.859'E
Time	23:27

Moon Fraction	0.99

Okta (1-8)	5

Sky 60% obscured by trees. Within the forest

Direction	First	Max	Min
MLR	0.02	0.14	0.00
Zoo	0.00	0.01	0.00
Forest	0.00	0.02	0.00
Mandai Road	0.01	0.01	0.00

Observable Light Sources
• Streetlight • Moonlight partially obscured by trees

Point: LD 02

Weather
Partially cloudy

Date	2 June 2015
GPS	1° 24.384'N
	103° 46.773'E
Time	23:05

Moon Fraction	0.99

Okta (1-8)	5

At open area, low elevation

Direction	First	Max	Min
PCN	0.28	0.31	0.26
Away from MLR	0.28	0.29	0.26
Away from PCN	0.29	0.31	0.26
MLR	0.27	0.29	0.25

Observable Light Sources

- Moonlight very bright, not obscured
- Streetlamps approx. 600-900 m away

Point: LF 02

Weather
Cloudy

Date	22 May 2015
GPS	1° 24.203'N
	103° 47.280'E
Time	21:07

Moon Fraction	0.17

Okta (1-8)	7

Direction	**First**	**Max**	**Min**
Facing Wallaby trail	0.06	0.06	0.06
Zebra crossing	0.05	0.07	0.04
Facing lions	0.04	0.05	0.04
Facing road	0.05	0.07	0.05

Observable Light Sources

- Some minimal light perceivable from location; blocked out by vegetation
- Fairly dark, but sky had orange glow similar to what was observed at LB 01

Point: LF 03

Weather
Cloudy

Date	22 May 2015
GPS	1° 24.148'N
	103° 47.292'E
Time	20:48

Moon Fraction	0.17

Okta (1-8)	7

Direction	**First**	**Max**	**Min**
Facing tram road	1.31	1.63	1.31
Facing trail (out)	0.60	0.60	0.53
Facing dark – no entry sign	3.14	3.24	3.18
Exhibit	6.88	6.01	5.22
Exhibit (2nd reading)	3.93	4.28	4.12

Observable Light Sources

- One white light 4 m overhead, strong lighting.
- Short light orange angled downwards, < 1m tall lining the trail.
- Exhibit light partly visible from location.
- Sky partially obscured by surrounding vegetation of height approx. 5-7 m.

Point: LD 03

Weather
Cloudy

Date	20 May 2015
GPS	1° 24.289'N
	103° 46.820'E
Time	23:04

Moon Fraction	0.04

Direction	First	Max	Min
Facing road	0.00	0.03	0.00
Facing zoo	0.02	0.02	0.07
Facing range	0.09	0.03	0.00
Away from zoo	0.03	0.05	0.02

Okta (1-8)	4

Fairly clear skies with visible stars

Observable Light Sources
• Starlight • Streetlamp (from range)

Point: LD 01

Weather
Cloudy

Date	20 May 2015
GPS	1° 24.513'N
	103° 46.814'E
Time	23:34

Moon Fraction	0.04

Direction	First	Max	Min
Facing road	7.43	8.40	8.21
Zoo	9.25	9.81	9.40
Away from road	11.87	11.77	11.52
Mandai road	8.28	8.06	7.69

Okta (1-8)	7

Observable Light Sources
• Streetlamps lining Mandai Lake Road • Less starlight, obscured by clouds

Point: LB 02

Weather
Cloudy

Date	20 May 2015
GPS	1° 24.502'N
	103°46.859'E
Time	23:39

Moon Fraction	0.04

Direction	First	Max	Min
Zoo	0.12	0.00	0.00
Mandai Lake Road	0.00	0.00	0.00
Mandai Road	0.00	0.00	0.00
Forest	0.00	0.00	0.00

Okta (1-8)	7

Observable Light Sources
• Streetlamp visible from direction facing Mandai Lake Road • High canopy but relatively closed

Point: LB 01

Weather
Cloudy

Date	20 May 2015
GPS	1° 24.624'N
	103° 46.747'E
Time	23:50

Moon Fraction	0.04

Okta (1-8)	7

Direction	**First**	**Max**	**Min**
Mandai Road	0.15	0.21	0.17
Left	0.24	0.18	0.17
Forest	0.01	0.01	0.00
Mandai Lake Road	0.07	0.01	0.01

Observable Light Sources

- Streetlamp along Mandai Lake Road and Mandai Road
- Relatively bright white light from park connector lamps at Mandai Road direction (single lamp perceivable)

Point: LE 03

Weather
Fair

Date	15 Oct 2015
GPS	1° 24.221'N
	103° 46.920'E
Time	21:05

Moon Fraction	0.04

Direction	First	Max	Min
Facing zoo	0.00	0.05	0.00
-	0.00	0.00	0.00
-	0.00	0.00	0.00
-	0.00	0.00	0.00

Okta (1-8)	9

Observable Light Sources

- Canopy height 8 m
- Sky obscured by tree cover of 70- 90%
- Faint orange glow in the sky
- No artificial light sources observed
- No moonlight, no starlight

Point: LE 05

Weather
Fair

Date	15 Oct 2015
GPS	1° 24.181'N
	103° 46.890'E
Time	21:35

Moon Fraction	0.04

Okta (1-8)	9

Direction	First	Max	Min
-	0.00	0.00	0.00
	0.00	0.00	0.00
	0.00	0.07	0.00
	0.00	0.00	0.00

Observable Light Sources

- No observable artificial light
- Obscured, canopy cover 100%

Point: LF 04

Weather
Fair

Date	15 Oct 2015
GPS	1° 24.279'N
	103° 47.346'E
Time	22:30

Moon Fraction	0.04

Direction	First	Max	Min
	2.01	2.07	1.93
	1.56	1.89	1.52
	1.67	2.28	1.94
	2.51	2.72	2.08

Okta (1-8)	0

Observable Light Sources

- Light from carpark (bright, white light) lamps approx. 3 m tall
- Light from coach shelter bay (small white light, square shaped and angled outwards, slightly downwards)
- Canopy cover 0
- Some bushes blocking carpark lamps slightly

Point: LD 02

Weather
Fair

Date	15 Oct 2015
GPS	1° 24.384'N
	103° 46.773'E
Time	21:50

Moon Fraction	0.04

Okta (1-8)	2

Direction	**First**	**Max**	**Min**
Facing zoo	0.02	0.02	0.00
Facing firing range	0.01	0.02	0.01
Facing Zone C	0.02	0.02	0.00
Facing stream (Mandai Lake Road)	0.01	0.02	0.00

Observable Light Sources
• Open canopy, 0% coverage • No artificial light sources observable

Point: LE 04

Weather
Fair

Date	15 Oct 2015
GPS	1° 24.191'N
	103° 46.915'E
Time	21:20

Moon Fraction	0.04

Direction	First	Max	Min
-	0.00	0.00	0.00
-	0.00	0.00	0.00
-	0.00	0.00	0.00
-	0.00	0.01	0.00

Okta (1-8)	9

Observable Light Sources

- No observable light sources
- Completely obscured by canopy at 100%
- Canopy height 8-12 m

Point: LE 02

Weather
Fair

Date	15 Oct 2015
GPS	1° 24.336'N
	103° 46.975'E
Time	22:13

Moon Fraction	0.04

Direction	First	Max	Min
-	0.02	0.03	0.00
-	0.00	0.01	0.00
-	0.01	0.04	0.00
-	0.01	0.02	0.00

Okta (1-8)	0

Observable Light Sources
• Some light from Mandai Lake Road but approximately 500 m away and indistinct • No canopy cover (0%) • White glow in sky from direction of woodlands • Note that this point position is slightly different from LE 02 during full moon. Original point location could not be accessed due to fallen trees.

Point: LE 02

Weather
Cloudy

Date	28 Aug 2015
GPS	1° 24.336'N
	103° 46.975'E
Time	21:11

Moon Fraction	0.95

Okta (1-8)	7

Direction	**First**	**Max**	**Min**
Facing zoo	0.01	0.03	0.00
Facing away from tower	0.04	0.00	0.00
Facing zone D	0.00	0.04	0.00
Facing towers	0.01	0.07	0.00

Observable Light Sources

- Vegetation approx. 5 m, but some tall trees at 15 m
- Full moon but clouds obscured the moon
- Sky visibility 85%.

Point: LE 04

Weather
Cloudy

Date	28 Aug 2015
GPS	1° 24.191'N
	103° 46.915'E
Time	21:30

Moon Fraction	0.95

Okta (1-8)	3

Direction	First	Max	Min
-	0.00	0.00	0.00
-	0.00	0.01	0.00
-	0.05	0.03	0.00
-	0.00	0.00	0.00

Observable Light Sources

- Moonlight filtering through the canopy.
- Dense canopy of about 10 m tall.
- Sky visibility 20%.

Point: LE 03

Weather
Cloudy

Date	28 Aug 2015
GPS	1° 24.221'N
	103° 46.920'E
Time	21:44

Moon Fraction	0.95

Okta (1-8)	2

Direction	**First**	**Max**	**Min**
-	0.03	0.12	0.00
-	0.01	0.09	0.00
-	0.00	0.02	0.00
-	0.00	0.00	0.00

Observable Light Sources

- Canopy height approx. 10 m and sky visibility 30%.
- Moonlight filtering through, dense canopy overhead.

Point: LF 04

Weather
Fair

Date	28 Aug 2015
GPS	1° 24.279'N
	103° 47.346'E
Time	20:26

Moon Fraction	0.95

Direction	First	Max	Min
Facing Night safari	3.14	3.63	2.41
Facing Multi-storey carpark	2.86	2.45	1.85
Facing parked vans	2.17	2.31	1.85
Facing coach bay	3.33	4.77	3.25

Okta (1-8)	8

Observable Light Sources

- Visitor plaza lighting
- Carpark white light but partially obscured by short trees
- Lights from coach bay
- Clear open sky, 100% visible.

Point: LE 05

Weather
Fair

Date	28 Aug 2015
GPS	1° 24.181'N
	103° 46.890'E
Time	21:55

Moon Fraction	0.95

Direction	First	Max	Min
-	0.09	0.08	0.00
-	0.02	0.02	0.00
-	0.02	0.01	0.00
-	0.00	0.01	0.00

Okta (1-8)	8

Observable Light Sources

- Right on fringe of Zone D and E
- Partially obscured by canopy but some light filtering in strongly.
- White glow in sky in direction of woodlands and kranji.
- 35% sky visibility
- 10-13m canopy height.

Annex 5.0

Air Quality Survey Results

Figure A5.1 Photographs of Air Quality Survey Locations

Annex 5.1

Round 1 Survey Results
(24 July – 18 August 2015)

Table A5.1 Measurements at AQ01 (Round 1)

Emission Sources: Vehicular traffic along Mandai Road; evidence of grass cutting activities on Day 5

Description	DustTrak II Meter Findings							
	Day 1 (wkend)	Day 2 (wkend)	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
	1/8/2015	2/8/2015	3/8/2015	4/8/2015	5/8/2015	6/8/2015	7/8/2015	8/8/2015
Filter ID	218	220	222	224	226	228	230	232
Min. Conc (mg/m3)	7	5	5	13	15	11	4	2
Max. Conc (mg/m3)	45	31	139	43	109	52	37	34
Average Conc (mg/m3)	22	14	17	21	23	27	22	17
Gravimetric Results (mg/m3)	0	63	52	56	56	0	52	38

Table A5.2 Measurements at AQ02 (Round 1)

Emission Sources: Distant vehicular traffic along Mandai Lake Road and within the Night Safari amphitheatre compound/tram trail; construction works outside the Night Safari Amphitheatre compound

Description	DustTrak II Meter Findings							
	Day 1	Day 2	Day 3	Day 4	Day 5 (wkend)	Day 6 (wkend)	Day 7	Day 8
	11/8/2015	12/8/2015	13/8/2015	14/8/2015	15/8/2015	16/8/2015	17/8/2015	18/8/2015
Filter ID	234	236	238	240	242	271	273	N/A
Min. Conc (mg/m3)	8	8	6	11	15	11	6	
Max. Conc (mg/m3)	40	54	46	341	27	29	51	
Average Conc (mg/m3)	22	27	18	19	19	15	17	
Gravimetric Results (mg/m3)	38	52	35	28	17	17	21	

Table A5.3 Measurements at AQ03 (Round 1)

Emission Sources: None

Description	DustTrak II Meter Findings							
	Day 1 (wkend)	Day 2 (wkend)	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
	1/8/2015	2/8/2015	3/8/2015	4/8/2015	5/8/2015	6/8/2015	7/8/2015	8/8/2015
Filter ID	219	221	223	225	227	-	231	229
Min. Conc (mg/m3)	4	5	4	12	11	10	0	1
Max. Conc (mg/m3)	35	827	32	31	44	28	26	29
Average Conc (mg/m3)	18	14	13	17	19	21	18	16
Gravimetric Results (mg/m3)	35	0	35	35	28	0	31	28

KEY

	Null data due to meter error
	Highest recorded data over survey period
XXX	Exceeds 24 hr PM10 limit of 0.050 mg/m3

Table A5.4 Measurements at AQ04 (Round 1)

Emission Sources: Vehicular traffic along Mandai Lake Road; evidence of grass cutting activities on Day 5

Description	DustTrak II Meter Findings							
	Day 1	Day 2 (wkend)	Day 3 (wkend)	Day 4	Day 5	Day 6	Day 7	Day 8
	24/7/2015	25/7/2015	26/7/2015	27/7/2015	28/7/2015	29/7/2015	30/7/2015	31/7/2015
Filter ID	201	203	205	207	209	211	213	215
Min. Conc (mg/m3)	19	0	18	20	15	15	14	35
Max. Conc (mg/m3)	136	143	128	102	631	88	123	399
Average Conc (mg/m3)	55	38	43	50	27	33	50	61
Gravimetric Results (mg/m3)	21	39	49	28	42	38	49	45

Table A5.5 Measurements at AQ05 (Round 1)

Emission Sources: Vehicles used by military or public users of the nearby gravel road

Description	DustTrak II Meter Findings							
	Day 1	Day 2 (wkend)	Day 3 (wkend)	Day 4	Day 5	Day 6	Day 7	Day 8
	24/7/2015	25/7/2015	26/7/2015	27/7/2015	28/7/2015	29/7/2015	30/7/2015	31/7/2015
Filter ID	202	204	206	208	210	212	214	216
Min. Conc (mg/m3)	17	17	12	14	6	9	10	28
Max. Conc (mg/m3)	112	69	106	66	71	78	130	101
Average Conc (mg/m3)	52	31	35	39	17	23	43	56
Gravimetric Results (mg/m3)	28	35	42	31	31	31	45	38

Table A5.6 Measurements at AQ06 (Round 1)

Emission Sources: Vehicles within the WWTP compound

Description	DustTrak II Meter Findings							
	Day 1	Day 2	Day 3	Day 4	Day 5 (wkend)	Day 6 (wkend)	Day 7	Day 8
	11/8/2015	12/8/2015	13/8/2015	14/8/2015	15/8/2015	16/8/2015	17/8/2015	18/8/2015
Filter ID	233	235	237	239	241	270	272	N/A
Min. Conc (mg/m3)	9	8	7	11	15	12	8	N/A
Max. Conc (mg/m3)	41	56	66	162	132	26	50	N/A
Average Conc (mg/m3)	23	28	19	18	19	16	17	N/A
Gravimetric Results (mg/m3)	35	49	38	28	21	21	24	N/A

KEY

	Null data due to meter error
	Highest recorded data over survey period
XXX	Exceeds 24 hr PM10 limit of 0.050 mg/m3
	Rainfall event

Figure A5.2 Graphs of PM_{10} Concentrations over Time (Round 1 Survey at AQ01)

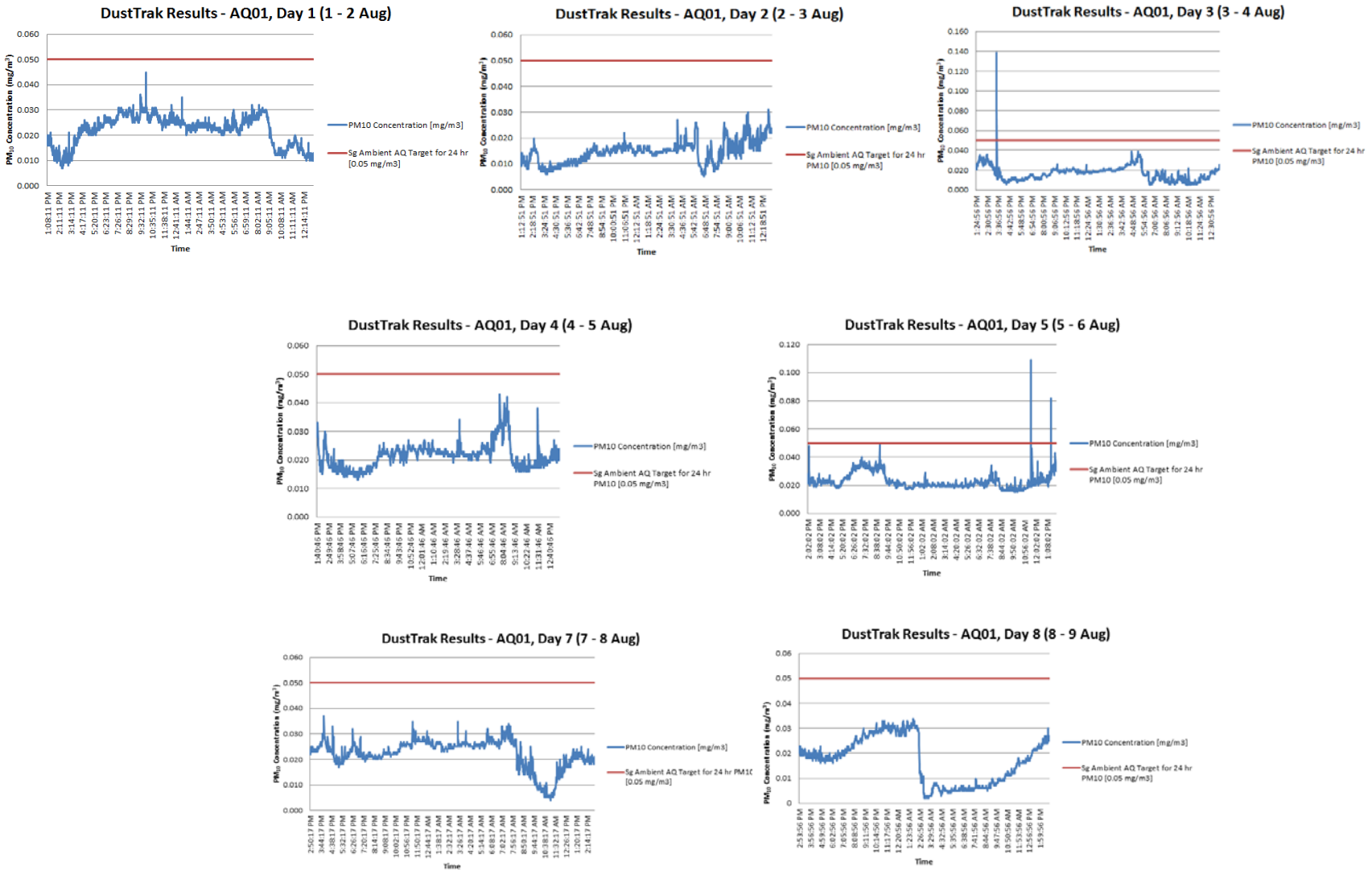


Figure A5.3 Graphs of PM_{10} Concentrations over Time (Round 1 Survey at AQ02)

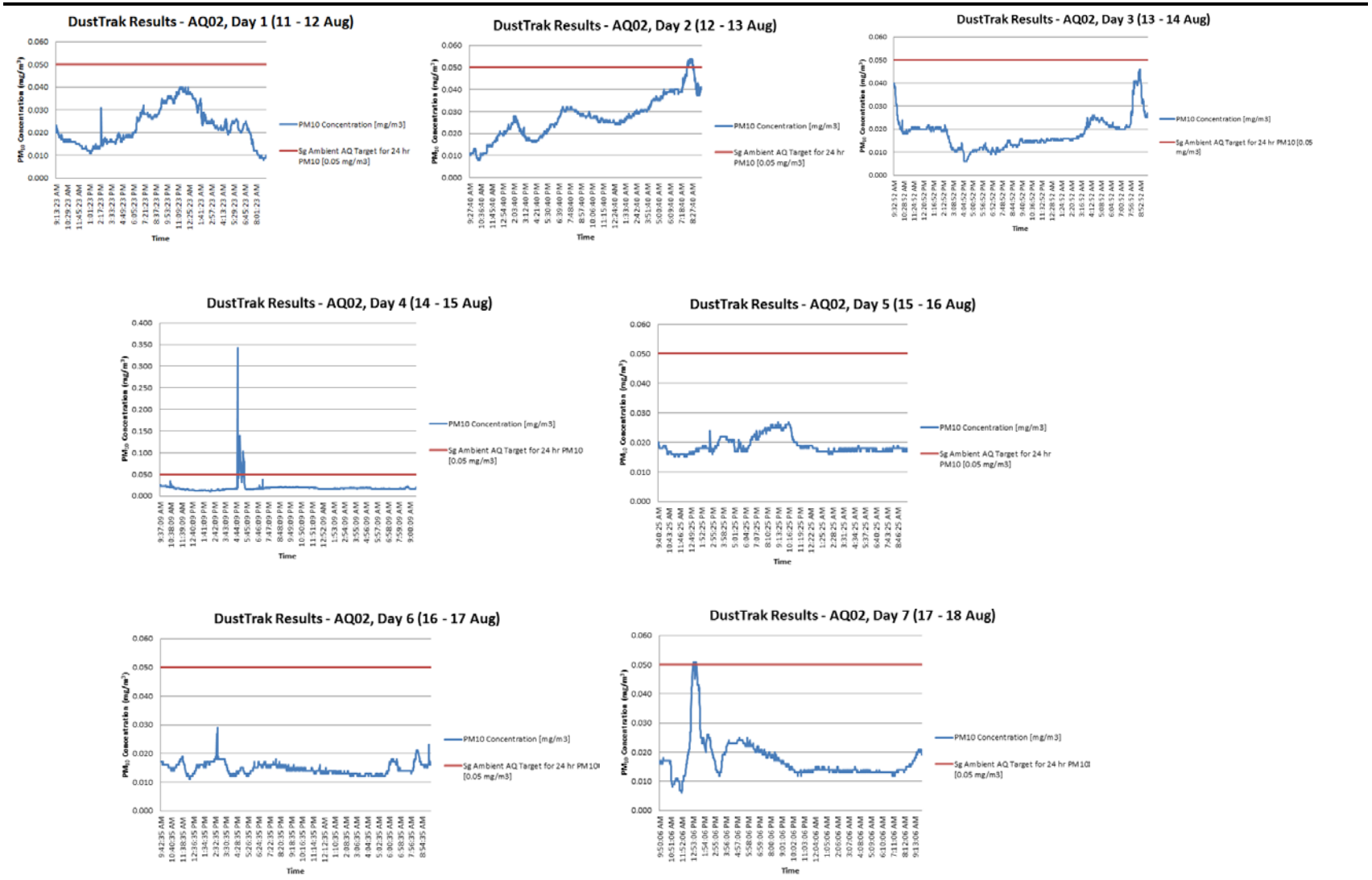


Figure A5.4 Graphs of PM10 Concentrations over Time (Round 1 Survey at AQ03)

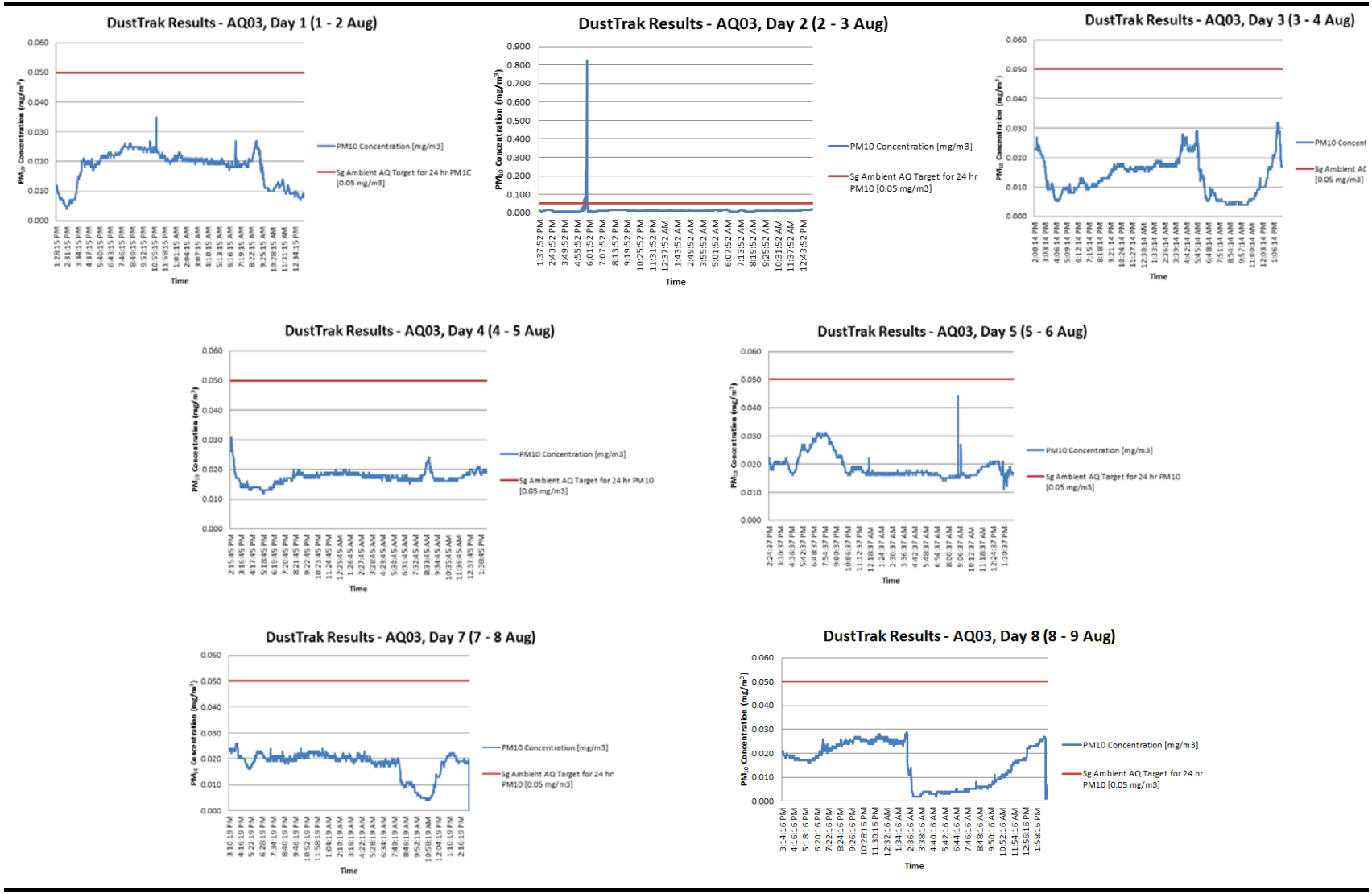


Figure A5.5 Graphs of PM10 Concentrations over Time (Round 1 Survey at AQ04)

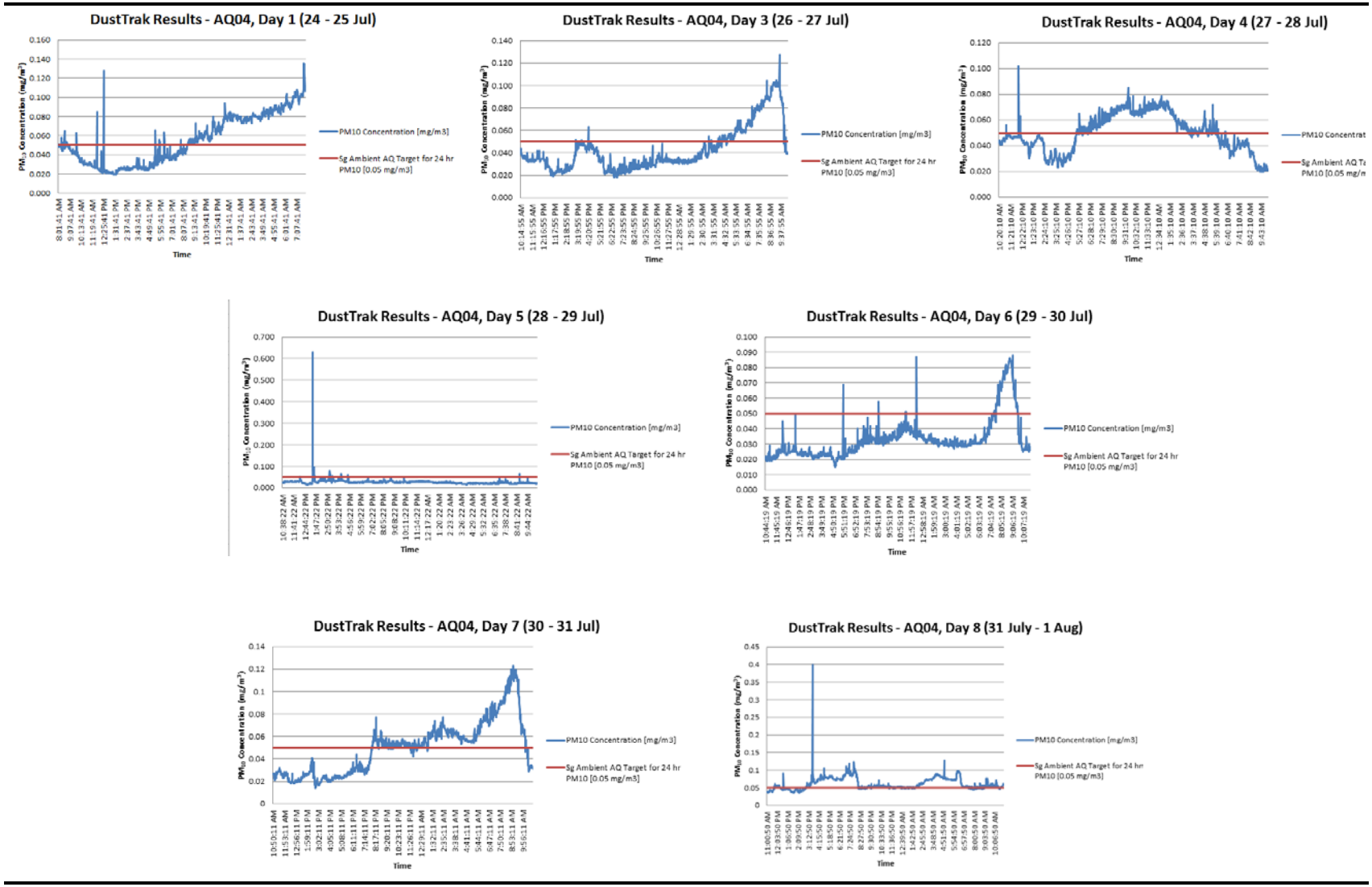


Figure A5.6 Graphs of PM10 Concentrations over Time (Round 1 Survey at AQ05)

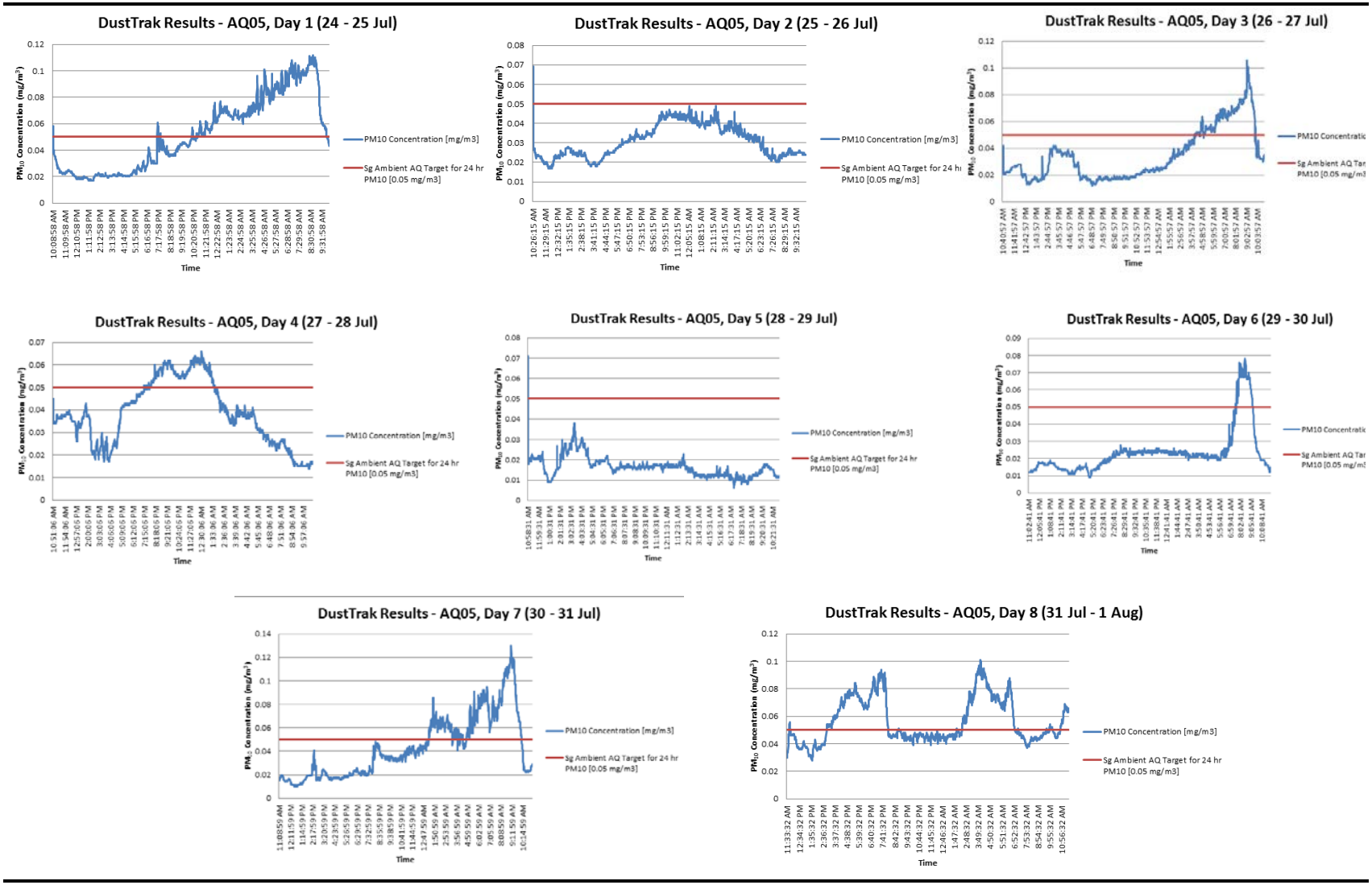
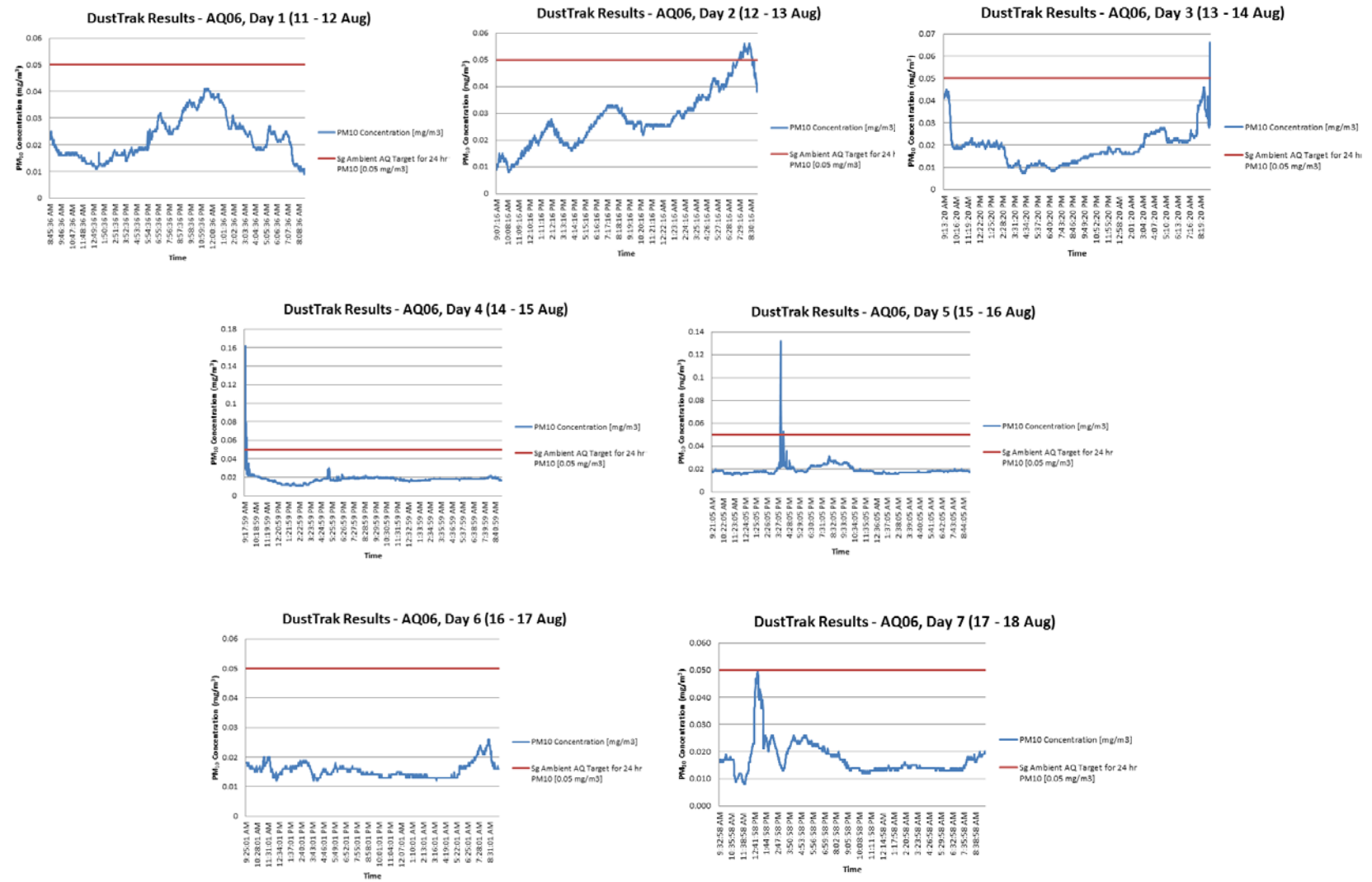


Figure A5.7 Graphs of PM10 Concentrations over Time (Round 1 Survey at AQ06)



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REPORT

OUR REF NO : ATS/IH/122/15/pg

DATE : 24 August, 2015

COMPANY : Environmental Resources Management (S) Pte Ltd
120 Robinson Road #10-01
Singapore 068913

DATE ANALYSED : 27 & 31 July & 5, 12 & 18 August, 2015

DATE COMPLETED : 21 August, 2015

SAMPLE DESCRIPTION : Forty Four pre-weighed PVC samples were received on 27 & 31 July & 5, 12 & 18 August, 2015 with references:

Refs No.	Sample ID	Date Received	Refs No.	Sample ID	Date Received
1	PVC201	27 July, 2015	23	PVC224	05 August, 2015
2	PVC202	27 July, 2015	24	PVC225	05 August, 2015
3	PVC203	27 July, 2015	25	PVC229	12 August, 2015
4	PVC204	27 July, 2015	26	PVC230	12 August, 2015
5	PVC205	27 July, 2015	27	PVC231	12 August, 2015
6	PVC206	27 July, 2015	28	PVC232	12 August, 2015
7	PVC207	31 July, 2015	29	PVC233	12 August, 2015
8	PVC208	31 July, 2015	30	PVC234	12 August, 2015
9	PVC209	31 July, 2015	31	PVC226	18 August, 2015
10	PVC210	31 July, 2015	32	PVC227	18 August, 2015
11	PVC211	31 July, 2015	33	PVC235	18 August, 2015
12	PVC212	31 July, 2015	34	PVC236	18 August, 2015
13	PVC213	31 July, 2015	35	PVC237	18 August, 2015
14	PVC214	31 July, 2015	36	PVC238	18 August, 2015
15	PVC215	05 August, 2015	37	PVC239	18 August, 2015
16	PVC216	05 August, 2015	38	PVC240	18 August, 2015
17	PVC218	05 August, 2015	39	PVC241	18 August, 2015
18	PVC219	05 August, 2015	40	PVC242	18 August, 2015
19	PVC220	05 August, 2015	41	PVC270	18 August, 2015
20	PVC221	05 August, 2015	42	PVC271	18 August, 2015
21	PVC222	05 August, 2015	43	PVC272	18 August, 2015
22	PVC223	05 August, 2015	44	PVC273	18 August, 2015

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OUR REF NO : ATS/IH/122/15/pg 24 August, 2015
COMPANY : Environmental Resources Management Pte Ltd
(Continued)

RESULTS : On analysis, the following results were obtained:-

Sample ID	Method	LOR	Weight Gained, mg
PVC201	Gravimetric Analysis	0.05	0.06
PVC202			0.08
PVC203			0.08
PVC204			0.10
PVC205			0.14
PVC206			0.12
PVC207			0.08
PVC208			0.09
PVC209			0.12
PVC210			0.09
PVC211			0.11
PVC212			0.09
PVC213			0.14
PVC214			0.13
PVC215			0.13
PVC216			0.11
PVC218			<0.05
PVC219			0.10
PVC220			0.13
PVC221			<0.05
PVC222			0.15
PVC223			0.10
PVC224			0.16
PVC225			0.10
PVC229			0.08
PVC230			0.15
PVC231			0.09
PVC232			0.11
PVC233			0.10
PVC234			0.11
PVC226			0.16
PVC227			0.08

.../3/-

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OUR REF NO : ATS/IH/122/15/pg 24 August, 2015
COMPANY : Environmental Resources Management Pte Ltd
(Continued)

RESULTS : On analysis, the following results were obtained:-

Sample ID	Method	LOR	Weight Gained, mg
PVC235	Gravimetric Analysis	0.05	0.14
PVC236			0.15
PVC237			0.11
PVC238			0.10
PVC239			0.08
PVC240			0.08
PVC241			0.06
PVC242			0.05
PVC270			0.06
PVC271			0.05
PVC272			0.07
PVC273			0.06

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TAN TEONG HUAT
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Annex 5.2

Round 2 Survey Results (1 October – 1 November 2015)

Table A5.7 Measurements at AQ01 (Round 2)

Emission Sources: Vehicles along Mandai Road; Leaf vacuuming vehicle observed along the Park Connector on 13 Oct; Small scla eroad works (excavation observed at junction of Mandai Lake Road (~290 m from AQ01)

Description	DustTrak II Meter Findings							
	Day 1	Day 2	Day 3 (wkend)	Day 4 (wkend)	Day 5	Day 6	Day 7	
Start Date	**8/10/2015**	**9/10/2015**	**10/10/2015**	**11/10/2015**	**12/10/2015**	**13/10/15**	**14/10/15**	
Filter ID	**388**	**390**	**392**	**394**	**396**	**398**	**400**	
Min. Conc (mg/m3)	25	35	32	60	69	55	44	
Max. Conc (mg/m3)	78	74	69	93	168	129	57	
Average Conc (mg/m3)	50	52	46	80	99	79	49	
Adjusted Average Conc (mg/m3)	47	49	44	76	94	75	46	
Gravimetric Results (mg/m3)	142	159	101	111	135	135	122	

Table A5.8 Measurements at AQ02 (Round 2)

Emission Sources: Minor landscaping work behind the Night Safari amphitheatre (29 Oct); minor construction of new tram station (by 30 Oct); 2 workers observed smoking < 10 m from AQ02 (30 Oct)

Description	DustTrak II Meter Findings							
	Day 1 (wkend)	Day 2 (wkend)	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8 (wkend)
Start Date	**24/10/15**	**25/10/15**	**26/10/15**	**27/10/15**	**28/10/15**	**29/10/15**	**30/10/15**	**31/10/15**
Filter ID	**449**	**451**	**453**	**455**	**457**	**459**	**461**	**463**
Min. Conc (mg/m3)	45	43	28	6	17	8	10	11
Max. Conc (mg/m3)	111	109	112	117	65	34	23	47
Average Conc (mg/m3)	65	64	71	77	38	17	14	24
Adjusted Average Conc (mg/m3)	62	61	67	73	36	16	13	23
Gravimetric Results (mg/m3)	98	104	108	76	102	97	52	52

Table A5.9 Measurements at AQ03 (Round 2)

Emission Sources: None observed

Description	DustTrak II Meter Findings							
	Day 1	Day 2	Day 3 (wkend)	Day 4 (wkend)	Day 5	Day 6	Day 7	Day 8
Start Date	**15/10/15**	**16/10/15**	**17/10/15**	**18/10/15**	**19/10/15**	**20/10/15**	**21/10/15**	
Filter ID	**402**	**404**	**406**	**408**	**410**	**412**	**414**	
Min. Conc (mg/m3)	40	42	41	68	28	35	42	
Max. Conc (mg/m3)	132	164	223	203	279	133	137	
Average Conc (mg/m3)	66	76	76	136	119	81	74	
Adjusted Average Conc (mg/m3)	62	72	72	129	113	77	70	
Gravimetric Results (mg/m3)	69	80	76	76	73	66	80	
% difference between two methods	-5.219	-5.080	-0.512	43.832	38.725	18.553	-7.920	
% difference from last day - Dusttrak	-	15.2	0.0	78.9	-12.5	-31.9	-8.6	
% difference from last day - Gravimetric	-	15.0	-4.3	0.0	-4.5	-9.5	21.1	

KEY

- Null data due to meter error
- Highest recorded data over survey period
- XXX Exceeds 24 hr PM10 limit of 0.050 mg/m3
- Rainfall event

Table A5.10 Measurements at AQ04 (Round 2)

Emission Sources: Vehicles along Mandai Lake Road; grass cutting activities observed on 5 Oct, AM

Description	DustTrak II Meter Findings							
	Day 1	Day 2	Day 3 (wkend)	Day 4 (wkend)	Day 5	Day 6	Day 7	Day 8
Start Date	1/10/2015	2/10/2015	3/10/2015	4/10/2015	5/10/2015	6/10/2015	7/10/2015	
Filter ID	373	375	377	379	381	383	385	
Min. Conc (mg/m3)	56	0	29	0	105	40	34	
Max. Conc (mg/m3)	180	150	332	105	202	178	47	
Average Conc (mg/m3)	120	105	146	68	149	106	38	
Adjsuted Average Conc (mg/m3)	114	99	138	64	141	100	36	
Gravimetric Results (mg/m3)	118	169	110	73	135	108	118	

Table A5.11 Measurements at AQ05 (Round 2)

Emission Sources: Sounds of equipment operation, suspected to be grass cutting activities at the military firing range (~180 m from AQ05) on 1 & 6 Oct

Description	DustTrak II Meter Findings							
	Day 1	Day 2	Day 3 (wkend)	Day 4 (wkend)	Day 5	Day 6	Day 7	Day 8
Start Date	1/10/2015	2/10/2015	3/10/2015	4/10/2015	5/10/2015	6/10/2015	7/10/2015	
Filter ID	374	376	378	380	382	384	386	
Min. Conc (mg/m3)	60	68	30	34	109	40	31	
Max. Conc (mg/m3)	187	163	353	101	215	191	52	
Average Conc (mg/m3)	125	122	141	70	162	108	37	
Adjusted Average Conc (mg/m3)	118	115	133	66	153	102	35	
Gravimetric Results (mg/m3)	104	111	76	69	115	97	104	

Table A5.12 Measurements at AQ06 (Round 2)

Emission Sources: None observed

Description	DustTrak II Meter Findings							
	Day 1 (wkend)	Day 2 (wkend)	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8 (wkend)
Start Date	24/10/15	25/10/15	26/10/15	27/10/15	28/10/15	29/10/15	30/10/15	31/10/15
Filter ID	450	452	454	456	458	460	462	464
Min. Conc (mg/m3)	82	87	84	0	0	8	0	11
Max. Conc (mg/m3)	165	163	168	106	27	33	21	39
Average Conc (mg/m3)	115	112	119	55	11	17	13	23
Adjusted Average Conc (mg/m3)	109	106	113	52	10	16	12	22
Gravimetric Results (mg/m3)	125	83	80	<17	63	66	31	38

KEY

- Null data due to meter error
- Highest recorded data over survey period
- XXX — Exceeds 24 hr PM10 limit of 0.050 mg/m3
- Rainfall event

Table A5.13 Measurements at AQ07, Yishun Monitoring Station (Collocated Meter)

Emission Sources: Emissions from diesel leaf blowers operated by park maintenance crew (12 Oct, AM); 2 trucks within Yishun Neighbourhood Park collecting yard waste

Description	DustTrak II Meter Findings												
	Day 1	Day 2	Day 3 (wkend)	Day 4 (wkend)	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10 (wkend)	Day 11 (wkend)	Day 12	Day 13	Day 14
Start Date	8/10/2015	9/10/2015	10/10/2015	11/10/2015	12/10/2015	13/10/15	14/10/15	15/10/15	16/10/15	17/10/15	18/10/15	19/10/15	20/10/15	21/10/15
Filter ID	387	389	391	393	395	397	399	401	403	405	407	409	411	413
Min. Conc (mg/m3)	26	45	32	66	67	58	36	13	28	30	60	27	0	28
Max. Conc (mg/m3)	101	89	72	107	173	123	61	109	178	202	227	159	180	86
Average Conc (mg/m3)	55	61	48	87	109	93	50	64	85	63	135	81	86	59
Gravimetric Results (mg/m3)	115	97	63	69	73	97	63	66	69	69	73	76	97	69

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REPORT

OUR REF NO : ATS/IH/177/15/pl

DATE : 23 November, 2015

COMPANY : Environmental Resources Management (S) Pte Ltd
120 Robinson Road #10-01
Singapore 068913

DATE ANALYSED : 8,15 & 23 October & 2 November, 2015

DATE COMPLETED : 23 November, 2015

SAMPLE DESCRIPTION : Fifty eight pre-weighed PVC samples were received on 8, 15, 23 October and 2 November, 2015 with references:

Refs No.	Sample ID	Date Received	Refs No.	Sample ID	Date Received
1	PVC373	8 October 2015	30	PVC402	23 October 2015
2	PVC374	8 October 2015	31	PVC403	23 October 2015
3	PVC375	8 October 2015	32	PVC404	23 October 2015
4	PVC376	8 October 2015	33	PVC405	23 October 2015
5	PVC377	8 October 2015	34	PVC406	23 October 2015
6	PVC378	8 October 2015	35	PVC407	23 October 2015
7	PVC379	8 October 2015	36	PVC408	23 October 2015
8	PVC380	8 October 2015	37	PVC409	23 October 2015
9	PVC381	8 October 2015	38	PVC410	23 October 2015
10	PVC382	8 October 2015	39	PVC411	23 October 2015
11	PVC383	8 October 2015	40	PVC412	23 October 2015
12	PVC384	8 October 2015	41	PVC413	23 October 2015
13	PVC385	15 October 2015	42	PVC414	23 October 2015
14	PVC386	15 October 2015	43	PVC449	2 November 2015
15	PVC387	15 October 2015	44	PVC450	2 November 2015
16	PVC388	15 October 2015	45	PVC451	2 November 2015
17	PVC389	15 October 2015	46	PVC452	2 November 2015
18	PVC390	15 October 2015	47	PVC453	2 November 2015
19	PVC391	15 October 2015	48	PVC454	2 November 2015
20	PVC392	15 October 2015	49	PVC455	2 November 2015
21	PVC393	15 October 2015	50	PVC456	2 November 2015
22	PVC394	15 October 2015	51	PVC457	2 November 2015
23	PVC395	15 October 2015	52	PVC458	2 November 2015
24	PVC396	15 October 2015	53	PVC459	2 November 2015
25	PVC397	15 October 2015	54	PVC460	2 November 2015
26	PVC398	15 October 2015	55	PVC461	2 November 2015
27	PVC399	23 October 2015	56	PVC462	2 November 2015
28	PVC400	23 October 2015	57	PVC463	2 November 2015
29	PVC401	23 October 2015	58	PVC464	2 November 2015

2/-

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OUR REF NO : ATS/IH/177/15/pl 23 November, 2015
COMPANY : Environmental Resources Management Pte Ltd
(Continued)

RESULTS : On analysis, the following results were obtained:-

Sample ID	Method	LOR	Weight Gained, mg
PVC373	Gravimetric Analysis	0.05	0.34
PVC374			0.30
PVC375			0.35
PVC376			0.32
PVC377			0.29
PVC378			0.22
PVC379			0.21
PVC380			0.20
PVC381			0.39
PVC382			0.33
PVC383			0.31
PVC384			0.28
PVC385			0.34
PVC386			0.30
PVC387			0.33
PVC388			0.41
PVC389			0.28
PVC390			0.33
PVC391			0.18
PVC392			0.29
PVC393			0.20
PVC394			0.32
PVC395			0.21
PVC396			0.39
PVC397			0.28
PVC398			0.39
PVC399			0.18
PVC400			0.35
PVC401			0.19
PVC402			0.20
PVC403			0.20
PVC404			0.23

...3/-

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OUR REF NO : ATS/IH/177/15/pl 3 November, 2015
COMPANY : Environmental Resources Management Pte Ltd
(Continued)

RESULTS : On analysis, the following results were obtained:-

Sample ID	Method	LOR	Weight Gained, mg
PVC405	Gravimetric Analysis	0.05	0.20
PVC406			0.22
PVC407			0.21
PVC408			0.22
PVC409			0.20
PVC410			0.21
PVC411			0.28
PVC412			0.19
PVC413			0.20
PVC414			0.23
PVC449			0.27
PVC450			0.36
PVC451			0.30
PVC452			0.24
PVC453			0.31
PVC454			0.23
PVC455			0.22
PVC456			<0.05
PVC457			0.27
PVC458			0.18
PVC459			0.28
PVC460			0.19
PVC461			0.15
PVC462			0.09
PVC463			0.14
PVC464			0.11

ALS TECHNICHEM (S) PTE LTD

TAN TEONG HUAT
B.Sc., M.Sc., MSNIC.

Annex 6.0

Noise Survey Results

Table A6-1: Long-Term Noise Measurements at Zone B (NL01, NL03 & NL04)

Averaging Period	Period[1]		Round 1 Noise Levels, dB(A) [2]			Observed Noise Sources Contributing to Baseline	Round 2 Noise Levels, dB(A) [2]			Observed Noise Sources Contributing to Baseline
			NL01	NL03	NL04		NL01	NL03	NL04	
$L_{Aeq, 12hr}$	Weekday	Day	70	53	71	**NL01:** Vehicular traffic along Mandai Road and Mandai Lake Road and military aircraft overhead **NL03:** Insect vocalizations; military aircraft overhead and human activity (fruit pickers) **NL04:** Vehicular traffic along Mandai Lake Road; military aircraft overhead and insect vocalizations	70	56	71	**NL01:** Vehicular traffic along Mandai Road and Mandai Lake Road and military aircraft overhead **NL03:** Insect vocalizations and military aircraft overhead **NL04:** Vehicular traffic along Mandai Lake Road; military aircraft overhead and insect vocalizations
		Night	67	53	67		67	51	67	
	Weekend	Day	72	53	73		70	54	72	
		Night	68	53	68		67	52	68	
$L_{Aeq, 1hr}$	Weekday	Day	69	50	67		69	49	68	
		Evening	68	50	70		69	53	70	
		Night	59	48	54		59	44	51	
	Weekend	Day	69	51	68		68	49	68	
		Evening	70	51	70		69	54	71	
		Night	61	50	53		61	46	52	
$L_{Aeq, 5min}$	Weekday	Day	70	53	71		70	56	71	
		Evening	69	53	71		70	54	71	
		Night	65	52	64		65	48	64	
	Weekend	Day	72	53	73		70	54	72	
		Evening	70	53	71		70	55	71	
		Night	67	53	66		65	50	66	

Notes:

1 Relevant periods are defined as:
- Day: 7 am to 7 pm
- Evening: 7 pm to 10 pm
- Night: 7pm to 7 am (LAeq, 12hr averaging period) or 10 pm to 7 am (LAeq,1hr and LAeq,5min averaging periods)

2 The lowest noise level over one week is presented.

Table A6-2: Long-Term Noise Measurements at Zone D (NL05 & NL06) and Zone E (NL10)

Averaging Period	Period[1]		Round 1 Noise Levels, dB(A) [2]			Observed Noise Sources Contributing to Baseline	Round 2 Noise Levels, dB(A) [2]			Observed Noise Sources Contributing to Baseline
			NL05	NL06	NL10		NL05	NL06	NL10	
$L_{Aeq, 12hr}$	Weekday	Day	51	52	54	Insect vocalizations; military aircraft overhead and artillery firing at Mandai firing range	53	55	52	**NL05 & NL10:** Insect vocalizations; military aircraft overhead and artillery firing at Mandai firing range **NL06:** Insect vocalizations; military aircraft overhead; artillery firing at Mandai firing range; grass cutting activities in the direction of the Mandai firing range (6 October, AM)
		Night	51	48	52		51	52	48	
	Weekend	Day	48	47	52		46	47	50	
		Night	54	49	51		52	53	48	
$L_{Aeq, 1hr}$	Weekday	Day	44	45	46		43	44	43	
		Evening	46	48	51		49	49	47	
		Night	47	45	48		49	46	44	
	Weekend	Day	41	42	46		40	41	44	
		Evening	46	48	49		48	51	49	
		Night	48	46	49		48	46	45	
$L_{Aeq, 5min}$	Weekday	Day	51	52	54		53	55	52	
		Evening	50	51	56		52	50	49	
		Night	50	47	50		51	48	46	
	Weekend	Day	48	47	52		46	47	50	
		Evening	55	50	51		51	55	50	
		Night	53	48	51		52	52	47	

Notes:

1 Relevant periods are defined as:
- Day: 7 am to 7 pm
- Evening: 7 pm to 10 pm
- Night: 7pm to 7 am (LAeq, 12hr averaging period) or 10 pm to 7 am (LAeq,1hr and LAeq,5min averaging periods)

2 The lowest noise level over one week is presented.

Table A6-3: Long-Term Noise Measurements at Zone F (NL07, NL08 & NL09)

Averaging Period	Period[1]		Round 1 Noise Levels, dB(A) [2]			Observed Noise Sources Contributing to Baseline	Round 2 Noise Levels, dB(A) [2]			Observed Noise Sources Contributing to Baseline
			NL07	NL08	NL09		NL07	NL08	NL09	
$L_{Aeq, 12hr}$	Weekday	Day	55	60	53	**NL07:** Vehicular traffic along Mandai Lake Road; military aircraft overhead; zoo maintenance operations in the day; shows at the Night Safari amphitheatre at night **NL08:** Human activity around Palm Park and animal calls (gibbon cage at exhibit and quarantine area) **NL09:** Insect vocalizations and human activity within the staff dormitory	57	58	52	**NL07:** Vehicular traffic along Mandai Lake Road; military aircraft overhead; zoo maintenance operations in the day; shows at the Night Safari amphitheatre at night; and construction activity within Night Safari **NL08:** Human activity around Palm Park (crane operations observed on 15 October ~60 m away) and animal calls (gibbon cage at exhibit and quarantine area) **NL09:** Insect vocalizations and human activity within the staff dormitory
		Night	55	49	49		54	47	49	
	Weekend	Day	54	61	51		55	54	49	
		Night	56	48	49		55	46	49	
$L_{Aeq, 1hr}$	Weekday	Day	51	45	49		49	46	48	
		Evening	57	46	49		56	45	48	
		Night	47	46	47		47	44	47	
	Weekend	Day	51	45	49		48	45	48	
		Evening	58	46	49		57	44	47	
		Night	52	48	48		50	45	48	
$L_{Aeq, 5min}$	Weekday	Day	55	60	53		55	58	52	
		Evening	58	48	49		56	46	48	
		Night	51	48	49		52	46	49	
	Weekend	Day	54	61	51		58	54	49	
		Evening	58	48	49		58	45	48	
		Night	56	49	50		52	47	49	

Notes:

1 Relevant periods are defined as:
- Day: 7 am to 7 pm
- Evening: 7 pm to 10 pm
- Night: 7pm to 7 am (LAeq, 12hr averaging period) or 10 pm to 7 am (LAeq,1hr and LAeq,5min averaging periods)

2 The lowest noise level over one week is presented.

Table A6-4: Round 1 Short-Term Noise Measurements & Vehicular Traffic Count (NL01, NL04 & NL07)

Monitoring Point ID	Period	Peak Period [1]						Off-Peak Period						Observed Noise Sources Contributing to Baseline
		Noise Levels, dB(A)			Vehicle Count			Noise Levels, dB(A)			Vehicle Count			
		L_{Amax} [2]	$L_{Aeq,15min}$	L_{A90} [2]	Vehicles [3]	Heavy Vehicle [4]	Motor-cycles	L_{Amax} [2]	$L_{Aeq,15min}$	L_{A90} [2]	Vehicles	Heavy Vehicles	Motor-cycles	
NL01 [5]	Weekday	93	70	57	432	196	61	94	70	58	269	245	26	Vehicular traffic along Mandai Road and Mandai Lake Road and military aircraft overhead
	Weekend	95	72	61	373	199	24	95	72	61	318	189	43	
NL04 [6]	Weekday	95	70	47	74	17	19	96	70	45	54	28	3	Vehicular traffic along Mandai Lake Road and military aircraft overhead
	Weekend	96	72	50	130	23	2	87	71	53	126	22	5	
NL07 [7]	Weekday	85	69	53	113	22	14	83	67	51	67	30	3	Vehicular traffic along Mandai Lake Road
	Weekend	85	70	53	142	26	4	91	70	53	163	16	4	

Notes:

(1) Peak hours as defined in the LTA's Code of Practice for Traffic Control at Work Zone (23 July 2010)[1]
- Monday to Friday: 7.30 – 9.30 am and 5 – 8 pm
- Saturday: 12 – 2pm.

(2) Values apply to the levels measured during the 15 minute survey.

(3) Light vehicles comprise of family cars, sedans and non-commercial vans.

(4) Heavy vehicles comprise of goods vans, lorries, cargo trucks, road tankers, buses, construction vehicles, etc.

(5) NL01 is located < 2 m from Mandai Lake Road and approximately 30 m from Mandai Road.

(6) NL04 is located < 2 m from Mandai Lake Road.

(7) NL07 is located approximately 30 m from Mandai Lake Road.

Table A6-5: Round 2 Short-Term Noise Measurements & Vehicular Traffic Count (NL01, NL04 & NL07)

Monitoring Point ID	Period	Peak Period [1]						Off-Peak Period						Observed Noise Sources Contributing to Baseline
		Noise Levels, dB(A)			Vehicle Count			Noise Levels, dB(A)			Vehicle Count			
		L_{Amax} [2]	$L_{Aeq,15min}$	L_{A90} [2]	Vehicles [3]	Heavy Vehicle [4]	Motor-cycles	L_{Amax} [2]	$L_{Aeq,15min}$	L_{A90} [2]	Vehicles	Heavy Vehicles	Motor-cycles	
NL01 [5]	Weekday	83.1	70.4	60.2	590	295	105	80.5	67.9	59.2	234	163	31	Vehicular traffic along Mandai Road and Mandai Lake Road and military aircraft overhead
	Weekend	86.6	70.7	61.7	347	172	45	82.1	68.6	57.9	344	205	34	
NL04 [6]	Weekday	80.6	69.9	49.6	87	21	8	82.1	68.7	50.3	51	18	4	Vehicular traffic along Mandai Lake Road and military aircraft overhead
	Weekend	85.3	70.3	51.4	108	18	4	80.4	70.5	53.9	105	10	4	
NL07 [7]	Weekday	82.8	66.8	48.1	73	25	7	83.1	66.1	48.2	72	10	10	Vehicular traffic along Mandai Lake Road
	Weekend	81.5	68.9	57.2	110	18	10	87.0	68.9	52.4	143	19	2	

Notes:

(1) Peak hours as defined in the LTA's Code of Practice for Traffic Control at Work Zone (23 July 2010)[1]
- Monday to Friday: 7.30 – 9.30 am and 5 – 8 pm
- Saturday: 12 – 2pm.

(2) Values apply to the levels measured during the 15 minute survey.

(3) Light vehicles comprise of family cars, sedans and non-commercial vans.

(4) Heavy vehicles comprise of goods vans, lorries, cargo trucks, road tankers, buses, construction vehicles, etc.

(5) NL01 is located < 2 m from Mandai Lake Road and approximately 30 m from Mandai Road.

(6) NL04 is located < 2 m from Mandai Lake Road.

(7) NL07 is located approximately 30 m from Mandai Lake Road.

Table A6-6: Supplementary Short-term Noise Measurements

Monitoring Point ID	Period	Peak Period [1] Noise Levels, dB(A)					Off Peak Period Noise Levels, dB(A)					Observed Noise Source(s)
		$L_{Aeq,5min}$	L_{A90} [2]	L_{A10} [2]	L_{Amax} [2]	L_{Amin} [2]	$L_{Aeq,5min}$	L_{A90} [2]	L_{A10} [2]	L_{Amax} [2]	L_{Amin} [2]	
NL02	Weekday	54 - 56	47	56	68	45	54 - 57	43	58	69	41	**Peak Period:** Military aircraft overhead (weekday); show at Night Safari amphitheater; passing trams with audio guide; animal vocalizations
	Weekend	43 - 47	42	44	50	41	46 - 51	40	46	68	38	**Off peak Period:** Operations at elephant den area (clanging of gate and equipment, staff speaking/shouting); passing vehicles; military aircraft overhead (weekday); insect and bird vocalizations
NL11	Weekday	52 - 58	45	55	65	43	47 - 48	44	49	56	43	**Peak Period:** Military aircraft overhead (weekday peak period); intermittent insect and bird vocalizations; traffic along Mandai Lake Road
	Weekend	49 - 50	44	51	60	43	46 - 53	43	47	58	42	**Off peak Period:** Insect and bird vocalizations; intermittent traffic along Mandai Lake Road
NL12	Weekday	52 - 54	43	58	66	40	47 - 52	44	49	55	40	**Peak Period:** Military aircraft overhead (weekday peak period); vehicles along Mandai Lake Road and Mandai Road; intermittent insect and bird vocalizations
	Weekend	47 - 48	43	50	57	41	45 - 47	41	48	56	39	**Off peak Period:** Insect and bird vocalizations; intermittent traffic along Mandai Lake Road; distant traffic along Mandai Road; distant construction works along Mandai Road; animal vocalizations from the zoo; distant music from the Zoo multi-storey carpark
NL13	Weekday	66 - 70	64	68	75	60	60 - 66	55	60	82	54	**Peak Period:** Background music; military aircraft overhead; tourists speaking/shouting; dropped cutlery
	Weekend	70	67	71	80	65	58 - 63	56	59	66	55	**Off peak Period:** Staff speaking; movement of chairs/tables/cutlery; closure of zoo entrance grating.

Notes:

(1) Peak hours were determined based on the operational hours of the Night Safari and the Singapore Zoo: Night Safari opening hours (NL02): 5.30 pm – 12 midnight; and Singapore Zoo opening hours (NL13): 8.30 am – 6 pm

(2) Lowest value of the three measurements (taken over 15 minutes) was selected, to establish a conservative baseline. Each measurement has been averaged over 5 minutes.

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

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Co. Reg No. 198403076R

Our Ref: ATS/IH/124/15TTH

Date: 05 August 2015

NOISE MONITORING REPORT

For

ENVIRONMENTAL RESOURCES MANAGEMENT (S) PTE LTD
120 ROBINSON ROAD #10-01,
SINGAPORE 068913

Chai Wai Hang Field Engineer	Tan Teong Huat Senior Manager BSc, MSc (SHE Tech.), MSNIC

EXECUTIVE SUMMARY

ALS Technichem (S) Pte Ltd has carried out noise monitoring covering the areas around the Singapore Zoo and forested area around Mandai Lake Road. The first round of monitoring started on on 26th June to 13th July 2015. The objective of this monitoring is to establish a baseline and to determine whether the noise level at the selected points is in compliance with the limits as per stipulated in the National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

In general, the results obtained at NL07-NL09 were in compliance with the National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites-Buildings other than above Part I & II) Regulations, 2011 Revised Ed. And there are no relevant limits for NL01, NL03-NL06 and NL10.

In conclusion, monitoring of the baseline noise level of these points is recommended when the construction work is commenced. This exercise will help to determine the presence of any nuisance noise contribution on their daily operations and activities to their immediate neighbouring occupants on site.

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dB(A)	Decibel A

1.0 INTRODUCTION

ALS TECHNICHEM (S) PTE LTD (hereafter as "ALS") has been appointed as the contractor to perform the Noise Monitoring around the area of Singapore Zoo and the forested area around Mandai Lake Road, as request by Environmental Resources Management (S) Pte Ltd (hereafter as "ERM").

1.1 Objectives

The objective of the monitoring is to determine whether the baseline noise levels emitted from the area of Singapore Zoo and the forested area around Mandai Lake Road were in compliance with the limits stipulated in the National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites -Buildings other than above Part I & II) Regulations, 2011 Revised Ed. The information can be used as a point of reference for future environmental monitoring and decision-making.

1.2 Scope of Work

The scope of works for the noise monitoring included:

1. Preparation of Noise Monitoring Plan;

2. Noise Monitoring station setup and sampling at selected nine sampling points, namely Point NL01_R1 and NL03_R1-NL10_R1(sampling points were dictated by ERM);

3. Determination of equivalent noise level (L_{Aeq}) over a period of 24 hour period on a 5 minutes interval as a baseline to be conducted over a week. Measured noise level of NL07-NL09 were analyzed according to regulatory limit:

    - Two specified period according to the Part I, Second Schedule, Maximum Permissible Noise Levels For Construction Work Commenced On or After 1st October 2007, National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.
    - Three specified period according to the Part II, Second Schedule, Maximum Permissible Noise Levels For Construction Work Commenced On or After 1st October 2007, National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.
    - Three specified period according to the Part III, Second Schedule, Maximum Permissible Noise Levels For Construction Work Commenced On or After 1st October 2007, National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

4. Determination of noise level (L_{Aeq}, L_{max} and L_{90}) over a period of 15 minutes at NL01_R1, NL04_R1 and NL07_R1 monitoring points on a weekday and weekend (Saturday);

5. Assessing the noise level against the adopted standard; and

6. Providing a report outlining the findings and results of the study.

1.2.1 Monitoring Requirement

Noise is measured in decibel (dB) with reference to the frequency of noise, 'A' weighting was selected for this entire monitoring. The 'FAST' response was selected to measure the noise levels. It is used for the measurement of time-varying sounds with a response time of 0.125 seconds which is similar to human ear response.

Table 1 lists the maximum permitted noise level of specified period based on type of affected buildings as per Second Schedule of National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

Table 1: Maximum permitted noise level for construction work commenced after 1st October 2007

PART I		
Type of affected Buildings	***Maximum permitted noise level in decibels (A)**	
	7am – 7pm	**7pm – 7am**
Hospital, Schools, Institutions of higher learning, homes for the aged sick etc.	60	50
Residential buildings located less than 150m from the construction site where the noise is being emitted	75	-
Buildings (other than above)	75	65
*reckoned as an equivalent continuous noise level over a period of 12 hours		

PART II			
	7am – 7pm	**7pm – 10pm**	**10pm – 7am**
Hospital, Schools, Institutions of higher learning, homes for the aged sick etc.	-	-	-
Residential buildings located less than 150m from the construction site where the noise is being emitted	-	65	55
Buildings (other than above)	-	-	-
*reckoned as an equivalent continuous noise level over a period of 1 hour			

PART III			
	7am – 7pm	**7pm – 10pm**	**10pm – 7am**
Hospital, Schools, Institutions of higher learning, homes for the aged sick etc.	75	55	55
Residential buildings located less than 150m from the construction site where the noise is being emitted:- (i) on Monday to Saturday	90	70	55
(ii) on Sundays & Public Holiday	75	55	55
Buildings (other than above)	90	70	70
*reckoned as an equivalent continuous noise level over a period of 5 minutes			

2.0 SAMPLING AND FIELD MONITORING

ALS has performed all the required sampling for noise level monitoring at selected locations.

2.1 Sampling Equipment

A portable Quest SoundPro SP DL-1 Sound Level Meter (Class 1) was used to measure noise levels of the selected points. This instrument is complies with the standards as specified in the International Electrotechnical Commission Publication 651 (Class 1) and Publication 804 (Type 1).

2.2 Sampling Locations

Figures 1 – 2 illustrate the sampling locations for this monitoring program.

Figure 1: Sampling Locations

Remarks: 🔴 Denote traffic counts and short-term measurement were taken

Figure 2: Sampling Locations

Remarks: Denote traffic counts and short-term measurement were taken

Noise Monitoring
(First Round of Survey)

Date of Survey: 26th June to 13th July 2015

2.3 Detail of Noise Monitoring Point

There were a total of nine noise monitoring points have been selected, namely NL01_R1 and NL03_R1 - NL10_R1. The monitoring points were dictated by ERM. During the noise measurement, it was noted a range of possible noise sources at the respective monitoring points that may contribute to the overall ambient noise levels. The detail of the monitoring points and identified noise sources near to the monitoring points are listed in Table 2 on the day of monitoring. In addition, Table 3 and 4 lists the number of vehicles/motorbikes and short-term noise measurement which traveled along the respective areas of concerned during the 2 periods (peak and off peak hours) for each individual location on selected date is listed as below.

Table 2: Identified noise sources near to the monitoring points

Monitoring Point	Date		Time (hr)		Noise Sources
	Start	Stop	Star	Stop	
NL01_R1	26/06/15	02/07/15	0000	1155	Traffic noise (vehicles) from Mandai Road and Mandai Lake Road, military aircraft/helicopter overflight
NL03_R1	26/06/15	02/07/15	0000	1157	Insect noise, military aircraft/helicopter overflight, outsiders were seen at the monitoring area during the battery check on 27 June
NL04_R1	26/06/15	02/07/15	0000	1158	Traffic noise (vehicles) from Mandai Lake Road, military aircraft/helicopter overflight, insect noise
NL05_R1	26/06/15	02/07/15	0000	1159	Insect noise, military aircraft/helicopter overflight, shooting training at Mandai camp
NL06_R1	26/06/15	02/07/15	0000	1159	Insect noise, military aircraft/helicopter overflight, shooting training at Mandai camp
NL07_R1	07/07/15	13/07/15	0000	1158	Traffic noise (vehicles) from Mandai Lake Road, military aircraft/helicopter overflight
NL08_R1	07/07/15	13/07/15	0000	1159	Human activities around the palm park, screech sound from monkey (the cage located near to the monitoring area)
NL09_R1	07/07/15	13/07/15	0000	1157	Insect noise, human activities near to the staff dormitory
NL10_R1	07/07/15	13/07/15	0000	1157	Insect noise, military aircraft/helicopter overflight, shooting training at Mandai camp

Table 3: Vehicular Traffic volume for peak and off peak hour

Location	Weekend / Weekday	Peak Hour			Off Peak hour		
		Vehicles	Heavy Vehicles	Motor-bikes	Vehicles	Heavy Vehicles	Motor-bikes
NL01_R1	Weekend	373	199	24	318	189	43
	Weekday	432	196	61	269	245	26
NL04_R1	Weekend	130	23	2	126	22	5
	Weekday	74	17	19	54	28	3
NL07_R1	Weekend	142	26	4	163	16	4
	Weekday	113	22	14	67	30	3

Remarks:

a) Traffic volume was noted based on 15 minutes duration of each period;
b) The heavy vehicles included trucks, vans, lorries, buses, in general, all heavy vehicle which involve in business. The vehicles included house use car, four-wheel car, in general, all the small vehicle which is non commercial.
c) Peak Hour - (7.30am – 9.30am) & (5.00pm-8.00pm) for weekday
- 12pm-2pm for weekend
Non-Peak Hour - Hours other than above

Table 4: Summary of results for short term noise level measurement (Lmax, LAeq & L90) over 15 minutes

Monitoring Point	Date	Weekend / Weekday	Peak Hour					Off-Peak Hour					Noise Sourse
			Time		Noise Level, dB(A)			Time		Noise Level, dB(A)			
			Start	Stop	L_{max}	L_{Aeq}	L_{90}	Start	Stop	L_{max}	L_{Aeq}	L_{90}	
NL01_R1	27/06/15	Weekend	1253	1308	94.9	72.4	60.9	1110	1125	94.7	71.6	61.4	Traffic noise (vehicles) from Mandai Road and Mandai Lake Road, military aircraft/helicopter overflight
	30/06/15	Weekday	1717	1732	93.4	69.7	57.4	1507	1522	93.8	69.5	58.1	
NL04_R1	27/06/15	Weekend	1200	1215	96.3	71.8	50.4	1145	1200	86.7	71.1	52.5	Traffic noise (vehicles) from Mandai Lake Road, military aircraft/helicopter overflight
	30/06/15	Weekday	1700	1715	95.4	69.9	46.9	1552	1607	96.3	69.7	44.5	
NL07_R1	11/07/15	Weekend	1210	1225	85.4	69.5	53.0	1135	1150	90.7	70.1	52.9	Light drizzle on 08 July Traffic noise (vehicles) from Mandai Lake Road
	08/07/15	Weekday	1815	1830	85.1	69.3	53.3	1530	1545	83.1	67.0	51.0	

3.0 SAMPLING METHODOLOGY

The measuring instruments were installed in such a way so that the measurements were not affected by external factors (draft, vibration, wind, magnetic field, etc). Measurement were carried out at 1.2-1.5m from the ground or working level.

The equivalent continuous noise level (L_{Aeq}) was measured by using the sound level meter for 5 minutes interval datalog over 24 hours sampling period at the selected monitoring point. Table 5 summarized the sound level meter set up in this study. To determine the noise level on specified period, the recorded noise data was then analyzed by using *QuestSuite* Software.

Table 5: Summary of sound level meter setting

Parameter	Setting
Response	Fast
Frequency weighting for RMS	A
Measurement range	30 – 120 dB
Exchange Rate (Q)	3

3.1 Calibration of Sound Level Meter

All sound level meters were calibrated by an accredited laboratory under ISO/IEC 17025 standard. The certificates of field equipment's calibrations were attached in Appendix 1. Sound level meter used for ambient noise survey shall have its calibration certified by an authorized calibration laboratory within one year of the actual measurement sessions.

4.0 LOCATION INDEX / SAMPLING SCHEDULE / TEST RESULTS

Location index, sampling schedule and their respective test results obtained were tabulated and reflected our findings on 26th June to 13th July 2015.

Please refer to Table 6 to 76 and the daily noise level at all monitoring points were illustrated in Figure 3 to 65 and sampling locations at Figure 1 to 2.

Table 6: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours

Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL01_R1	Day 1	71.5	67.2
	Day 2 (weekend)	72.3	69.5
	Day 3 (weekend)	71.7	67.9
	Day 4	71.3	67.7
	Day 5	71.2	67.2
	Day 6	70.3	66.5
	Day 7	70.8	66.5
NL03_R1	Day 1	54.6	53.4
	Day 2 (weekend)	56.0	53.2
	Day 3 (weekend)	53.2	52.9
	Day 4	56.2	54.1
	Day 5	55.1	52.7
	Day 6	53.1	54.7
	Day 7	57.0	58.3
Limit		NA	NA

Remark: NA denote Not Available

Table 7: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours

Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL04_R1	Day 1	72.5	68.2
	Day 2 (weekend)	73.4	69.0
	Day 3 (weekend)	73.4	68.1
	Day 4	71.3	66.9
	Day 5	71.1	67.2
	Day 6	71.1	67.3
	Day 7	71.5	67.6
NL05_R1	Day 1	51.8	52.9
	Day 2 (weekend)	55.0	53.8
	Day 3 (weekend)	48.3	56.3
	Day 4	56.6	58.8
	Day 5	56.4	55.6
	Day 6	50.5	50.7
	Day 7	53.2	52.1
NL06_R1	Day 1	54.6	51.8
	Day 2 (weekend)	56.8	49.3
	Day 3 (weekend)	47.0	48.5
	Day 4	57.9	54.2
	Day 5	56.5	51.0
	Day 6	51.8	49.0
	Day 7	51.5	48.1
Limit		NA	NA

Remark: NA denote Not Available

Table 8: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours

Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL07_R1	Day 1	58.5	55.3
	Day 2	59.6	56.8
	Day 3	55.5	55.4
	Day 4	55.4	57.8
	Day 5 (weekend)	58.8	60.3
	Day 6 (weekend)	54.0	56.4
	Day 7	55.8	55.8
NL08_R1	Day 1	68.2	50.3
	Day 2	61.5	52.1
	Day 3	60.4	48.8
	Day 4	63.1	51.0
	Day 5 (weekend)	60.8	53.4
	Day 6 (weekend)	61.5	48.4
	Day 7	61.5	52.4
NL09_R1	Day 1	54.1	52.3
	Day 2	53.5	51.5
	Day 3	52.5	49.2
	Day 4	53.3	54.6
	Day 5 (weekend)	53.8	57.7
	Day 6 (weekend)	50.6	49.4
	Day 7	53.5	51.6
***Limit of Affected Buildings (other than those above)**		75	65

Remark: * Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)

Table 9: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours

Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL10_R1	Day 1	55.6	52.1
	Day 2	56.8	63.3
	Day 3	54.7	54.3
	Day 4	53.8	55.1
	Day 5 (Weekend)	53.4	62.0
	Day 6 (Weekend)	51.5	51.0
	Day 7	55.9	52.9
Limit		NA	NA

Remark: NA denote Not Available

Table 10: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes

Monitoring Point	Day	Noise levels Leq in dB (A)		
		7am – 7pm	7pm – 10pm	10pm – 7am
NL01_R1	Day 1	71.5	70.1	65.5
	Day 2 (weekend)	72.3	73.3	66.8
	Day 3 (weekend)	71.7	70.2	66.7
	Day 4	71.3	71.0	65.7
	Day 5	71.2	69.7	65.9
	Day 6	70.3	69.2	64.9
	Day 7	70.8	69.4	64.7
NL03_R1	Day 1	54.6	53.3	53.4
	Day 2 (weekend)	56.0	53.9	53.0
	Day 3 (weekend)	53.2	52.7	53.0
	Day 4	56.3	55.8	53.3
	Day 5	55.1	54.4	52.0
	Day 6	53.1	53.6	55.0
	Day 7	57.0	56.1	58.8
Limit		NA	NA	NA

Remark: NA denote Not Available

Table 11: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes

Monitoring Point	Day	Noise levels Leq in dB (A)		
		7am – 7pm	7pm – 10pm	10pm – 7am
NL04_R1	Day 1	72.5	71.5	66.1
	Day 2(weekend)	73.4	72.4	66.8
	Day 3(weekend)	73.4	71.4	66.0
	Day 4	71.3	70.9	63.9
	Day 5	71.1	70.8	64.7
	Day 6	71.1	70.8	64.9
	Day 7	71.5	71.0	65.3
NL05_R1	Day 1	51.8	50.0	53.5
	Day 2 (weekend)	55.0	55.4	53.1
	Day 3 (weekend)	48.3	54.7	56.7
	Day 4	56.7	58.9	58.7
	Day 5	56.4	53.3	56.1
	Day 6	50.5	52.2	50.1
	Day 7	53.2	52.9	51.8
NL06_R1	Day 1	54.6	55.2	49.5
	Day 2 (weekend)	56.8	52.0	47.9
	Day 3 (weekend)	47.0	49.8	47.9
	Day 4	57.9	58.8	49.9
	Day 5	56.5	54.6	48.6
	Day 6	51.8	52.6	46.6
	Day 7	51.5	50.6	46.9
Limit		NA	NA	NA

Remark: NA denote Not Available

Table 12: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes

Monitoring Point	Day	Noise levels Leq in dB (A)		
		7am – 7pm	7pm – 10pm	10pm – 7am
NL07_R1	Day 1	58.5	59.9	51.0
	Day 2	59.6	61.7	51.4
	Day 3	55.5	58.4	53.7
	Day 4	55.4	59.6	57.1
	Day 5 (Weekend)	58.8	58.6	60.7
	Day 6 (Weekend)	54.0	57.9	55.7
	Day 7	55.8	59.7	52.9
NL08_R1	Day 1	68.2	53.2	48.6
	Day 2	61.5	56.5	48.3
	Day 3	60.4	47.9	49.1
	Day 4	63.2	48.1	51.7
	Day 5 (Weekend)	60.8	51.5	53.9
	Day 6 (Weekend)	61.5	47.7	48.6
	Day 7	61.5	54.6	51.3
NL09_R1	Day 1	54.1	53.1	52.0
	Day 2	53.5	55.2	48.8
	Day 3	52.5	49.3	49.2
	Day 4	53.3	49.2	55.5
	Day 5 (Weekend)	53.8	51.5	58.7
	Day 6 (Weekend)	50.6	49.1	49.5
	Day 7	53.5	55.0	49.3
***Limit of Affected Buildings (other than those above)**		90	70	70

Remark: * Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)

Table 13: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes

Monitoring Point	Day	Noise levels Leq in dB (A)		
		7am – 7pm	7pm – 10pm	10pm – 7am
NL10_R1	Day 1	55.6	55.6	49.8
	Day 2	56.8	69.1	51.5
	Day 3	54.7	57.5	52.3
	Day 4	53.8	57.0	54.2
	Day 5 (Weekend)	53.4	67.3	55.3
	Day 6 (Weekend)	51.5	50.7	51.1
	Day 7	55.9	56.5	50.5
Limit		NA	NA	NA

Remark: NA denote Not Available

Table 14: Sum mary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL01_R1 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	71.0	NA	NA
0800 – 0900	71.4		
0900 – 1000	74.0		
1000 – 1100	71.4		
1100 – 1200	71.4		
1200 – 1300	70.4		
1300 – 1400	70.5		
1400 – 1500	70.9		
1500 – 1600	71.9		
1600 – 1700	70.7		
1700 – 1800	71.7		
1800 – 1900	71.9		
1900 – 2000	71.3	NA	NA
2000 – 2100	69.3		
2100 – 2200	69.4		
2200 – 2300	68.7	NA	NA
2300 – 0000	69.4		
0000 – 0100	63.8		
0100 – 0200	61.3		
0200 – 0300	59.9		
0300 – 0400	60.2		
0400 – 0500	59.9		
0500 – 0600	64.1		
0600 – 0700	67.9		

Remark: NA denote Not Available

Table 15: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL01_R1 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	69.8	NA	NA
0800 – 0900	71.3		
0900 – 1000	71.8		
1000 – 1100	72.4		
1100 – 1200	70.9		
1200 – 1300	71.0		
1300 – 1400	71.7		
1400 – 1500	71.1		
1500 – 1600	71.7		
1600 – 1700	76.5		
1700 – 1800	71.2		
1800 – 1900	73.8		
1900 – 2000	75.8	NA	NA
2000 – 2100	71.0		
2100 – 2200	71.4		
2200 – 2300	70.5	NA	NA
2300 – 0000	71.7		
0000 – 0100	65.7		
0100 – 0200	62.9		
0200 – 0300	61.3		
0300 – 0400	61.6		
0400 – 0500	61.2		
0500 – 0600	62.9		
0600 – 0700	67.1		

Remark: NA denote Not Available

Table 16: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL01_R1 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	69.2	NA	NA
0800 – 0900	71.7		
0900 – 1000	72.7		
1000 – 1100	73.0		
1100 – 1200	71.3		
1200 – 1300	71.9		
1300 – 1400	71.5		
1400 – 1500	71.3		
1500 – 1600	71.7		
1600 – 1700	70.7		
1700 – 1800	71.4		
1800 – 1900	72.5		
1900 – 2000	70.3	NA	NA
2000 – 2100	69.8		
2100 – 2200	70.5		
2200 – 2300	70.8	NA	NA
2300 – 0000	68.6		
0000 – 0100	69.9		
0100 – 0200	63.6		
0200 – 0300	62.9		
0300 – 0400	62.4		
0400 – 0500	61.6		
0500 – 0600	63.4		
0600 – 0700	66.0		

Remark: NA denote Not Available

Table 17: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL01_R1 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	69.8	NA	NA
0800 – 0900	71.9		
0900 – 1000	71.9		
1000 – 1100	72.0		
1100 – 1200	70.7		
1200 – 1300	70.9		
1300 – 1400	70.3		
1400 – 1500	72.0		
1500 – 1600	71.3		
1600 – 1700	71.0		
1700 – 1800	71.5		
1800 – 1900	72.1		
1900 – 2000	72.4	NA	NA
2000 – 2100	70.1		
2100 – 2200	70.1		
2200 – 2300	69.0	NA	NA
2300 – 0000	67.2		
0000 – 0100	65.3		
0100 – 0200	61.3		
0200 – 0300	59.7		
0300 – 0400	59.6		
0400 – 0500	60.7		
0500 – 0600	64.5		
0600 – 0700	69.8		

Remark: NA denote Not Available

Table 18: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL01_R1 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	71.9	NA	NA
0800 – 0900	72.1		
0900 – 1000	71.8		
1000 – 1100	71.9		
1100 – 1200	70.6		
1200 – 1300	70.5		
1300 – 1400	70.9		
1400 – 1500	71.7		
1500 – 1600	70.4		
1600 – 1700	70.2		
1700 – 1800	69.9		
1800 – 1900	71.8		
1900 – 2000	70.7	NA	NA
2000 – 2100	69.1		
2100 – 2200	69.2		
2200 – 2300	68.1	NA	NA
2300 – 0000	67.3		
0000 – 0100	67.6		
0100 – 0200	61.1		
0200 – 0300	60.9		
0300 – 0400	60.4		
0400 – 0500	61.4		
0500 – 0600	64.5		
0600 – 0700	69.9		

Remark: NA denote Not Available

Table 19: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL01_R1 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	70.7	NA	NA
0800 – 0900	70.9		
0900 – 1000	70.0		
1000 – 1100	70.8		
1100 – 1200	70.1		
1200 – 1300	70.0		
1300 – 1400	69.2		
1400 – 1500	69.3		
1500 – 1600	70.5		
1600 – 1700	70.4		
1700 – 1800	70.0		
1800 – 1900	71.6		
1900 – 2000	70.5	NA	NA
2000 – 2100	68.6		
2100 – 2200	68.4		
2200 – 2300	67.9	NA	NA
2300 – 0000	67.3		
0000 – 0100	64.4		
0100 – 0200	61.6		
0200 – 0300	59.6		
0300 – 0400	61.7		
0400 – 0500	60.0		
0500 – 0600	63.7		
0600 – 0700	68.3		

Remark: NA denote Not Available

Table 20: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL01_R1 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	70.3	NA	NA
0800 – 0900	71.2		
0900 – 1000	72.8		
1000 – 1100	72.3		
1100 – 1200	70.4		
1200 – 1300	69.2		
1300 – 1400	68.8		
1400 – 1500	71.5		
1500 – 1600	70.5		
1600 – 1700	70.6		
1700 – 1800	69.9		
1800 – 1900	70.7		
1900 – 2000	70.3	NA	NA
2000 – 2100	69.2		
2100 – 2200	68.6		
2200 – 2300	67.8	NA	NA
2300 – 0000	68.1		
0000 – 0100	63.9		
0100 – 0200	59.3		
0200 – 0300	59.6		
0300 – 0400	58.9		
0400 – 0500	58.8		
0500 – 0600	63.9		
0600 – 0700	67.8		

Remark: NA denote Not Available

Table 21: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL03_R1 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	53.1	NA	NA
0800 – 0900	55.3		
0900 – 1000	55.1		
1000 – 1100	53.9		
1100 – 1200	53.1		
1200 – 1300	57.0		
1300 – 1400	54.7		
1400 – 1500	52.8		
1500 – 1600	58.0		
1600 – 1700	52.3		
1700 – 1800	51.9		
1800 – 1900	52.5		
1900 – 2000	52.4	NA	NA
2000 – 2100	53.2		
2100 – 2200	54.2		
2200 – 2300	54.9	NA	NA
2300 – 0000	54.8		
0000 – 0100	54.1		
0100 – 0200	55.1		
0200 – 0300	54.6		
0300 – 0400	52.8		
0400 – 0500	50.7		
0500 – 0600	48.2		
0600 – 0700	51.0		

Remark: NA denote Not Available

Table 22: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL03_R1 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	51.9	NA	NA
0800 – 0900	54.0		
0900 – 1000	54.4		
1000 – 1100	54.6		
1100 – 1200	53.2		
1200 – 1300	51.7		
1300 – 1400	53.6		
1400 – 1500	51.2		
1500 – 1600	51.7		
1600 – 1700	51.8		
1700 – 1800	52.8		
1800 – 1900	64.1		
1900 – 2000	53.9	NA	NA
2000 – 2100	52.9		
2100 – 2200	54.7		
2200 – 2300	54.2	NA	NA
2300 – 0000	54.3		
0000 – 0100	54.9		
0100 – 0200	53.5		
0200 – 0300	52.9		
0300 – 0400	52.3		
0400 – 0500	49.9		
0500 – 0600	50.1		
0600 – 0700	51.6		

Remark: NA denote Not Available

Table 23: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL03_R1 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	50.8	NA	NA
0800 – 0900	53.6		
0900 – 1000	52.8		
1000 – 1100	53.5		
1100 – 1200	53.4		
1200 – 1300	52.3		
1300 – 1400	53.5		
1400 – 1500	56.8		
1500 – 1600	51.6		
1600 – 1700	52.2		
1700 – 1800	51.7		
1800 – 1900	52.6		
1900 – 2000	51.0	NA	NA
2000 – 2100	53.1		
2100 – 2200	53.7		
2200 – 2300	53.2	NA	NA
2300 – 0000	53.2		
0000 – 0100	55.0		
0100 – 0200	54.6		
0200 – 0300	54.0		
0300 – 0400	52.9		
0400 – 0500	51.2		
0500 – 0600	50.1		
0600 – 0700	50.1		

Remark: NA denote Not Available

Table 24: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL03_R1 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	50.4	NA	NA
0800 – 0900	56.7		
0900 – 1000	55.9		
1000 – 1100	53.4		
1100 – 1200	56.0		
1200 – 1300	60.4		
1300 – 1400	56.3		
1400 – 1500	55.4		
1500 – 1600	59.4		
1600 – 1700	51.8		
1700 – 1800	55.8		
1800 – 1900	52.7		
1900 – 2000	55.6	NA	NA
2000 – 2100	55.9		
2100 – 2200	55.8		
2200 – 2300	54.4	NA	NA
2300 – 0000	57.5		
0000 – 0100	53.1		
0100 – 0200	52.8		
0200 – 0300	51.8		
0300 – 0400	52.8		
0400 – 0500	52.6		
0500 – 0600	49.6		
0600 – 0700	49.3		

Remark: NA denote Not Available

Table 25: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL03_R1 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	51.0	NA	NA
0800 – 0900	55.4		
0900 – 1000	53.2		
1000 – 1100	57.5		
1100 – 1200	58.9		
1200 – 1300	55.0		
1300 – 1400	54.4		
1400 – 1500	56.0		
1500 – 1600	54.3		
1600 – 1700	52.9		
1700 – 1800	53.4		
1800 – 1900	53.1		
1900 – 2000	52.2	NA	NA
2000 – 2100	54.7		
2100 – 2200	55.6		
2200 – 2300	53.9	NA	NA
2300 – 0000	53.2		
0000 – 0100	52.8		
0100 – 0200	53.4		
0200 – 0300	51.4		
0300 – 0400	51.3		
0400 – 0500	50.0		
0500 – 0600	49.1		
0600 – 0700	49.9		

Remark: NA denote Not Available

Table 26: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL03_R1 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	51.9	NA	NA
0800 – 0900	51.9		
0900 – 1000	52.2		
1000 – 1100	57.3		
1100 – 1200	52.1		
1200 – 1300	51.6		
1300 – 1400	52.1		
1400 – 1500	53.7		
1500 – 1600	53.3		
1600 – 1700	51.1		
1700 – 1800	53.4		
1800 – 1900	53.5		
1900 – 2000	50.4	NA	NA
2000 – 2100	52.7		
2100 – 2200	56.0		
2200 – 2300	59.9	NA	NA
2300 – 0000	59.4		
0000 – 0100	52.5		
0100 – 0200	51.5		
0200 – 0300	51.7		
0300 – 0400	51.8		
0400 – 0500	50.6		
0500 – 0600	52.1		
0600 – 0700	49.9		

Remark: NA denote Not Available

Table 27: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL03_R1 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	50.0	NA	NA
0800 – 0900	54.6		
0900 – 1000	66.3		
1000 – 1100	52.1		
1100 – 1200	52.6		
1200 – 1300	52.7		
1300 – 1400	52.1		
1400 – 1500	52.7		
1500 – 1600	52.7		
1600 – 1700	51.7		
1700 – 1800	51.2		
1800 – 1900	50.9		
1900 – 2000	52.0	NA	NA
2000 – 2100	57.3		
2100 – 2200	57.2		
2200 – 2300	56.0	NA	NA
2300 – 0000	55.1		
0000 – 0100	62.1		
0100 – 0200	62.1		
0200 – 0300	62.0		
0300 – 0400	60.3		
0400 – 0500	49.0		
0500 – 0600	48.5		
0600 – 0700	48.2		

Remark: NA denote Not Available

Table 28: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL04_R1 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	69.1	NA	NA
0800 – 0900	72.3		
0900 – 1000	74.4		
1000 – 1100	73.1		
1100 – 1200	72.4		
1200 – 1300	71.5		
1300 – 1400	72.3		
1400 – 1500	71.9		
1500 – 1600	72.7		
1600 – 1700	72.4		
1700 – 1800	72.8		
1800 – 1900	73.6		
1900 – 2000	72.0	NA	NA
2000 – 2100	70.9		
2100 – 2200	71.6		
2200 – 2300	71.5	NA	NA
2300 – 0000	71.0		
0000 – 0100	66.2		
0100 – 0200	59.0		
0200 – 0300	55.5		
0300 – 0400	53.8		
0400 – 0500	54.9		
0500 – 0600	60.8		
0600 – 0700	64.0		

Remark: NA denote Not Available

Table 29: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL04_R1 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	69.1	NA	NA
0800 – 0900	72.1		
0900 – 1000	74.1		
1000 – 1100	74.7		
1100 – 1200	73.3		
1200 – 1300	73.3		
1300 – 1400	73.8		
1400 – 1500	73.0		
1500 – 1600	73.1		
1600 – 1700	73.1		
1700 – 1800	73.9		
1800 – 1900	75.0		
1900 – 2000	73.4	NA	NA
2000 – 2100	71.2		
2100 – 2200	72.4		
2200 – 2300	72.0	NA	NA
2300 – 0000	72.6		
0000 – 0100	66.2		
0100 – 0200	56.5		
0200 – 0300	55.2		
0300 – 0400	53.0		
0400 – 0500	56.5		
0500 – 0600	58.4		
0600 – 0700	63.9		

Remark: NA denote Not Available

Table 30: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL04_R1 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	68.4	NA	NA
0800 – 0900	72.5		
0900 – 1000	74.3		
1000 – 1100	74.9		
1100 – 1200	73.8		
1200 – 1300	73.5		
1300 – 1400	73.2		
1400 – 1500	73.1		
1500 – 1600	73.3		
1600 – 1700	73.0		
1700 – 1800	73.5		
1800 – 1900	74.6		
1900 – 2000	71.8	NA	NA
2000 – 2100	70.3		
2100 – 2200	71.9		
2200 – 2300	71.7	NA	NA
2300 – 0000	68.7		
0000 – 0100	67.0		
0100 – 0200	66.7		
0200 – 0300	54.3		
0300 – 0400	55.3		
0400 – 0500	56.3		
0500 – 0600	59.6		
0600 – 0700	63.5		

Remark: NA denote Not Available

Table 31: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL04_R1 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	67.0	NA	NA
0800 – 0900	72.1		
0900 – 1000	72.1		
1000 – 1100	71.8		
1100 – 1200	71.0		
1200 – 1300	70.9		
1300 – 1400	70.0		
1400 – 1500	71.7		
1500 – 1600	71.1		
1600 – 1700	71.5		
1700 – 1800	71.4		
1800 – 1900	72.4		
1900 – 2000	71.9	NA	NA
2000 – 2100	69.8		
2100 – 2200	70.8		
2200 – 2300	69.6	NA	NA
2300 – 0000	67.0		
0000 – 0100	64.8		
0100 – 0200	56.4		
0200 – 0300	54.4		
0300 – 0400	54.6		
0400 – 0500	57.1		
0500 – 0600	61.3		
0600 – 0700	63.8		

Remark: NA denote Not Available

Table 32: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL04_R1 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	69.1	NA	NA
0800 – 0900	71.8		
0900 – 1000	71.4		
1000 – 1100	71.4		
1100 – 1200	71.3		
1200 – 1300	70.4		
1300 – 1400	70.6		
1400 – 1500	71.4		
1500 – 1600	70.4		
1600 – 1700	71.0		
1700 – 1800	71.3		
1800 – 1900	72.7		
1900 – 2000	71.0	NA	NA
2000 – 2100	69.8		
2100 – 2200	71.5		
2200 – 2300	70.1	NA	NA
2300 – 0000	67.8		
0000 – 0100	66.9		
0100 – 0200	56.8		
0200 – 0300	55.1		
0300 – 0400	54.8		
0400 – 0500	57.8		
0500 – 0600	58.9		
0600 – 0700	64.7		

Remark: NA denote Not Available

Table 33: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL04_R1 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	69.5	NA	NA
0800 – 0900	71.3		
0900 – 1000	70.4		
1000 – 1100	71.4		
1100 – 1200	71.4		
1200 – 1300	70.8		
1300 – 1400	70.1		
1400 – 1500	70.3		
1500 – 1600	70.8		
1600 – 1700	71.6		
1700 – 1800	71.8		
1800 – 1900	73.0		
1900 – 2000	71.4	NA	NA
2000 – 2100	69.8		
2100 – 2200	71.1		
2200 – 2300	70.1	NA	NA
2300 – 0000	68.3		
0000 – 0100	65.5		
0100 – 0200	57.4		
0200 – 0300	58.0		
0300 – 0400	59.1		
0400 – 0500	53.7		
0500 – 0600	58.1		
0600 – 0700	66.1		

Remark: NA denote Not Available

Table 34: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL04_R1 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	68.4	NA	NA
0800 – 0900	71.6		
0900 – 1000	72.9		
1000 – 1100	72.5		
1100 – 1200	72.0		
1200 – 1300	70.7		
1300 – 1400	69.9		
1400 – 1500	70.9		
1500 – 1600	71.3		
1600 – 1700	71.7		
1700 – 1800	71.7		
1800 – 1900	72.4		
1900 – 2000	71.7	NA	NA
2000 – 2100	70.2		
2100 – 2200	71.0		
2200 – 2300	71.2	NA	NA
2300 – 0000	69.9		
0000 – 0100	65.3		
0100 – 0200	55.4		
0200 – 0300	55.3		
0300 – 0400	55.3		
0400 – 0500	53.6		
0500 – 0600	59.6		
0600 – 0700	63.7		

Remark: NA denote Not Available

Table 35: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL05_R1 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	53.3	NA	NA
0800 – 0900	54.6		
0900 – 1000	52.8		
1000 – 1100	46.6		
1100 – 1200	46.3		
1200 – 1300	55.0		
1300 – 1400	50.2		
1400 – 1500	47.6		
1500 – 1600	56.4		
1600 – 1700	47.4		
1700 – 1800	45.6		
1800 – 1900	44.5		
1900 – 2000	47.6	NA	NA
2000 – 2100	51.6		
2100 – 2200	50.0		
2200 – 2300	47.8	NA	NA
2300 – 0000	54.9		
0000 – 0100	56.5		
0100 – 0200	53.5		
0200 – 0300	52.6		
0300 – 0400	51.0		
0400 – 0500	54.4		
0500 – 0600	52.3		
0600 – 0700	53.6		

Remark: NA denote Not Available

Table 36: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL05_R1 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	55.8	NA	NA
0800 – 0900	51.0		
0900 – 1000	47.0		
1000 – 1100	44.0		
1100 – 1200	47.8		
1200 – 1300	48.6		
1300 – 1400	47.1		
1400 – 1500	40.9		
1500 – 1600	45.0		
1600 – 1700	43.3		
1700 – 1800	47.3		
1800 – 1900	64.6		
1900 – 2000	50.5	NA	NA
2000 – 2100	58.2		
2100 – 2200	54.4		
2200 – 2300	50.6	NA	NA
2300 – 0000	47.8		
0000 – 0100	56.5		
0100 – 0200	55.6		
0200 – 0300	50.6		
0300 – 0400	51.8		
0400 – 0500	49.9		
0500 – 0600	50.9		
0600 – 0700	55.8		

Remark: NA denote Not Available

Table 37: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL05_R1 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	56.3	NA	NA
0800 – 0900	50.2		
0900 – 1000	45.5		
1000 – 1100	41.8		
1100 – 1200	47.8		
1200 – 1300	45.5		
1300 – 1400	41.1		
1400 – 1500	44.8		
1500 – 1600	41.8		
1600 – 1700	41.6		
1700 – 1800	43.7		
1800 – 1900	44.6		
1900 – 2000	46.3	NA	NA
2000 – 2100	54.9		
2100 – 2200	57.3		
2200 – 2300	61.4	NA	NA
2300 – 0000	63.2		
0000 – 0100	49.3		
0100 – 0200	50.0		
0200 – 0300	49.6		
0300 – 0400	50.3		
0400 – 0500	49.7		
0500 – 0600	48.9		
0600 – 0700	53.3		

Remark: NA denote Not Available

Table 38: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL05_R1 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	57.8	NA	NA
0800 – 0900	61.7		
0900 – 1000	51.9		
1000 – 1100	49.5		
1100 – 1200	55.8		
1200 – 1300	60.2		
1300 – 1400	53.1		
1400 – 1500	52.9		
1500 – 1600	59.7		
1600 – 1700	47.3		
1700 – 1800	54.2		
1800 – 1900	50.3		
1900 – 2000	52.9	NA	NA
2000 – 2100	57.5		
2100 – 2200	62.0		
2200 – 2300	63.2	NA	NA
2300 – 0000	63.6		
0000 – 0100	60.7		
0100 – 0200	58.7		
0200 – 0300	49.0		
0300 – 0400	49.2		
0400 – 0500	47.6		
0500 – 0600	48.6		
0600 – 0700	51.9		

Remark: NA denote Not Available

Table 39: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL05_R1 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	61.6	NA	NA
0800 – 0900	61.4		
0900 – 1000	49.1		
1000 – 1100	56.4		
1100 – 1200	57.6		
1200 – 1300	52.6		
1300 – 1400	53.9		
1400 – 1500	55.8		
1500 – 1600	53.1		
1600 – 1700	47.1		
1700 – 1800	50.8		
1800 – 1900	48.4		
1900 – 2000	48.8	NA	NA
2000 – 2100	51.9		
2100 – 2200	56.1		
2200 – 2300	52.0	NA	NA
2300 – 0000	52.5		
0000 – 0100	61.8		
0100 – 0200	58.0		
0200 – 0300	59.1		
0300 – 0400	49.6		
0400 – 0500	50.1		
0500 – 0600	48.1		
0600 – 0700	50.5		

Remark: NA denote Not Available

Table 40: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL05_R1 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	53.9	NA	NA
0800 – 0900	48.6		
0900 – 1000	46.4		
1000 – 1100	53.6		
1100 – 1200	49.2		
1200 – 1300	51.3		
1300 – 1400	48.7		
1400 – 1500	50.0		
1500 – 1600	50.9		
1600 – 1700	47.3		
1700 – 1800	49.9		
1800 – 1900	49.7		
1900 – 2000	46.4	NA	NA
2000 – 2100	55.6		
2100 – 2200	49.5		
2200 – 2300	47.8	NA	NA
2300 – 0000	53.1		
0000 – 0100	50.7		
0100 – 0200	47.9		
0200 – 0300	48.3		
0300 – 0400	48.3		
0400 – 0500	51.1		
0500 – 0600	47.3		
0600 – 0700	51.9		

Remark: NA denote Not Available

Table 41: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL05_R1 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	55.4	NA	NA
0800 – 0900	52.0		
0900 – 1000	62.1		
1000 – 1100	46.2		
1100 – 1200	48.3		
1200 – 1300	45.6		
1300 – 1400	47.5		
1400 – 1500	48.0		
1500 – 1600	47.3		
1600 – 1700	44.8		
1700 – 1800	44.0		
1800 – 1900	44.8		
1900 – 2000	49.3	NA	NA
2000 – 2100	54.4		
2100 – 2200	53.6		
2200 – 2300	52.3	NA	NA
2300 – 0000	51.6		
0000 – 0100	53.9		
0100 – 0200	51.6		
0200 – 0300	52.9		
0300 – 0400	50.9		
0400 – 0500	48.7		
0500 – 0600	49.8		
0600 – 0700	52.2		

Remark: NA denote Not Available

Table 42: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL06_R1 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	48.4	NA	NA
0800 – 0900	54.4		
0900 – 1000	52.2		
1000 – 1100	48.7		
1100 – 1200	48.4		
1200 – 1300	60.6		
1300 – 1400	52.3		
1400 – 1500	48.6		
1500 – 1600	60.8		
1600 – 1700	49.6		
1700 – 1800	46.3		
1800 – 1900	45.7		
1900 – 2000	47.5	NA	NA
2000 – 2100	56.8		
2100 – 2200	56.6		
2200 – 2300	55.6	NA	NA
2300 – 0000	49.0		
0000 – 0100	45.2		
0100 – 0200	46.2		
0200 – 0300	48.9		
0300 – 0400	45.4		
0400 – 0500	46.4		
0500 – 0600	47.0		
0600 – 0700	49.1		

Remark: NA denote Not Available

Table 43: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL06_R1 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	50.9	NA	NA
0800 – 0900	53.2		
0900 – 1000	48.8		
1000 – 1100	44.1		
1100 – 1200	51.8		
1200 – 1300	52.3		
1300 – 1400	50.9		
1400 – 1500	43.3		
1500 – 1600	46.3		
1600 – 1700	45.1		
1700 – 1800	49.0		
1800 – 1900	66.7		
1900 – 2000	51.7	NA	NA
2000 – 2100	51.1		
2100 – 2200	52.9		
2200 – 2300	51.2	NA	NA
2300 – 0000	48.5		
0000 – 0100	46.1		
0100 – 0200	47.5		
0200 – 0300	45.6		
0300 – 0400	46.2		
0400 – 0500	46.2		
0500 – 0600	46.4		
0600 – 0700	49.3		

Remark: NA denote Not Available

Table 44: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL06_R1 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	50.0	NA	NA
0800 – 0900	48.3		
0900 – 1000	46.2		
1000 – 1100	41.5		
1100 – 1200	48.9		
1200 – 1300	47.6		
1300 – 1400	42.4		
1400 – 1500	46.1		
1500 – 1600	48.3		
1600 – 1700	46.4		
1700 – 1800	46.0		
1800 – 1900	44.9		
1900 – 2000	48.4	NA	NA
2000 – 2100	50.4		
2100 – 2200	50.2		
2200 – 2300	51.5	NA	NA
2300 – 0000	48.4		
0000 – 0100	46.4		
0100 – 0200	47.0		
0200 – 0300	46.1		
0300 – 0400	46.1		
0400 – 0500	46.7		
0500 – 0600	46.7		
0600 – 0700	48.9		

Remark: NA denote Not Available

Table 45: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL06_R1 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	48.4	NA	NA
0800 – 0900	56.9		
0900 – 1000	55.0		
1000 – 1100	53.1		
1100 – 1200	59.0		
1200 – 1300	63.9		
1300 – 1400	57.8		
1400 – 1500	55.7		
1500 – 1600	61.0		
1600 – 1700	47.2		
1700 – 1800	57.6		
1800 – 1900	51.4		
1900 – 2000	58.3	NA	NA
2000 – 2100	59.4		
2100 – 2200	58.6		
2200 – 2300	55.0	NA	NA
2300 – 0000	53.0		
0000 – 0100	47.1		
0100 – 0200	45.9		
0200 – 0300	46.0		
0300 – 0400	46.6		
0400 – 0500	47.3		
0500 – 0600	46.7		
0600 – 0700	48.9		

Remark: NA denote Not Available

Table 46: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL06_R1 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	51.0	NA	NA
0800 – 0900	55.0		
0900 – 1000	51.3		
1000 – 1100	59.7		
1100 – 1200	61.3		
1200 – 1300	56.3		
1300 – 1400	55.4		
1400 – 1500	58.0		
1500 – 1600	57.7		
1600 – 1700	50.1		
1700 – 1800	54.2		
1800 – 1900	50.9		
1900 – 2000	53.0	NA	NA
2000 – 2100	49.8		
2100 – 2200	57.6		
2200 – 2300	47.6	NA	NA
2300 – 0000	47.1		
0000 – 0100	49.1		
0100 – 0200	48.9		
0200 – 0300	49.5		
0300 – 0400	49.1		
0400 – 0500	48.9		
0500 – 0600	47.1		
0600 – 0700	49.0		

Remark: NA denote Not Available

Table 47: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL06_R1 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	47.0	NA	NA
0800 – 0900	46.6		
0900 – 1000	47.8		
1000 – 1100	53.9		
1100 – 1200	53.3		
1200 – 1300	48.7		
1300 – 1400	52.3		
1400 – 1500	51.7		
1500 – 1600	54.8		
1600 – 1700	50.8		
1700 – 1800	53.3		
1800 – 1900	52.2		
1900 – 2000	47.5	NA	NA
2000 – 2100	50.8		
2100 – 2200	55.7		
2200 – 2300	48.6	NA	NA
2300 – 0000	47.3		
0000 – 0100	45.4		
0100 – 0200	45.0		
0200 – 0300	45.4		
0300 – 0400	45.9		
0400 – 0500	46.6		
0500 – 0600	46.5		
0600 – 0700	47.6		

Remark: NA denote Not Available

Table 48: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL06_R1 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	48.9	NA	NA
0800 – 0900	50.0		
0900 – 1000	59.8		
1000 – 1100	46.8		
1100 – 1200	50.8		
1200 – 1300	46.9		
1300 – 1400	48.8		
1400 – 1500	49.9		
1500 – 1600	47.8		
1600 – 1700	46.2		
1700 – 1800	45.1		
1800 – 1900	46.3		
1900 – 2000	47.6	NA	NA
2000 – 2100	51.1		
2100 – 2200	52.0		
2200 – 2300	48.7	NA	NA
2300 – 0000	47.1		
0000 – 0100	46.2		
0100 – 0200	45.1		
0200 – 0300	45.1		
0300 – 0400	45.8		
0400 – 0500	46.6		
0500 – 0600	48.1		
0600 – 0700	47.7		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 49: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL07_R1 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	52.1	NA	NA
0800 – 0900	53.6		
0900 – 1000	54.8		
1000 – 1100	56.8		
1100 – 1200	55.0		
1200 – 1300	55.1		
1300 – 1400	56.6		
1400 – 1500	66.4		
1500 – 1600	58.8		
1600 – 1700	55.4		
1700 – 1800	55.1		
1800 – 1900	56.4		
1900 – 2000	59.7	NA	NA
2000 – 2100	60.8		
2100 – 2200	59.0		
2200 – 2300	54.5	NA	NA
2300 – 0000	55.2		
0000 – 0100	50.5		
0100 – 0200	48.2		
0200 – 0300	48.0		
0300 – 0400	47.8		
0400 – 0500	48.8		
0500 – 0600	47.9		
0600 – 0700	48.2		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 50: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL07_R1 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	54.1	NA	NA
0800 – 0900	53.2		
0900 – 1000	52.4		
1000 – 1100	55.2		
1100 – 1200	54.2		
1200 – 1300	56.7		
1300 – 1400	55.5		
1400 – 1500	67.3		
1500 – 1600	56.9		
1600 – 1700	57.0		
1700 – 1800	63.3		
1800 – 1900	54.0		
1900 – 2000	60.3	NA	65
2000 – 2100	62.7		
2100 – 2200	61.9		
2200 – 2300	55.6	NA	55
2300 – 0000	54.3		
0000 – 0100	51.9		
0100 – 0200	49.0		
0200 – 0300	46.6		
0300 – 0400	47.6		
0400 – 0500	50.6		
0500 – 0600	49.1		
0600 – 0700	48.4		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 51: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL07_R1 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	51.5	NA	NA
0800 – 0900	55.7		
0900 – 1000	57.5		
1000 – 1100	58.1		
1100 – 1200	54.5		
1200 – 1300	54.6		
1300 – 1400	56.3		
1400 – 1500	54.7		
1500 – 1600	55.9		
1600 – 1700	52.8		
1700 – 1800	53.6		
1800 – 1900	56.2		
1900 – 2000	57.2	NA	NA
2000 – 2100	58.9		
2100 – 2200	58.9		
2200 – 2300	57.0	NA	NA
2300 – 0000	55.8		
0000 – 0100	52.1		
0100 – 0200	56.2		
0200 – 0300	54.5		
0300 – 0400	50.8		
0400 – 0500	49.3		
0500 – 0600	48.4		
0600 – 0700	49.4		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 52: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL07_R1 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	52.1	NA	NA
0800 – 0900	56.4		
0900 – 1000	55.7		
1000 – 1100	54.0		
1100 – 1200	55.2		
1200 – 1300	52.7		
1300 – 1400	56.0		
1400 – 1500	54.3		
1500 – 1600	59.8		
1600 – 1700	53.4		
1700 – 1800	53.5		
1800 – 1900	55.6		
1900 – 2000	59.6	NA	NA
2000 – 2100	59.9		
2100 – 2200	59.2		
2200 – 2300	58.9	NA	NA
2300 – 0000	57.7		
0000 – 0100	56.8		
0100 – 0200	56.1		
0200 – 0300	53.6		
0300 – 0400	50.3		
0400 – 0500	53.7		
0500 – 0600	48.6		
0600 – 0700	62.3		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 53: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL07_R1 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	50.7	NA	NA
0800 – 0900	52.3		
0900 – 1000	53.7		
1000 – 1100	53.0		
1100 – 1200	52.1		
1200 – 1300	52.7		
1300 – 1400	53.1		
1400 – 1500	67.7		
1500 – 1600	56.6		
1600 – 1700	53.7		
1700 – 1800	53.9		
1800 – 1900	59.9		
1900 – 2000	57.7	NA	NA
2000 – 2100	58.0		
2100 – 2200	59.9		
2200 – 2300	60.5	NA	NA
2300 – 0000	56.7		
0000 – 0100	52.8		
0100 – 0200	52.7		
0200 – 0300	56.0		
0300 – 0400	52.4		
0400 – 0500	53.6		
0500 – 0600	68.5		
0600 – 0700	58.5		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 54: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL07_R1 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	54.0	NA	NA
0800 – 0900	52.6		
0900 – 1000	53.5		
1000 – 1100	52.3		
1100 – 1200	52.1		
1200 – 1300	52.6		
1300 – 1400	52.6		
1400 – 1500	55.9		
1500 – 1600	56.1		
1600 – 1700	54.2		
1700 – 1800	54.8		
1800 – 1900	54.8		
1900 – 2000	57.8	NA	NA
2000 – 2100	58.4		
2100 – 2200	57.6		
2200 – 2300	55.0	NA	NA
2300 – 0000	56.3		
0000 – 0100	54.9		
0100 – 0200	56.7		
0200 – 0300	55.5		
0300 – 0400	55.3		
0400 – 0500	56.6		
0500 – 0600	55.0		
0600 – 0700	55.7		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 55: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL07_R1 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	50.5	NA	NA
0800 – 0900	54.9		
0900 – 1000	53.3		
1000 – 1100	54.6		
1100 – 1200	51.5		
1200 – 1300	53.8		
1300 – 1400	57.0		
1400 – 1500	56.6		
1500 – 1600	59.3		
1600 – 1700	54.8		
1700 – 1800	59.0		
1800 – 1900	55.4		
1900 – 2000	59.3	NA	NA
2000 – 2100	60.9		
2100 – 2200	58.6		
2200 – 2300	55.3	NA	NA
2300 – 0000	55.0		
0000 – 0100	55.0		
0100 – 0200	53.4		
0200 – 0300	54.4		
0300 – 0400	48.1		
0400 – 0500	48.2		
0500 – 0600	48.0		
0600 – 0700	49.1		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 56: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL08_R1 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	49.0	NA	NA
0800 – 0900	49.6		
0900 – 1000	66.8		
1000 – 1100	58.9		
1100 – 1200	78.1		
1200 – 1300	55.1		
1300 – 1400	68.7		
1400 – 1500	54.5		
1500 – 1600	52.3		
1600 – 1700	51.8		
1700 – 1800	53.2		
1800 – 1900	52.5		
1900 – 2000	50.5	NA	NA
2000 – 2100	55.8		
2100 – 2200	51.3		
2200 – 2300	50.8	NA	NA
2300 – 0000	45.8		
0000 – 0100	47.1		
0100 – 0200	48.2		
0200 – 0300	48.4		
0300 – 0400	49.1		
0400 – 0500	48.6		
0500 – 0600	47.8		
0600 – 0700	49.5		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 57: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL08_R1 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	49.9	NA	NA
0800 – 0900	67.2		
0900 – 1000	52.7		
1000 – 1100	66.9		
1100 – 1200	54.0		
1200 – 1300	54.1		
1300 – 1400	65.8		
1400 – 1500	54.0		
1500 – 1600	52.5		
1600 – 1700	54.8		
1700 – 1800	61.3		
1800 – 1900	47.3		
1900 – 2000	52.3	NA	NA
2000 – 2100	59.3		
2100 – 2200	55.1		
2200 – 2300	49.2	NA	NA
2300 – 0000	48.6		
0000 – 0100	46.3		
0100 – 0200	46.7		
0200 – 0300	48.6		
0300 – 0400	48.1		
0400 – 0500	48.7		
0500 – 0600	48.6		
0600 – 0700	48.9		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 58: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL08_R1 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	55.0	NA	NA
0800 – 0900	52.1		
0900 – 1000	68.0		
1000 – 1100	57.6		
1100 – 1200	52.4		
1200 – 1300	67.1		
1300 – 1400	47.0		
1400 – 1500	47.6		
1500 – 1600	46.3		
1600 – 1700	46.6		
1700 – 1800	48.1		
1800 – 1900	44.5		
1900 – 2000	47.0	NA	NA
2000 – 2100	48.4		
2100 – 2200	48.1		
2200 – 2300	50.7	NA	NA
2300 – 0000	50.0		
0000 – 0100	48.3		
0100 – 0200	49.0		
0200 – 0300	48.1		
0300 – 0400	49.0		
0400 – 0500	48.7		
0500 – 0600	48.9		
0600 – 0700	49.0		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 59: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL08_R1 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	50.6	NA	NA
0800 – 0900	67.4		
0900 – 1000	55.3		
1000 – 1100	66.9		
1100 – 1200	68.7		
1200 – 1300	49.8		
1300 – 1400	66.6		
1400 – 1500	62.1		
1500 – 1600	47.9		
1600 – 1700	48.6		
1700 – 1800	46.4		
1800 – 1900	45.7		
1900 – 2000	46.1	NA	NA
2000 – 2100	48.2		
2100 – 2200	49.5		
2200 – 2300	48.4	NA	NA
2300 – 0000	48.7		
0000 – 0100	50.5		
0100 – 0200	48.3		
0200 – 0300	48.8		
0300 – 0400	47.1		
0400 – 0500	48.0		
0500 – 0600	47.5		
0600 – 0700	58.7		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 60: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL08_R1 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	51.3	NA	NA
0800 – 0900	49.6		
0900 – 1000	67.5		
1000 – 1100	48.1		
1100 – 1200	68.3		
1200 – 1300	49.9		
1300 – 1400	50.7		
1400 – 1500	46.7		
1500 – 1600	48.9		
1600 – 1700	48.3		
1700 – 1800	49.9		
1800 – 1900	60.5		
1900 – 2000	52.7	NA	NA
2000 – 2100	50.8		
2100 – 2200	50.7		
2200 – 2300	49.5	NA	NA
2300 – 0000	48.5		
0000 – 0100	48.7		
0100 – 0200	49.0		
0200 – 0300	47.5		
0300 – 0400	48.3		
0400 – 0500	47.6		
0500 – 0600	60.3		
0600 – 0700	58.1		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 61: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL08_R1 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	49.7	NA	NA
0800 – 0900	48.2		
0900 – 1000	68.1		
1000 – 1100	49.2		
1100 – 1200	66.9		
1200 – 1300	47.6		
1300 – 1400	67.0		
1400 – 1500	45.0		
1500 – 1600	46.8		
1600 – 1700	46.0		
1700 – 1800	46.4		
1800 – 1900	47.1		
1900 – 2000	46.0	NA	NA
2000 – 2100	48.9		
2100 – 2200	47.8		
2200 – 2300	48.3	NA	NA
2300 – 0000	48.1		
0000 – 0100	48.5		
0100 – 0200	49.0		
0200 – 0300	48.5		
0300 – 0400	49.9		
0400 – 0500	47.6		
0500 – 0600	48.0		
0600 – 0700	49.1		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 62: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL08_R1 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	51.5	NA	NA
0800 – 0900	67.0		
0900 – 1000	66.0		
1000 – 1100	53.5		
1100 – 1200	51.3		
1200 – 1300	67.3		
1300 – 1400	51.3		
1400 – 1500	54.2		
1500 – 1600	55.6		
1600 – 1700	54.1		
1700 – 1800	57.3		
1800 – 1900	56.2		
1900 – 2000	54.1	NA	NA
2000 – 2100	56.3		
2100 – 2200	52.4		
2200 – 2300	49.5	NA	NA
2300 – 0000	58.2		
0000 – 0100	48.6		
0100 – 0200	47.6		
0200 – 0300	48.5		
0300 – 0400	48.2		
0400 – 0500	48.1		
0500 – 0600	47.7		
0600 – 0700	49.0		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 63: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL09_R1 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	53.1	NA	NA
0800 – 0900	52.1		
0900 – 1000	54.6		
1000 – 1100	56.5		
1100 – 1200	54.1		
1200 – 1300	54.8		
1300 – 1400	54.3		
1400 – 1500	56.2		
1500 – 1600	53.9		
1600 – 1700	53.2		
1700 – 1800	52.2		
1800 – 1900	51.4		
1900 – 2000	52.2	NA	NA
2000 – 2100	54.8		
2100 – 2200	51.5		
2200 – 2300	51.0	NA	NA
2300 – 0000	49.1		
0000 – 0100	56.3		
0100 – 0200	54.4		
0200 – 0300	50.2		
0300 – 0400	50.2		
0400 – 0500	49.9		
0500 – 0600	50.0		
0600 – 0700	50.7		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 64: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL09_R1 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	49.6	NA	NA
0800 – 0900	51.9		
0900 – 1000	54.1		
1000 – 1100	52.2		
1100 – 1200	53.9		
1200 – 1300	54.7		
1300 – 1400	53.4		
1400 – 1500	54.7		
1500 – 1600	52.1		
1600 – 1700	55.6		
1700 – 1800	55.4		
1800 – 1900	50.5		
1900 – 2000	53.6	NA	NA
2000 – 2100	57.4		
2100 – 2200	53.5		
2200 – 2300	50.3	NA	NA
2300 – 0000	49.8		
0000 – 0100	51.5		
0100 – 0200	47.2		
0200 – 0300	47.1		
0300 – 0400	47.8		
0400 – 0500	47.4		
0500 – 0600	47.3		
0600 – 0700	48.1		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 65: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL09_R1 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	51.1	NA	NA
0800 – 0900	52.6		
0900 – 1000	55.0		
1000 – 1100	56.2		
1100 – 1200	53.0		
1200 – 1300	53.5		
1300 – 1400	51.3		
1400 – 1500	50.1		
1500 – 1600	50.9		
1600 – 1700	50.2		
1700 – 1800	49.9		
1800 – 1900	49.7		
1900 – 2000	49.2	NA	NA
2000 – 2100	49.4		
2100 – 2200	49.2		
2200 – 2300	50.5	NA	NA
2300 – 0000	48.6		
0000 – 0100	49.7		
0100 – 0200	48.4		
0200 – 0300	48.7		
0300 – 0400	48.5		
0400 – 0500	49.1		
0500 – 0600	48.8		
0600 – 0700	50.2		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 66: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL09_R1 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	51.3	NA	NA
0800 – 0900	53.7		
0900 – 1000	54.9		
1000 – 1100	53.3		
1100 – 1200	55.7		
1200 – 1300	52.7		
1300 – 1400	53.7		
1400 – 1500	57.2		
1500 – 1600	50.6		
1600 – 1700	49.8		
1700 – 1800	49.0		
1800 – 1900	48.6		
1900 – 2000	48.7	NA	NA
2000 – 2100	49.7		
2100 – 2200	49.0		
2200 – 2300	49.4	NA	NA
2300 – 0000	50.0		
0000 – 0100	53.1		
0100 – 0200	50.9		
0200 – 0300	48.9		
0300 – 0400	48.7		
0400 – 0500	48.7		
0500 – 0600	48.7		
0600 – 0700	63.7		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 67: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL09_R1 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	51.6	NA	NA
0800 – 0900	50.5		
0900 – 1000	52.7		
1000 – 1100	56.9		
1100 – 1200	57.1		
1200 – 1300	52.0		
1300 – 1400	51.5		
1400 – 1500	51.5		
1500 – 1600	52.5		
1600 – 1700	49.9		
1700 – 1800	50.0		
1800 – 1900	57.9		
1900 – 2000	53.7	NA	NA
2000 – 2100	50.5		
2100 – 2200	48.8		
2200 – 2300	48.6	NA	NA
2300 – 0000	49.8		
0000 – 0100	51.4		
0100 – 0200	58.0		
0200 – 0300	51.7		
0300 – 0400	49.3		
0400 – 0500	48.7		
0500 – 0600	65.9		
0600 – 0700	61.8		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 68: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL09_R1 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	51.3	NA	NA
0800 – 0900	51.6		
0900 – 1000	51.5		
1000 – 1100	52.1		
1100 – 1200	50.7		
1200 – 1300	50.0		
1300 – 1400	50.0		
1400 – 1500	49.8		
1500 – 1600	50.5		
1600 – 1700	50.1		
1700 – 1800	48.8		
1800 – 1900	49.6		
1900 – 2000	49.2	NA	NA
2000 – 2100	48.9		
2100 – 2200	49.2		
2200 – 2300	49.8	NA	NA
2300 – 0000	49.7		
0000 – 0100	48.9		
0100 – 0200	50.9		
0200 – 0300	52.0		
0300 – 0400	48.5		
0400 – 0500	48.4		
0500 – 0600	47.6		
0600 – 0700	47.8		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 69: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL09_R1 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	51.5	NA	NA
0800 – 0900	53.5		
0900 – 1000	54.3		
1000 – 1100	54.3		
1100 – 1200	52.8		
1200 – 1300	53.0		
1300 – 1400	51.3		
1400 – 1500	54.1		
1500 – 1600	54.6		
1600 – 1700	52.0		
1700 – 1800	55.7		
1800 – 1900	53.1		
1900 – 2000	55.2	NA	NA
2000 – 2100	56.1		
2100 – 2200	55.3		
2200 – 2300	49.5	NA	NA
2300 – 0000	48.9		
0000 – 0100	49.8		
0100 – 0200	49.6		
0200 – 0300	49.1		
0300 – 0400	48.9		
0400 – 0500	48.9		
0500 – 0600	48.8		
0600 – 0700	50.3		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 70: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL10_R1 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	52.1	NA	NA
0800 – 0900	52.5		
0900 – 1000	57.3		
1000 – 1100	57.6		
1100 – 1200	56.6		
1200 – 1300	55.5		
1300 – 1400	55.7		
1400 – 1500	57.6		
1500 – 1600	55.5		
1600 – 1700	52.8		
1700 – 1800	55.5		
1800 – 1900	53.1		
1900 – 2000	54.0	NA	NA
2000 – 2100	58.5		
2100 – 2200	51.2		
2200 – 2300	50.2	NA	NA
2300 – 0000	49.6		
0000 – 0100	48.8		
0100 – 0200	49.5		
0200 – 0300	49.4		
0300 – 0400	50.8		
0400 – 0500	51.0		
0500 – 0600	49.7		
0600 – 0700	48.3		

Remark: NA denote Not Available

Table 71: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL10_R1 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	48.3	NA	NA
0800 – 0900	49.8		
0900 – 1000	52.6		
1000 – 1100	55.8		
1100 – 1200	55.4		
1200 – 1300	57.3		
1300 – 1400	55.0		
1400 – 1500	61.2		
1500 – 1600	55.4		
1600 – 1700	56.2		
1700 – 1800	61.7		
1800 – 1900	53.3		
1900 – 2000	66.2	NA	NA
2000 – 2100	73.0		
2100 – 2200	56.7		
2200 – 2300	51.8	NA	NA
2300 – 0000	54.0		
0000 – 0100	50.4		
0100 – 0200	51.3		
0200 – 0300	51.2		
0300 – 0400	51.7		
0400 – 0500	50.6		
0500 – 0600	50.4		
0600 – 0700	50.3		

Remark: NA denote Not Available

Table 72: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL10_R1 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	50.0	NA	NA
0800 – 0900	54.2		
0900 – 1000	56.3		
1000 – 1100	60.0		
1100 – 1200	56.3		
1200 – 1300	56.9		
1300 – 1400	54.0		
1400 – 1500	51.0		
1500 – 1600	52.5		
1600 – 1700	50.5		
1700 – 1800	50.1		
1800 – 1900	46.1		
1900 – 2000	59.3	NA	NA
2000 – 2100	57.1		
2100 – 2200	55.5		
2200 – 2300	55.2	NA	NA
2300 – 0000	53.7		
0000 – 0100	48.4		
0100 – 0200	50.7		
0200 – 0300	50.5		
0300 – 0400	48.8		
0400 – 0500	52.4		
0500 – 0600	53.1		
0600 – 0700	53.1		

Remark: NA denote Not Available

Table 73: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL10_R1 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	48.3	NA	NA
0800 – 0900	55.8		
0900 – 1000	55.8		
1000 – 1100	55.2		
1100 – 1200	55.7		
1200 – 1300	54.5		
1300 – 1400	56.5		
1400 – 1500	53.1		
1500 – 1600	53.9		
1600 – 1700	49.0		
1700 – 1800	47.0		
1800 – 1900	45.9		
1900 – 2000	57.8	NA	NA
2000 – 2100	57.5		
2100 – 2200	55.3		
2200 – 2300	52.2	NA	NA
2300 – 0000	50.9		
0000 – 0100	52.2		
0100 – 0200	50.4		
0200 – 0300	50.9		
0300 – 0400	50.5		
0400 – 0500	49.5		
0500 – 0600	50.3		
0600 – 0700	61.4		

Remark: NA denote Not Available

Table 74: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL10_R1 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	48.9	NA	NA
0800 – 0900	49.7		
0900 – 1000	55.5		
1000 – 1100	51.2		
1100 – 1200	53.8		
1200 – 1300	53.6		
1300 – 1400	54.5		
1400 – 1500	51.5		
1500 – 1600	52.2		
1600 – 1700	51.0		
1700 – 1800	49.4		
1800 – 1900	58.6		
1900 – 2000	66.2	NA	NA
2000 – 2100	70.6		
2100 – 2200	56.3		
2200 – 2300	52.6	NA	NA
2300 – 0000	51.9		
0000 – 0100	50.1		
0100 – 0200	50.8		
0200 – 0300	50.5		
0300 – 0400	50.5		
0400 – 0500	49.8		
0500 – 0600	63.0		
0600 – 0700	53.4		

Remark: NA denote Not Available

Table 75: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL10_R1 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	48.9	NA	NA
0800 – 0900	52.2		
0900 – 1000	54.7		
1000 – 1100	55.0		
1100 – 1200	53.6		
1200 – 1300	52.6		
1300 – 1400	50.5		
1400 – 1500	49.2		
1500 – 1600	50.6		
1600 – 1700	47.4		
1700 – 1800	46.4		
1800 – 1900	45.5		
1900 – 2000	48.7	NA	NA
2000 – 2100	51.4		
2100 – 2200	51.5		
2200 – 2300	51.0	NA	NA
2300 – 0000	50.5		
0000 – 0100	51.9		
0100 – 0200	51.8		
0200 – 0300	51.5		
0300 – 0400	51.5		
0400 – 0500	51.5		
0500 – 0600	50.9		
0600 – 0700	48.9		

Remark: NA denote Not Available

Table 76: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL10_R1 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	47.9	NA	NA
0800 – 0900	52.8		
0900 – 1000	54.5		
1000 – 1100	53.6		
1100 – 1200	55.2		
1200 – 1300	55.8		
1300 – 1400	55.0		
1400 – 1500	57.3		
1500 – 1600	59.5		
1600 – 1700	55.0		
1700 – 1800	59.3		
1800 – 1900	54.3		
1900 – 2000	53.6	NA	NA
2000 – 2100	59.2		
2100 – 2200	54.4		
2200 – 2300	50.7	NA	NA
2300 – 0000	49.6		
0000 – 0100	50.1		
0100 – 0200	49.9		
0200 – 0300	50.6		
0300 – 0400	51.1		
0400 – 0500	51.1		
0500 – 0600	50.8		
0600 – 0700	50.1		

Remark: NA denote Not Available

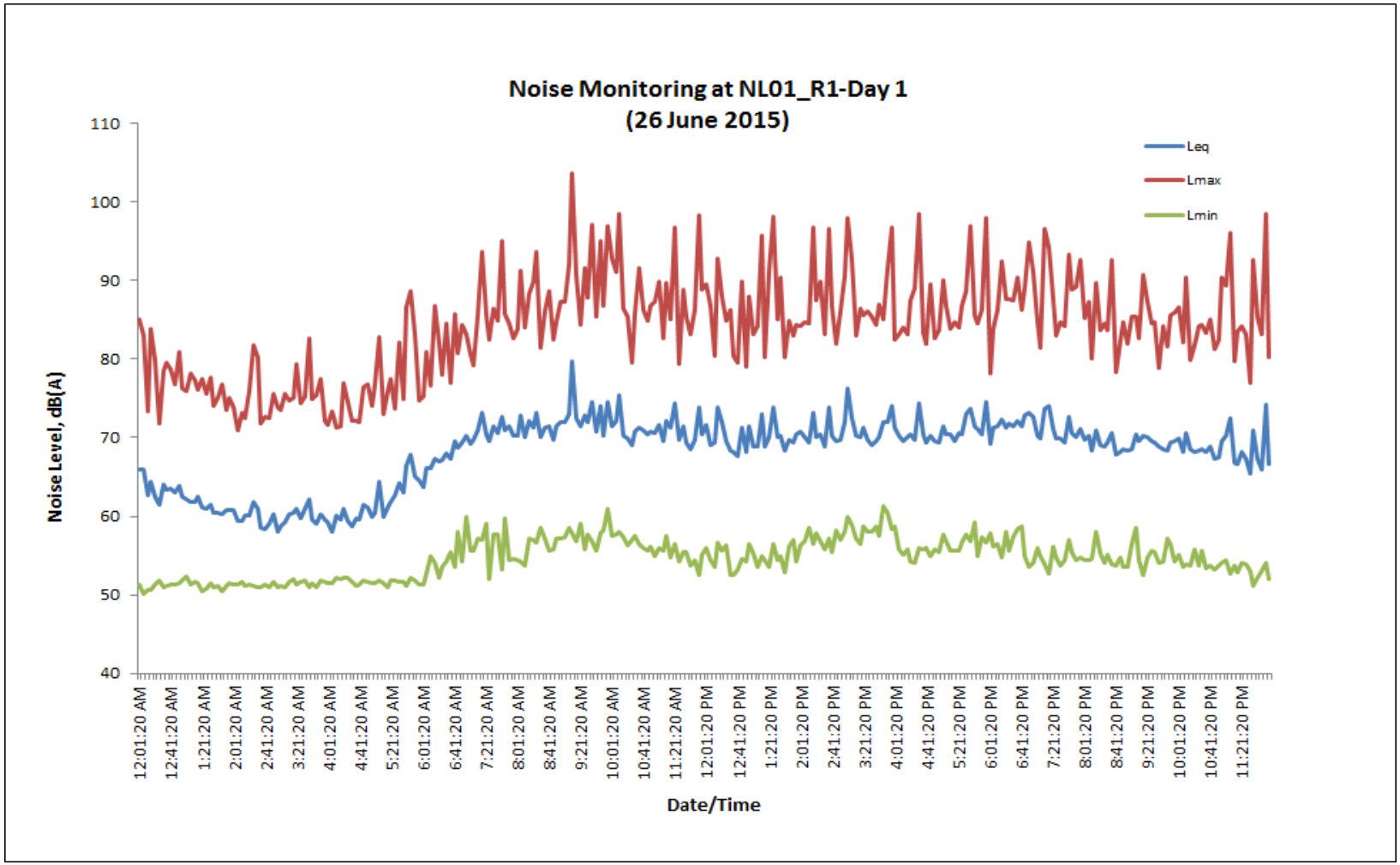

Figure 3: Daily noise level measured at Point NL01_R1 (Day 1)

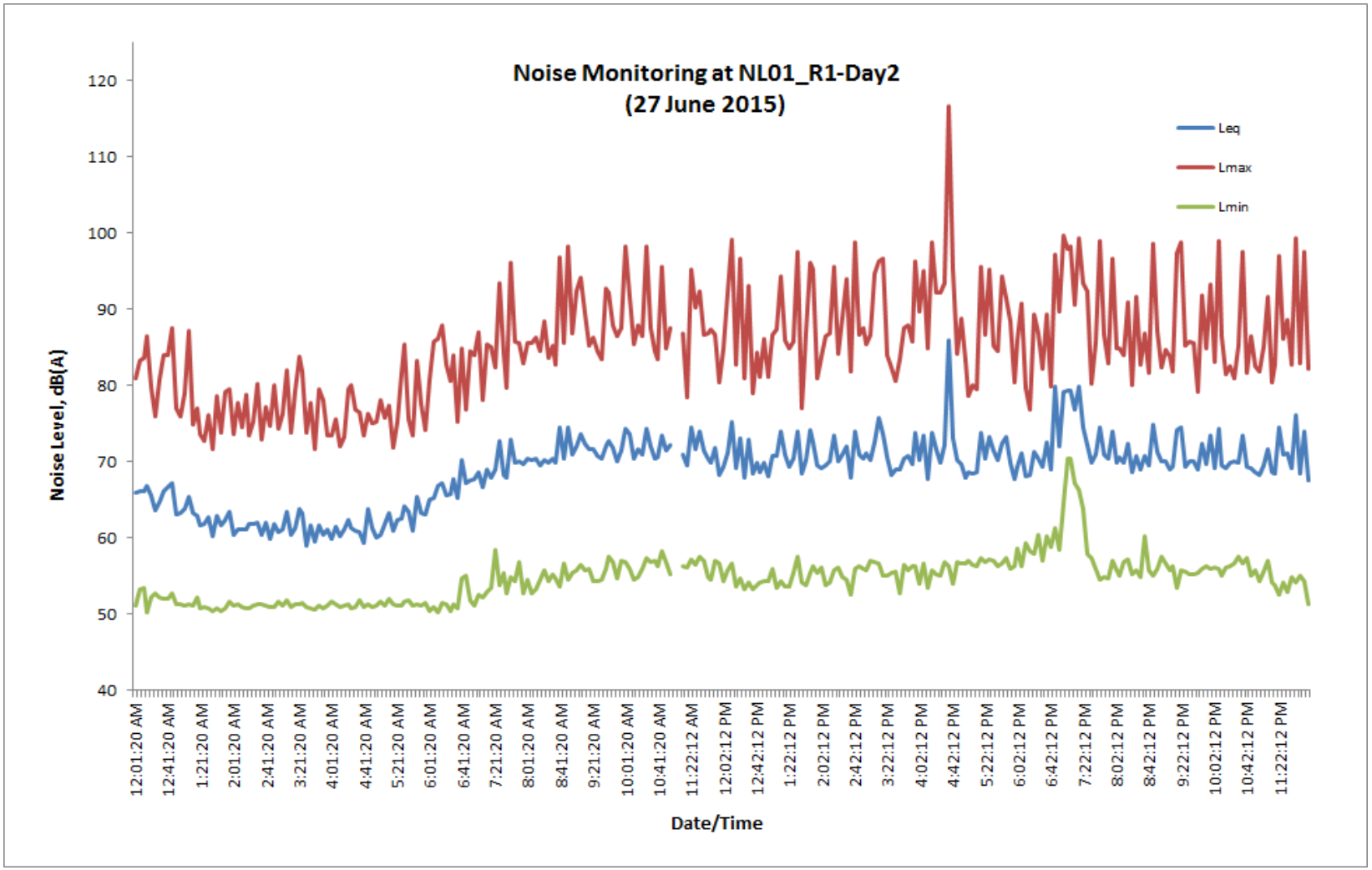

Figure 4: Daily noise level measured at Point NL01_R1 (Day 2)

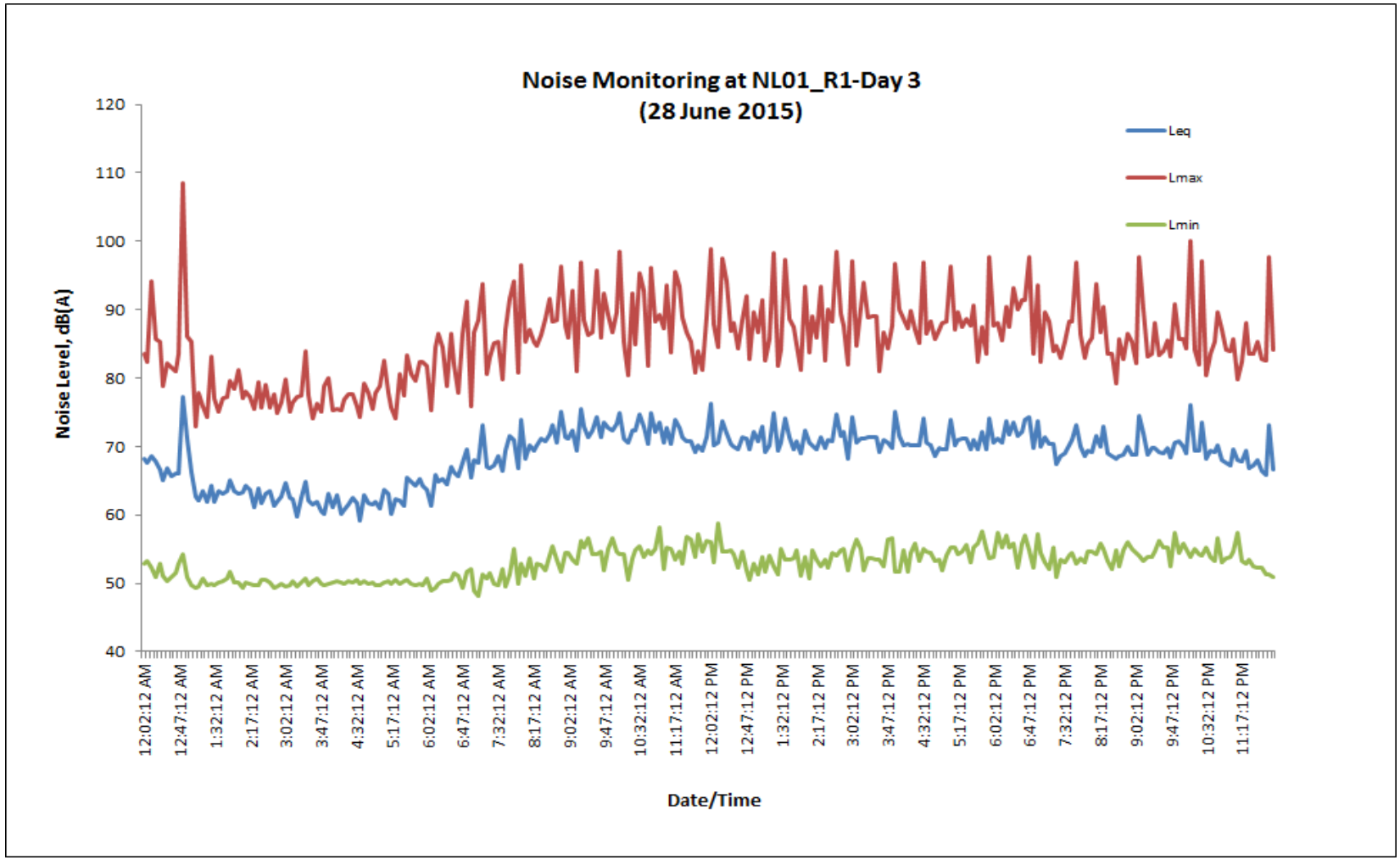

Figure 5: Daily noise level measured at Point NL01_R1 (Day 3)

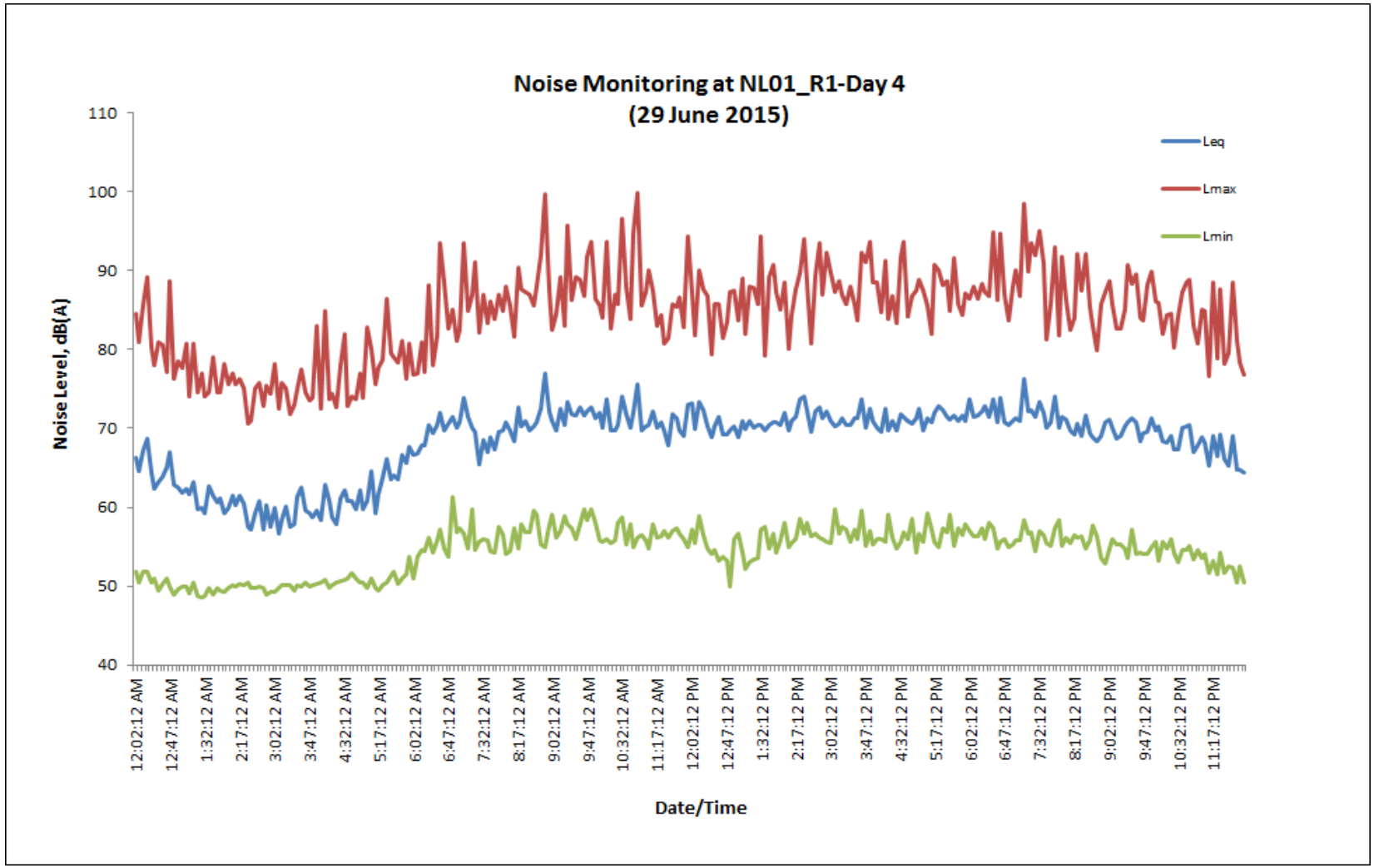

Figure 6: Daily noise level measured at Point NL01_R1 (Day 4)

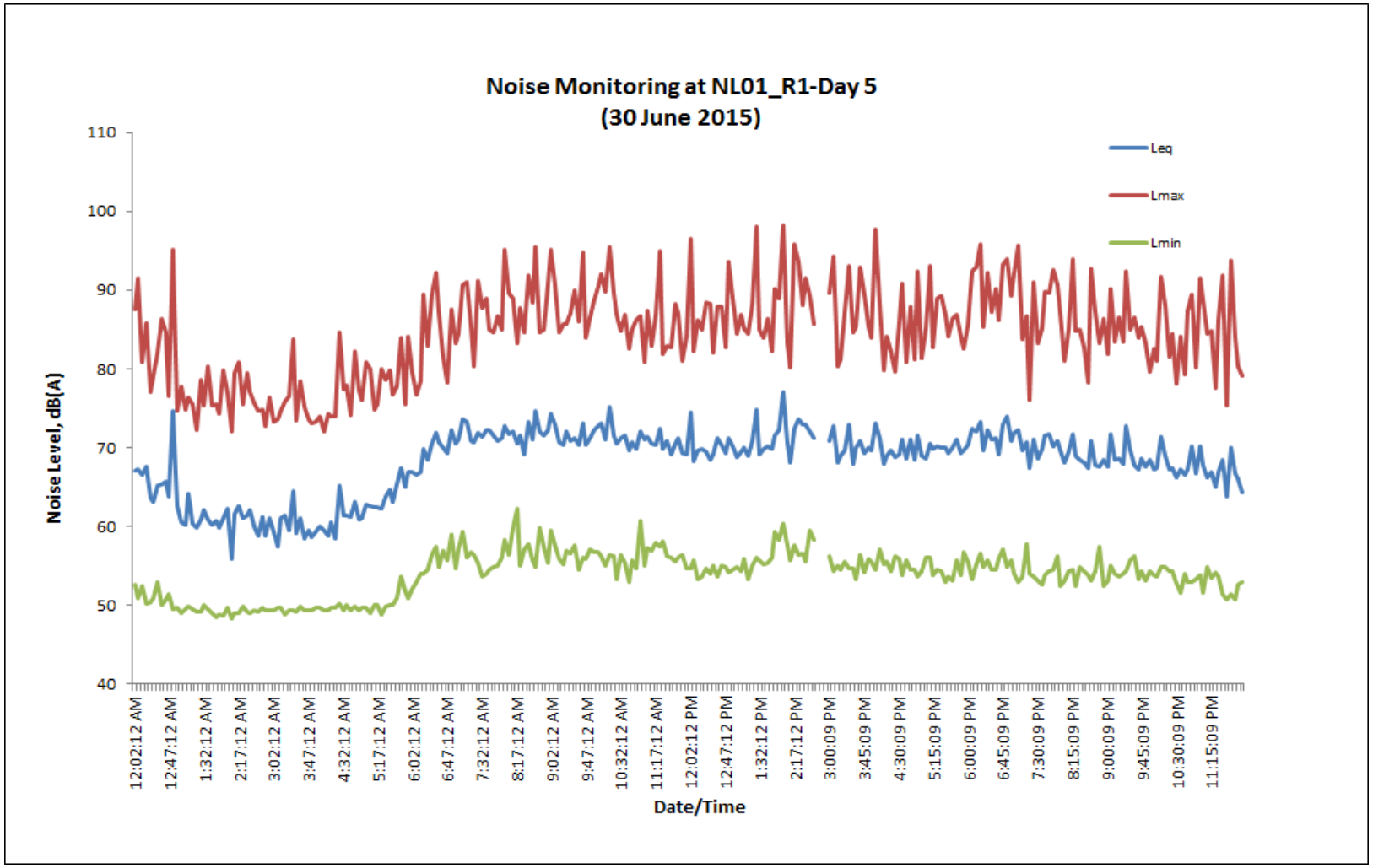

Figure 7: Daily noise level measured at Point NL01_R1 (Day 5)

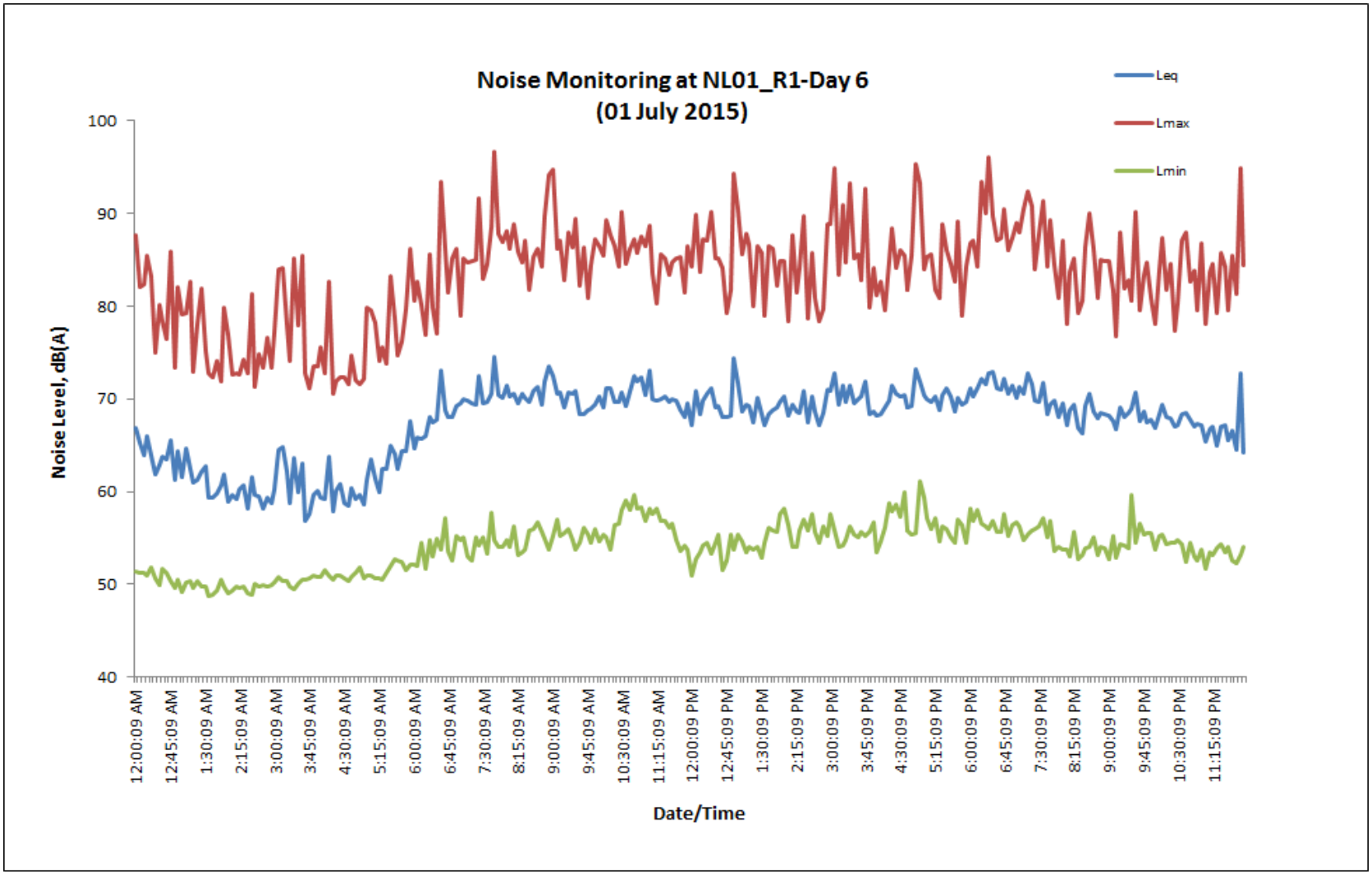

Figure 8: Daily noise level measured at Point NL01_R1 (Day 6)

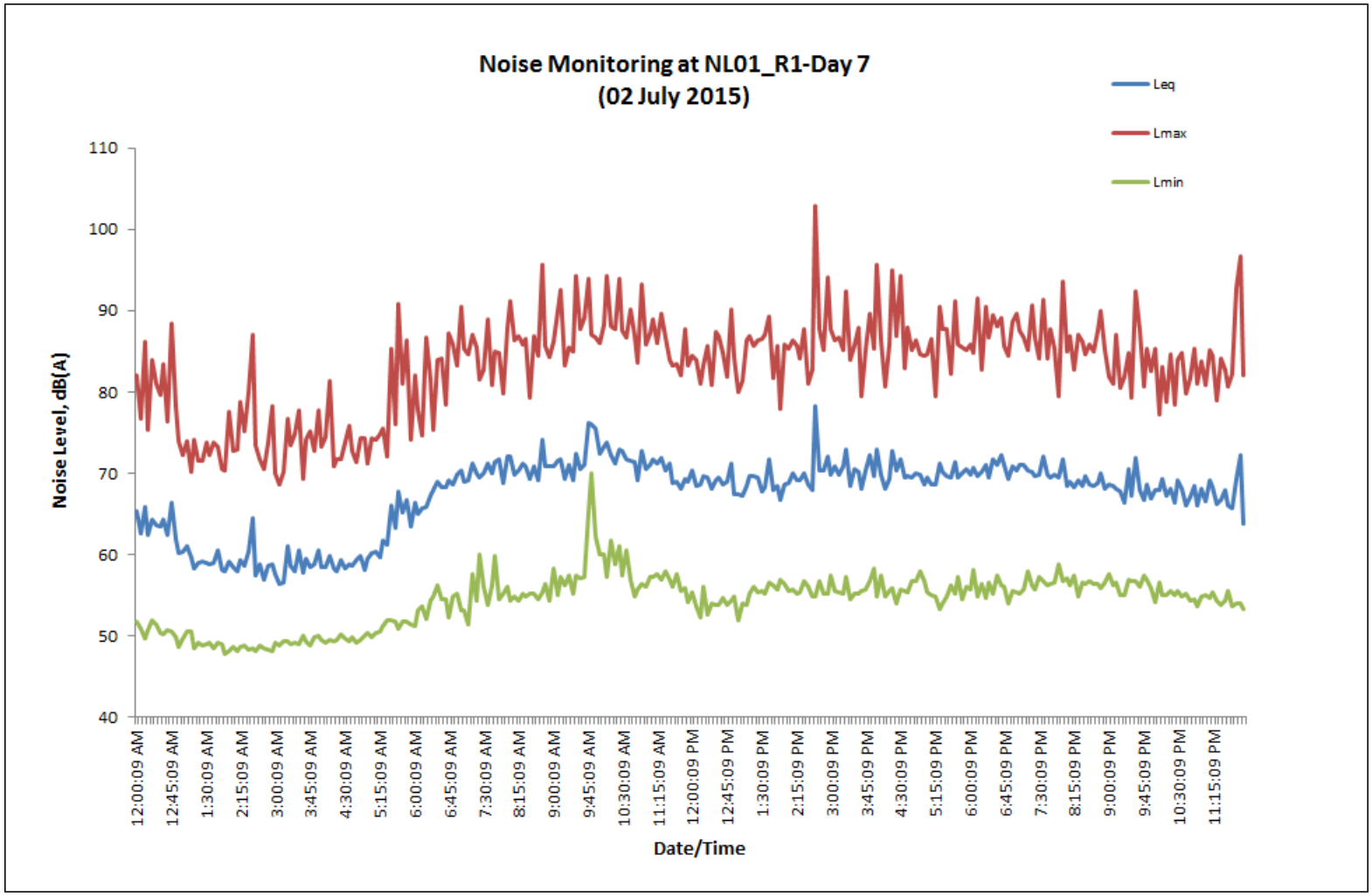

Figure 9: Daily noise level measured at Point NL01_R1 (Day 7)

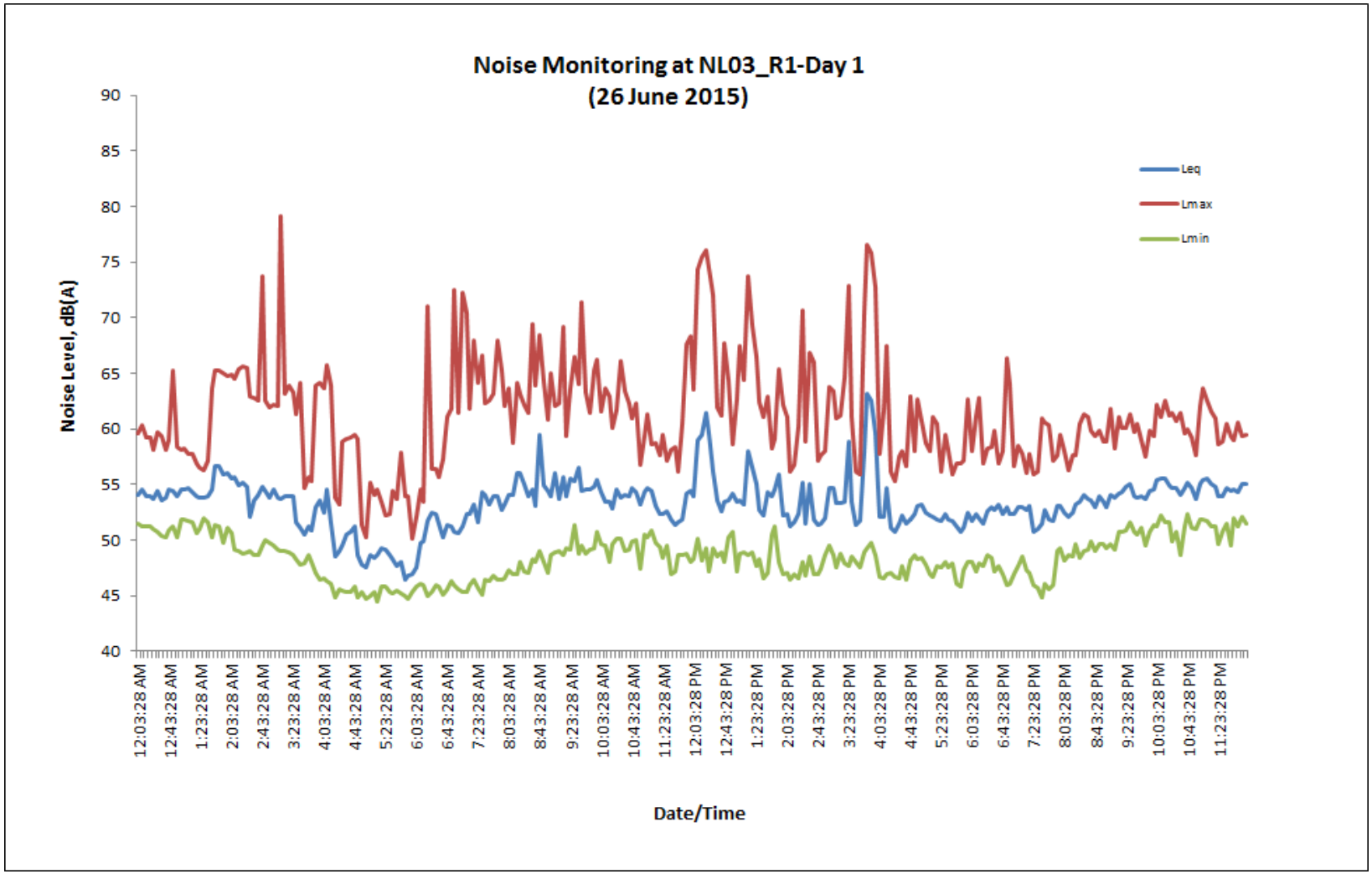

Figure 10: Daily noise level measured at Point NL03_R1 (Day 1)

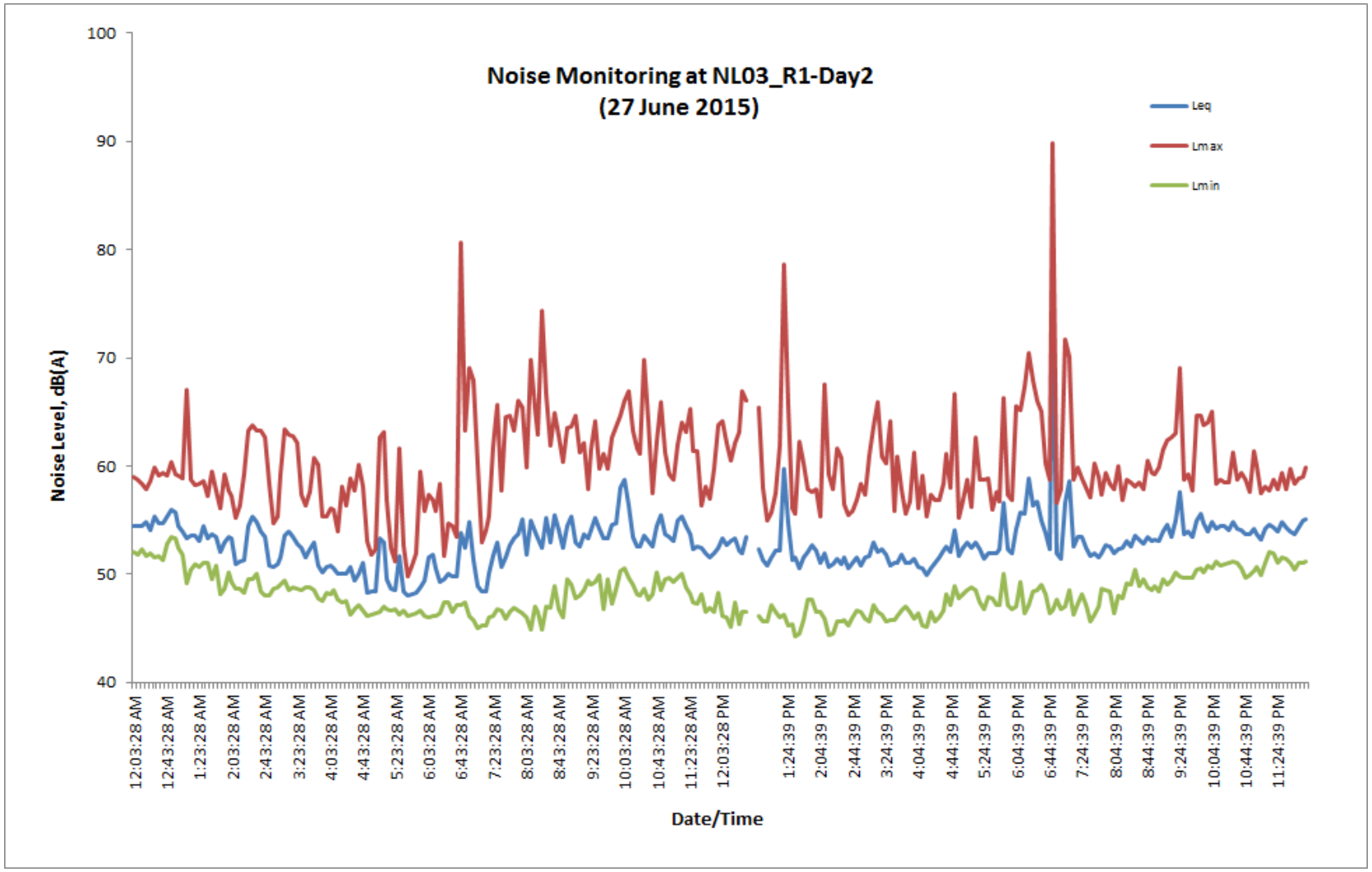

Figure 11: Daily noise level measured at Point NL03_R1 (Day 2)

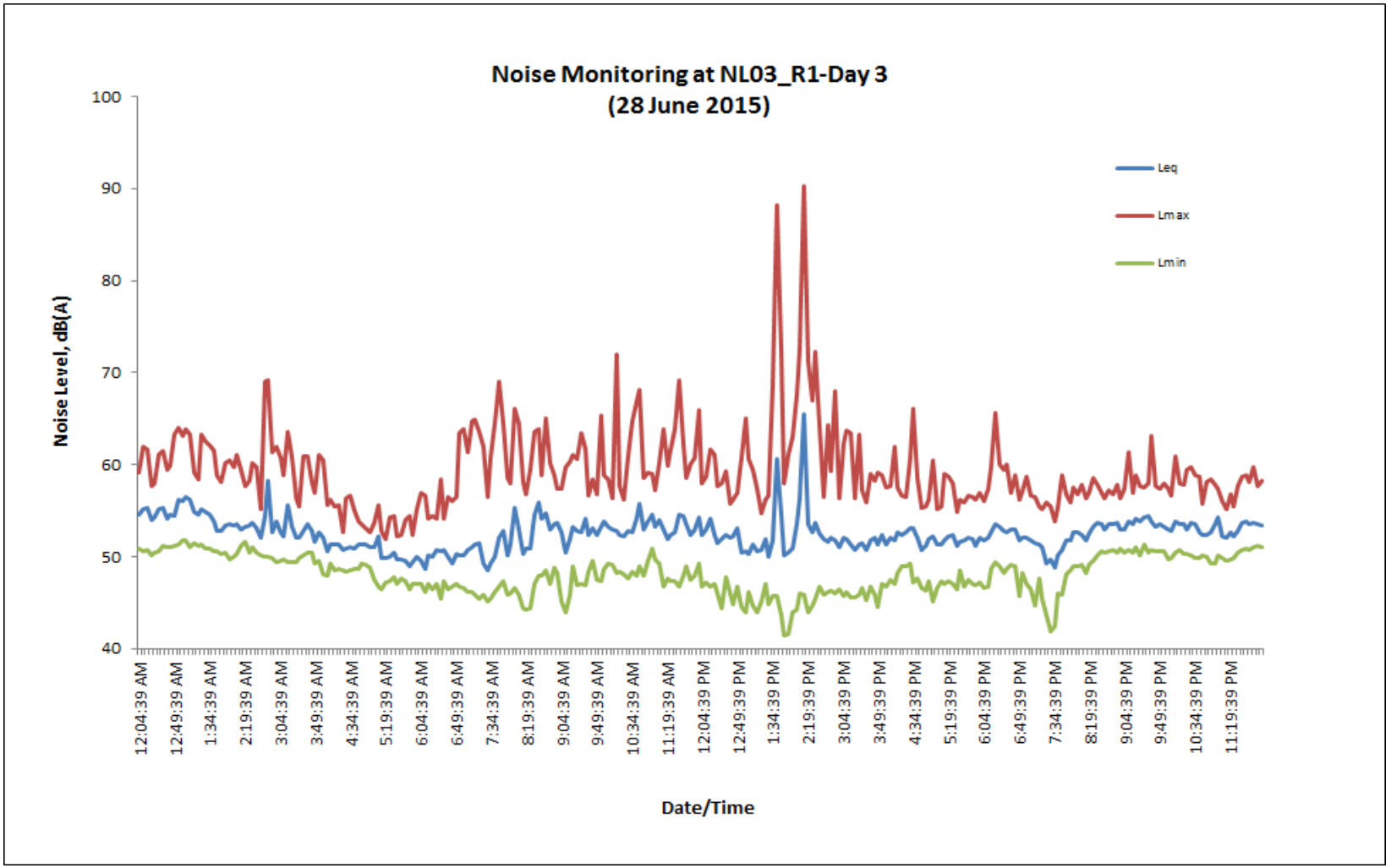

Figure 12: Daily noise level measured at Point NL03_R1 (Day 3)

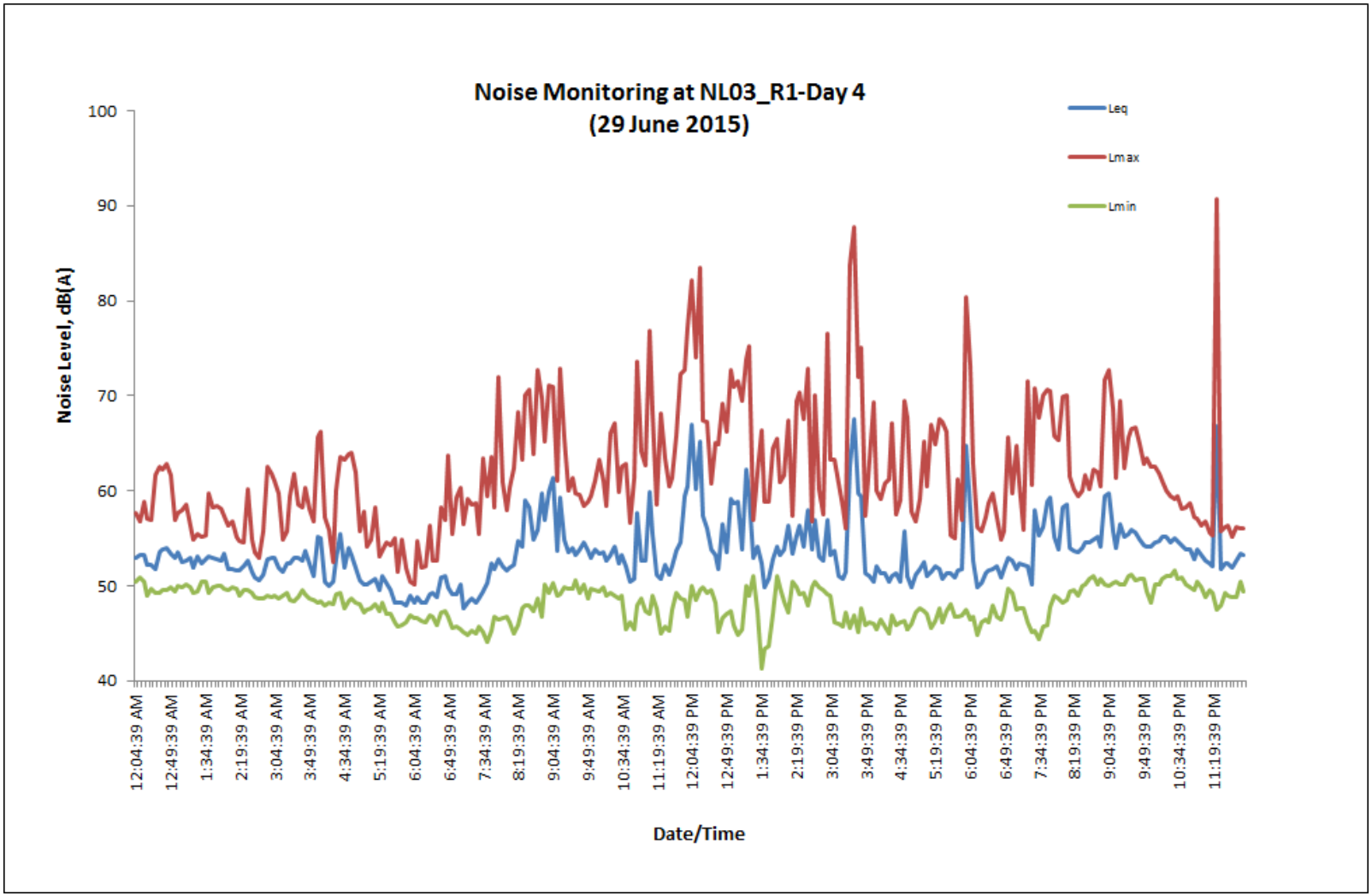

Figure 13: Daily noise level measured at Point NL03_R1 (Day 4)

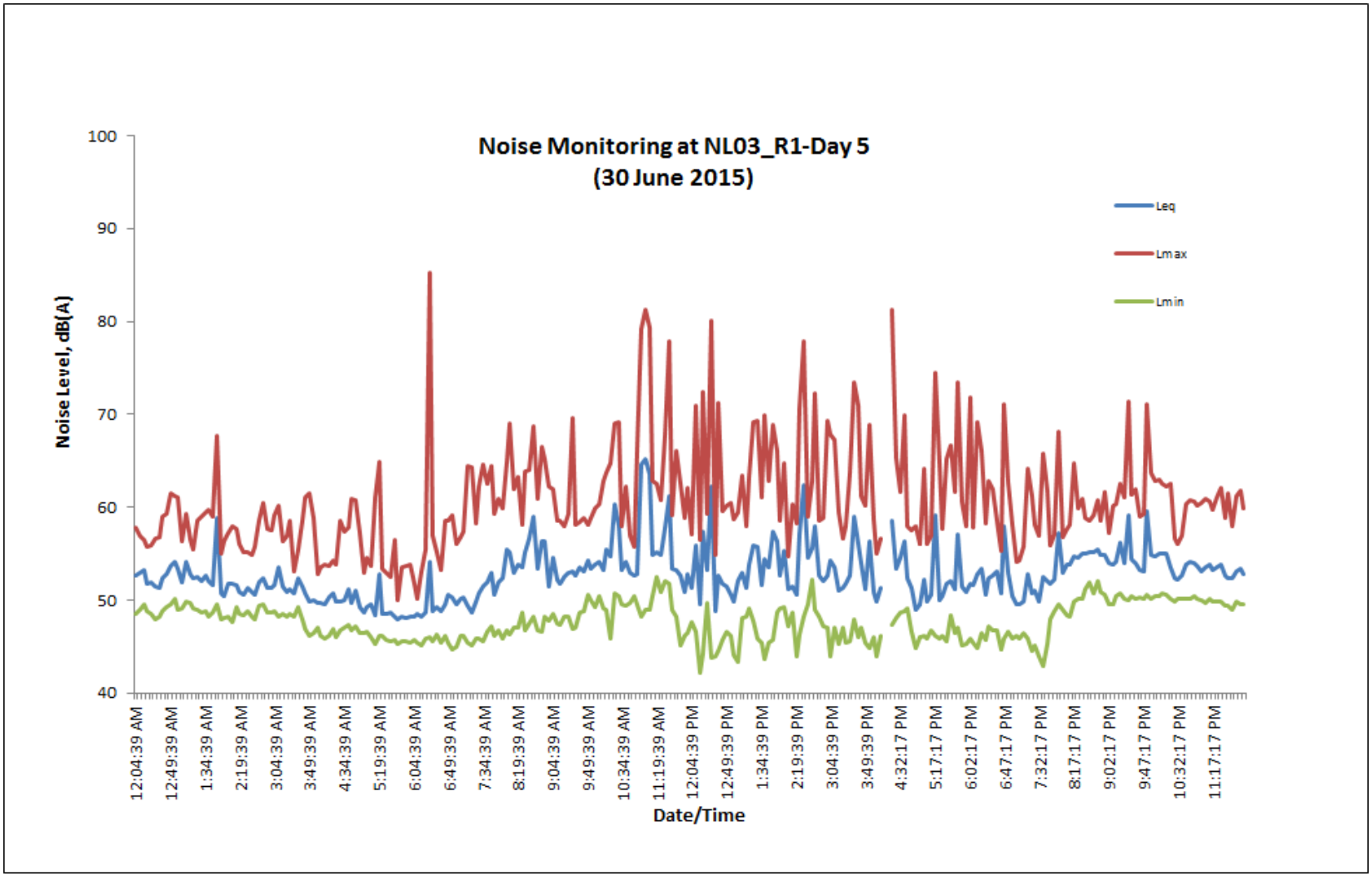

Figure 14: Daily noise level measured at Point NL03_R1 (Day 5)

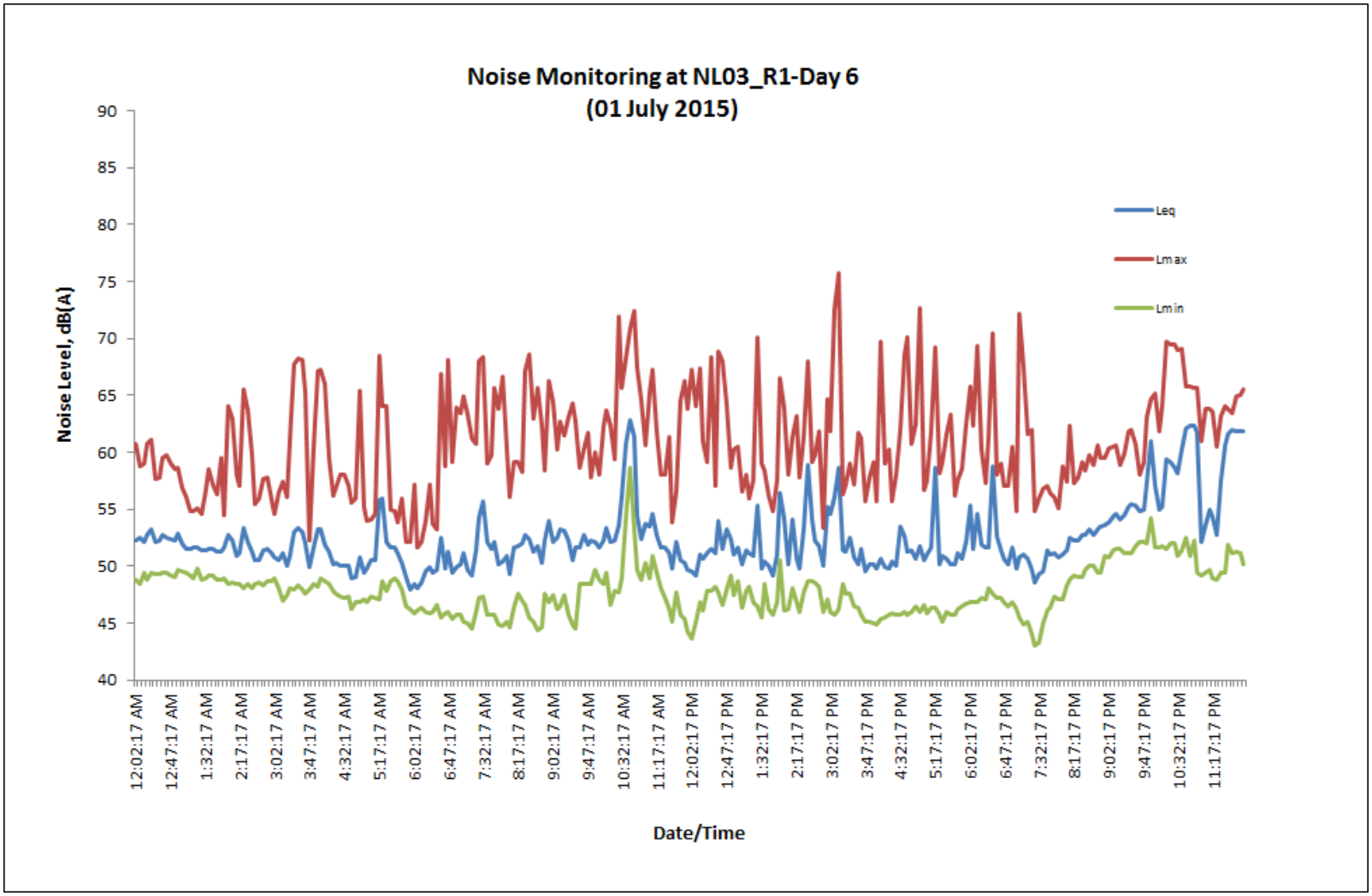

Figure 15: Daily noise level measured at Point NL03_R1 (Day 6)

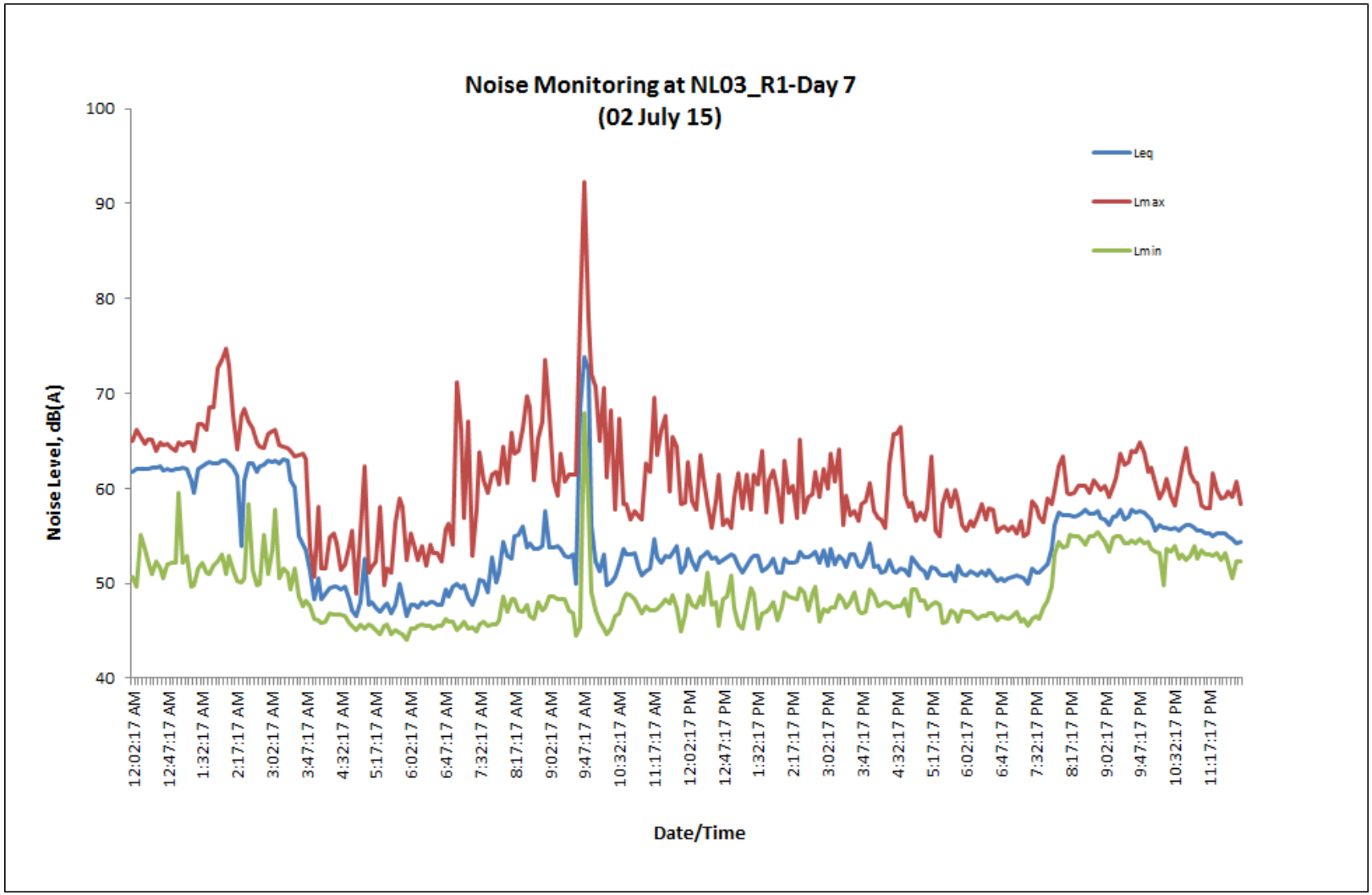

Figure 16: Daily noise level measured at Point NL03_R1 (Day 7)

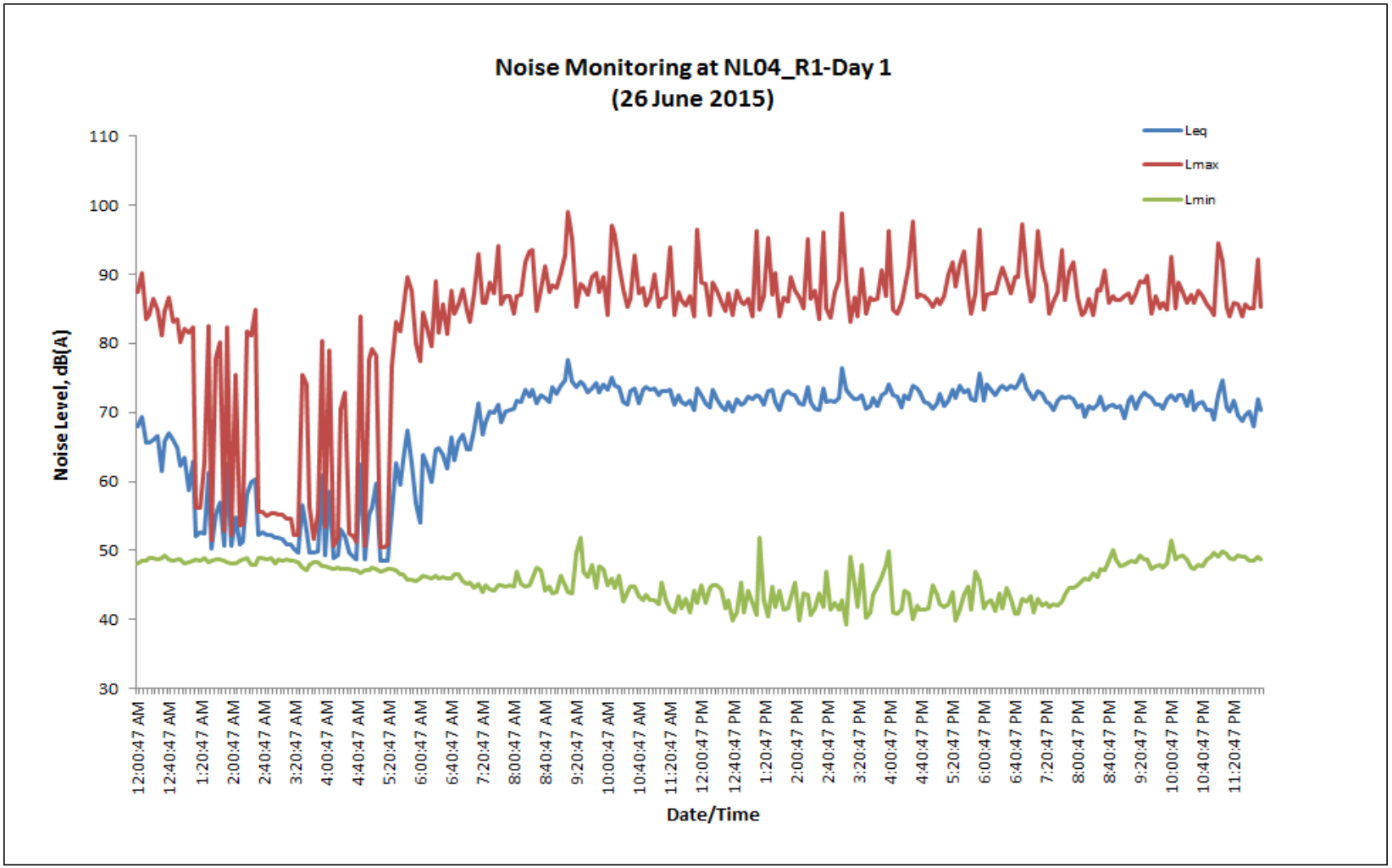

Figure 17: Daily noise level measured at Point NL04_R1 (Day 1)

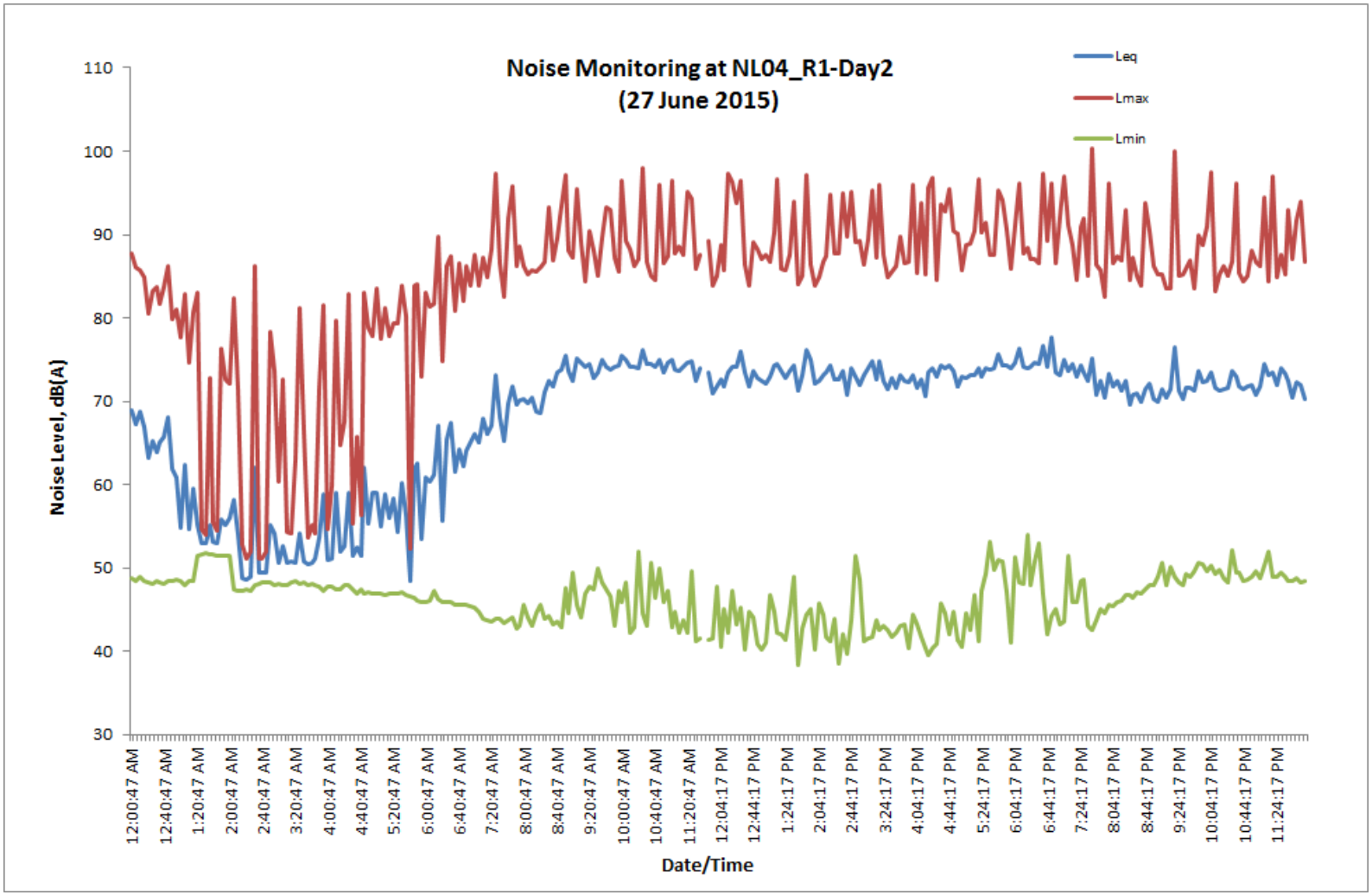

Figure 18: Daily noise level measured at Point NL04_R1 (Day 2)

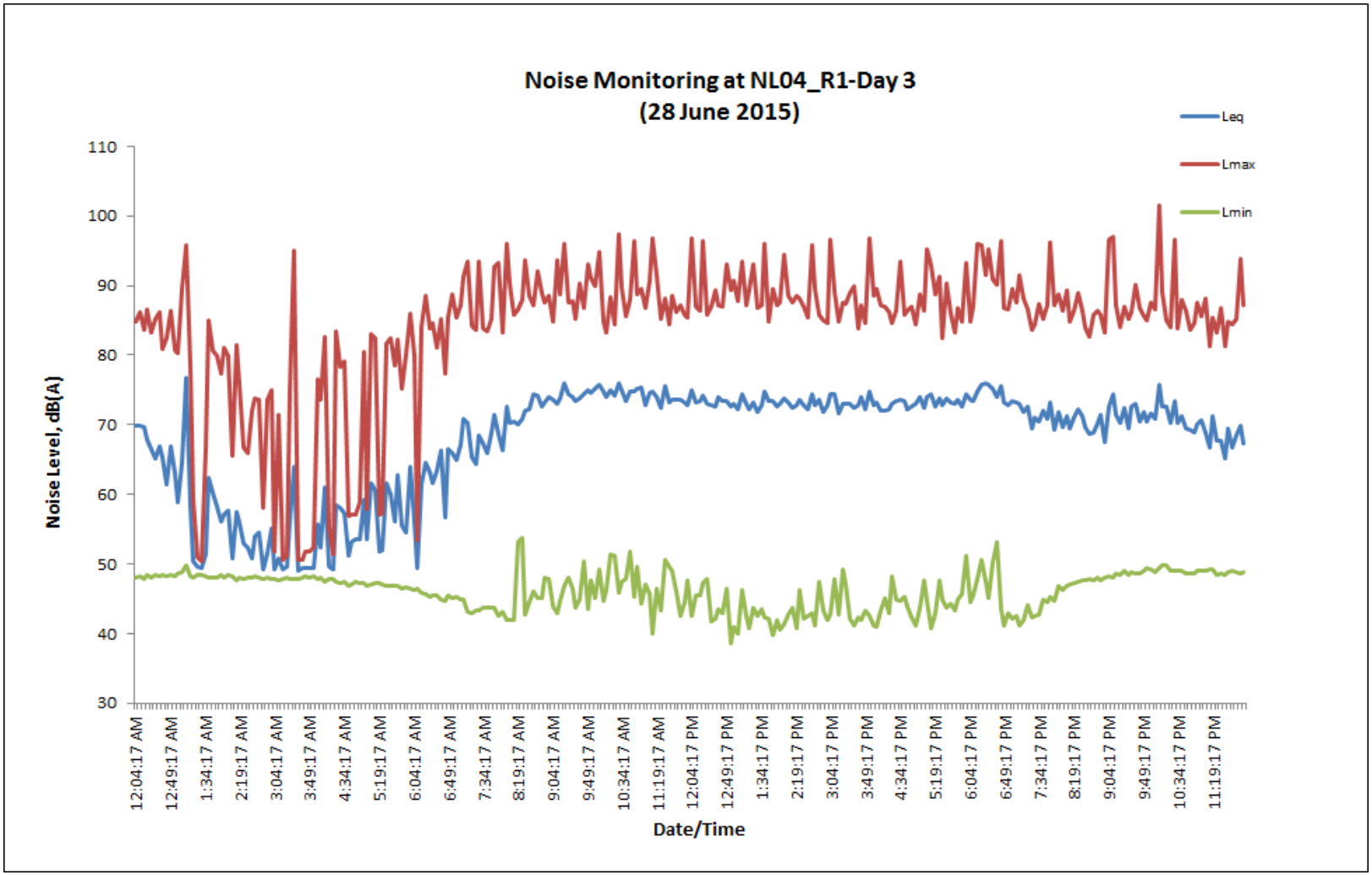

Figure 19: Daily noise level measured at Point NL04_R1 (Day 3)

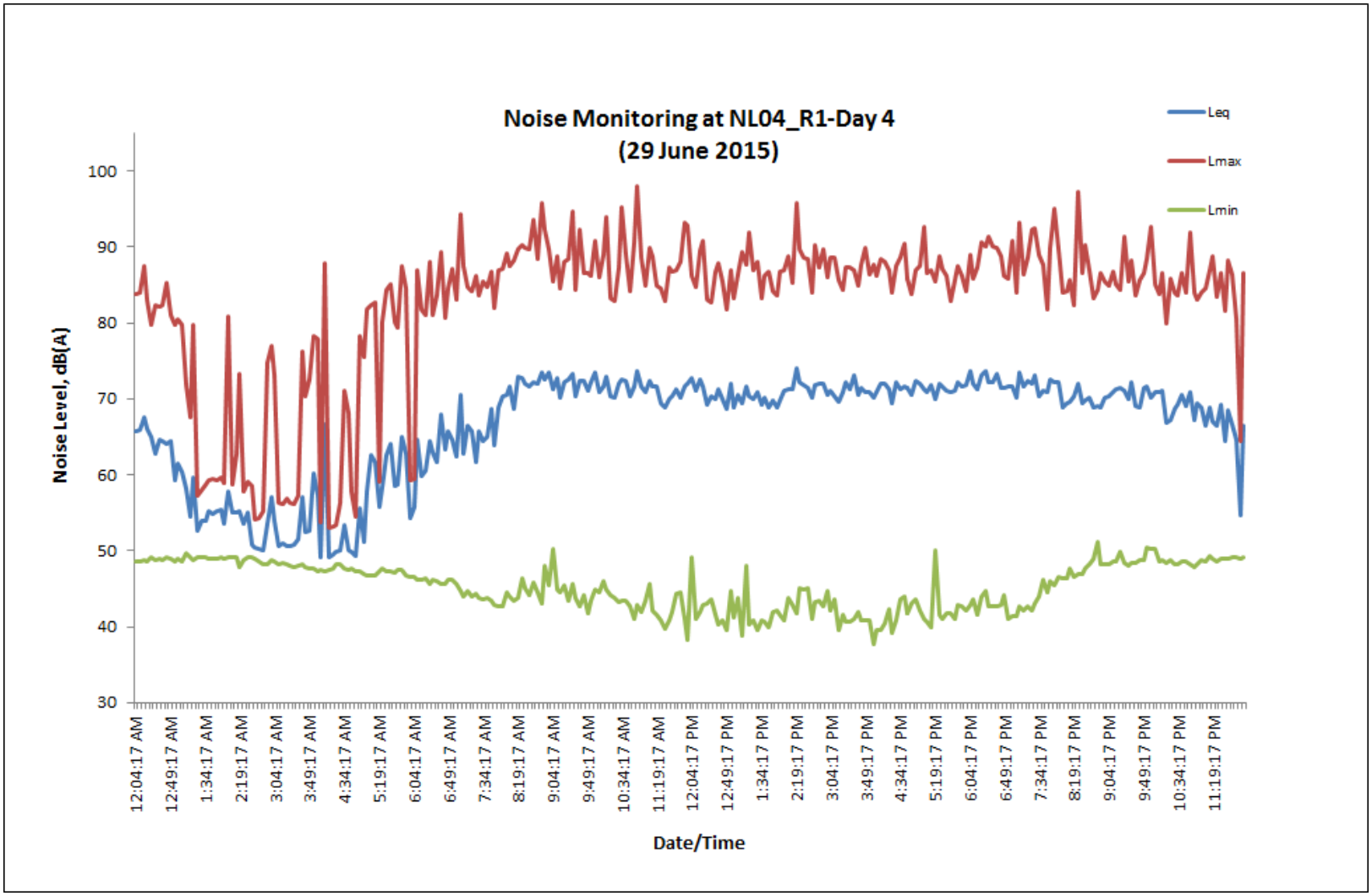

Figure 20: Daily noise level measured at Point NL04_R1 (Day 4)

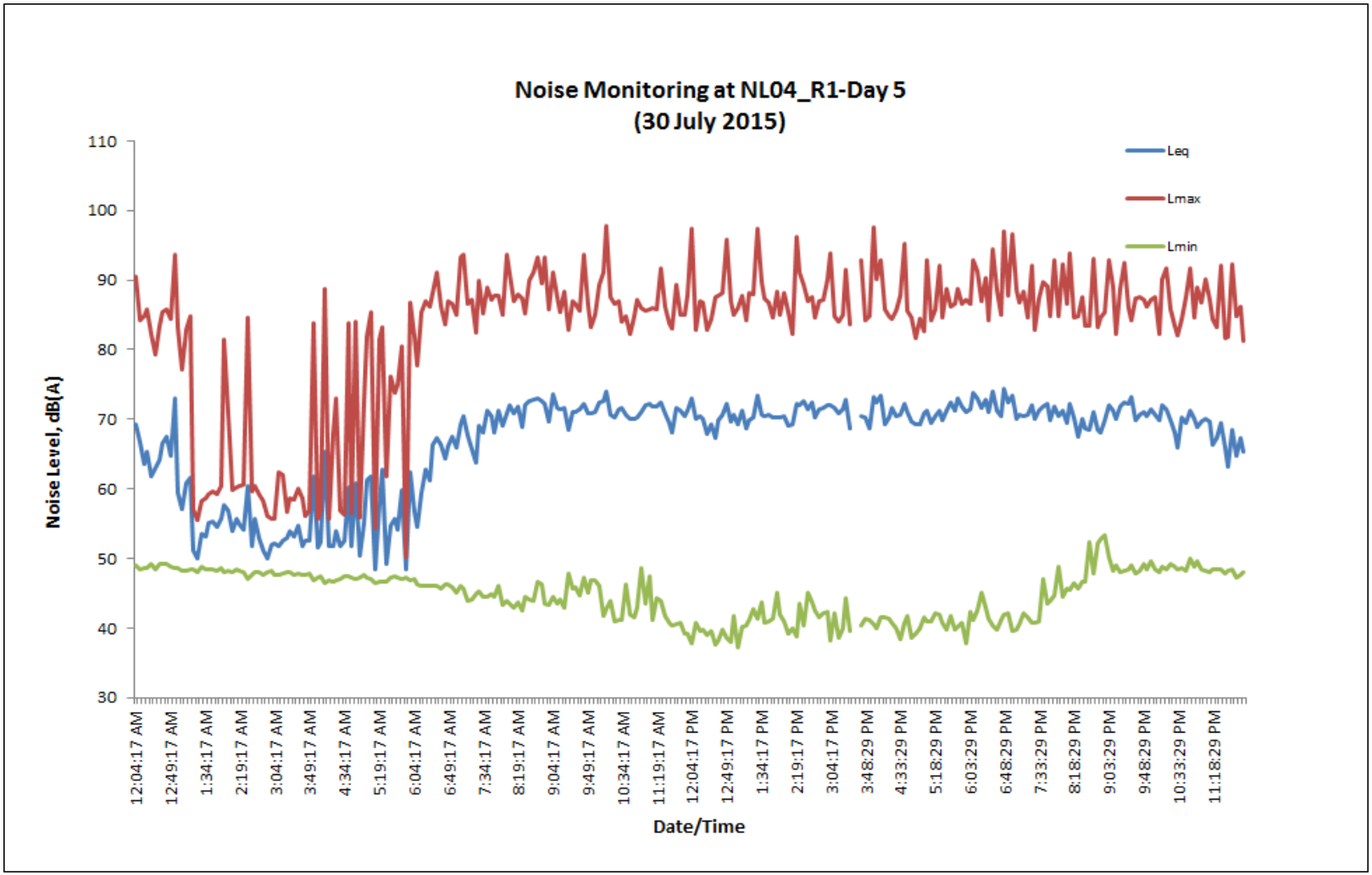

Figure 21: Daily noise level measured at Point NL04_R1 (Day 5)

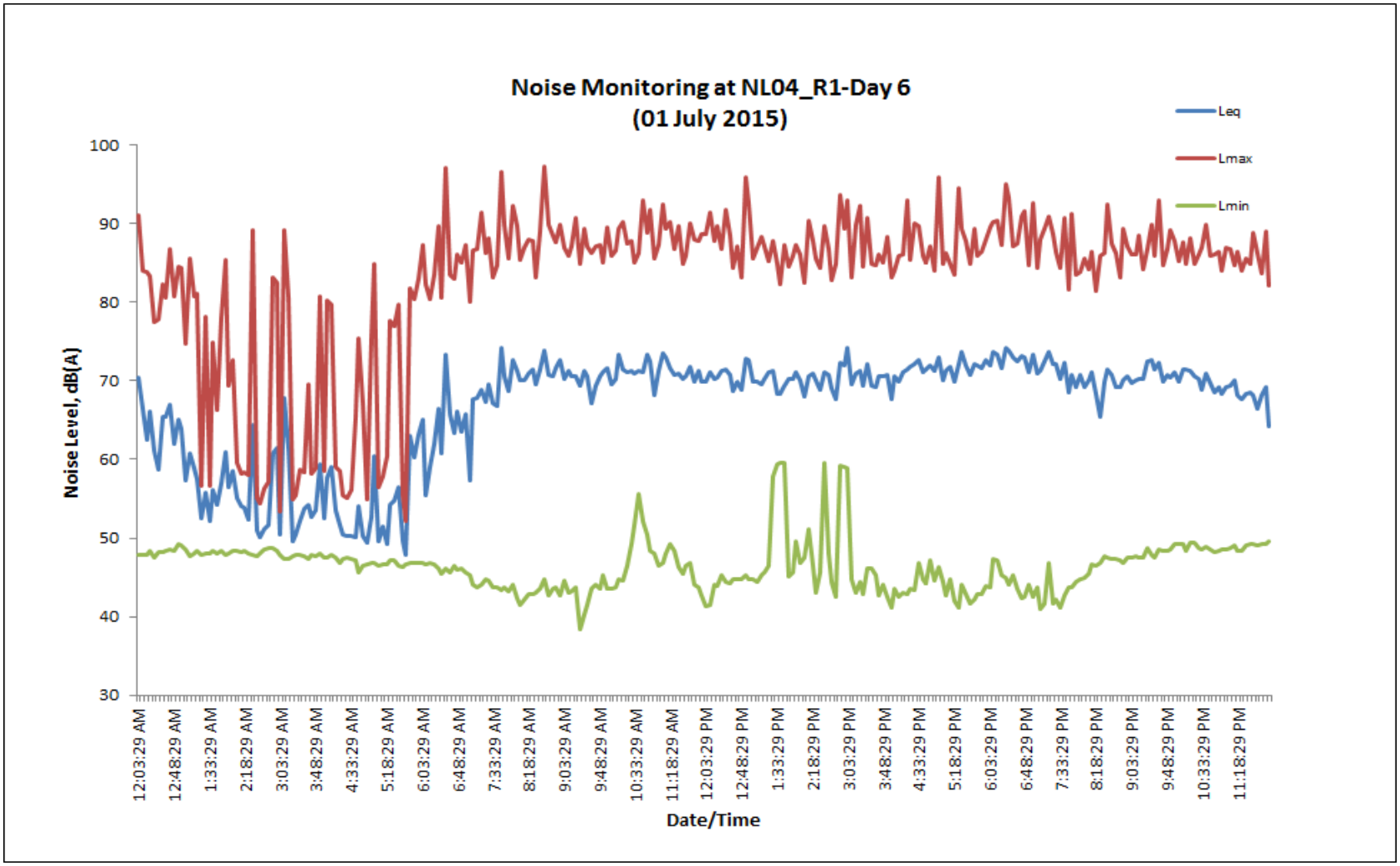

Figure 22: Daily noise level measured at Point NL04_R1 (Day 6)

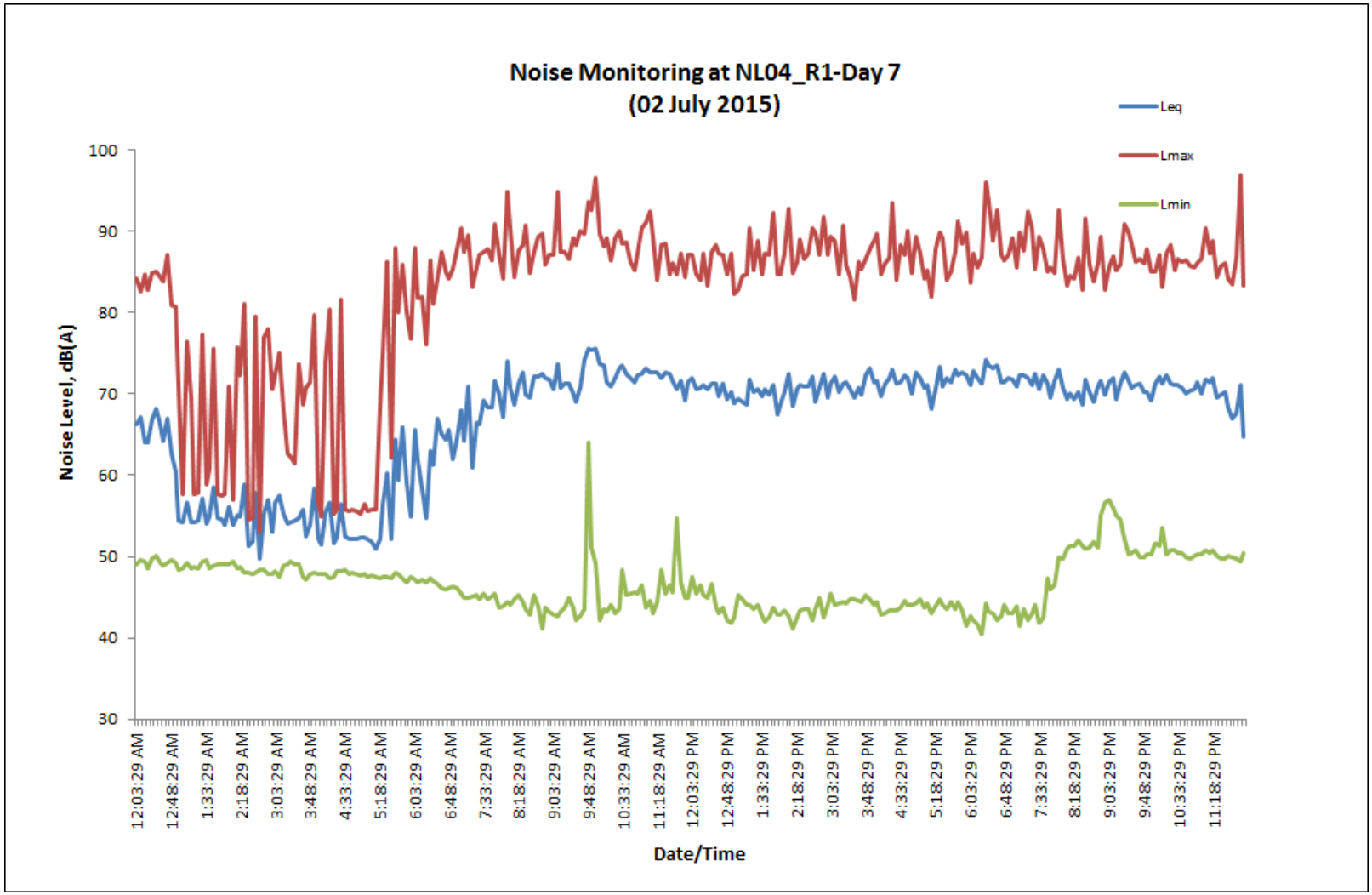

Figure 23: Daily noise level measured at Point NL04_R1 (Day 7)

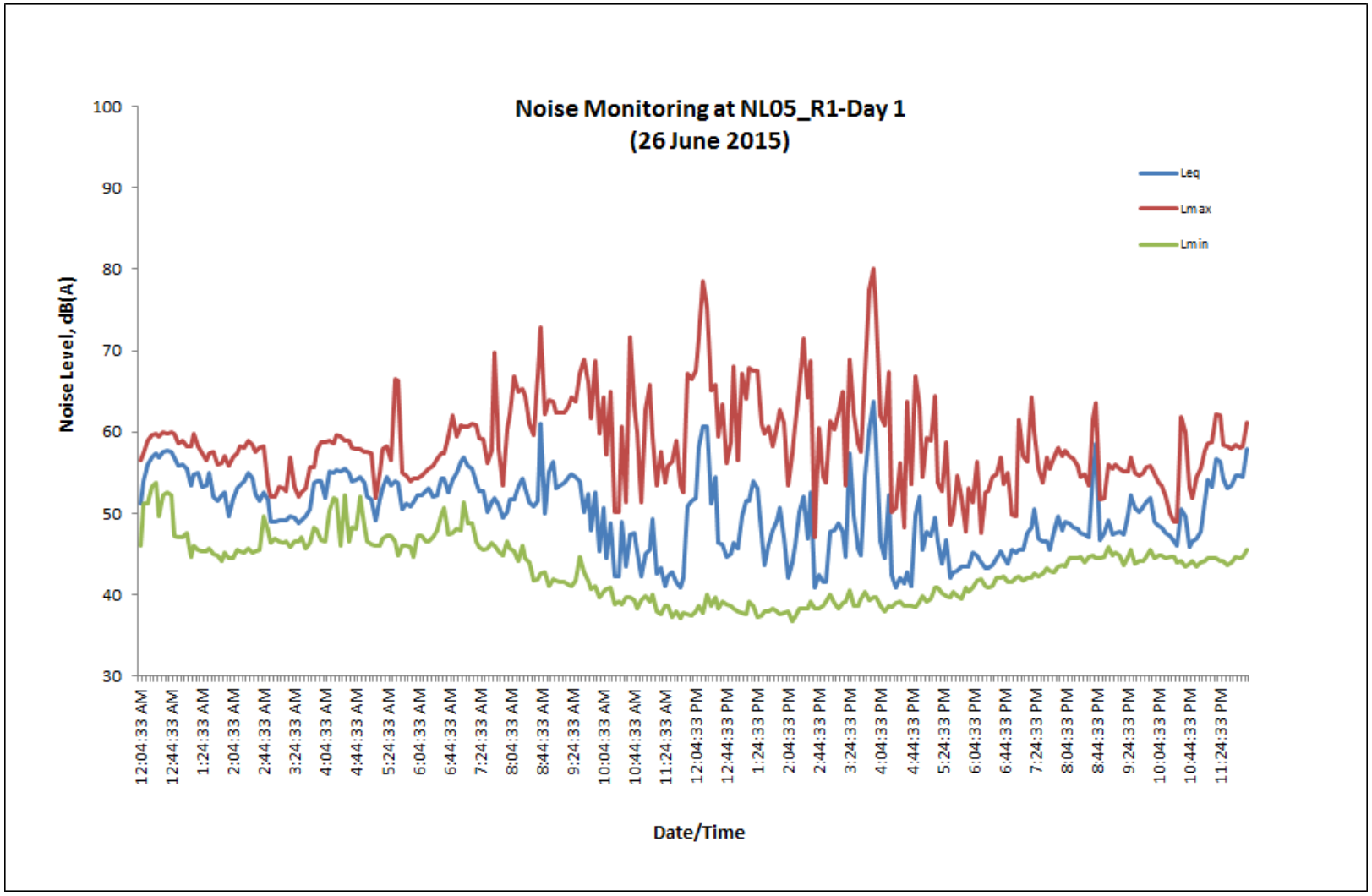

Figure 24: Daily noise level measured at Point NL05_R1 (Day 1)

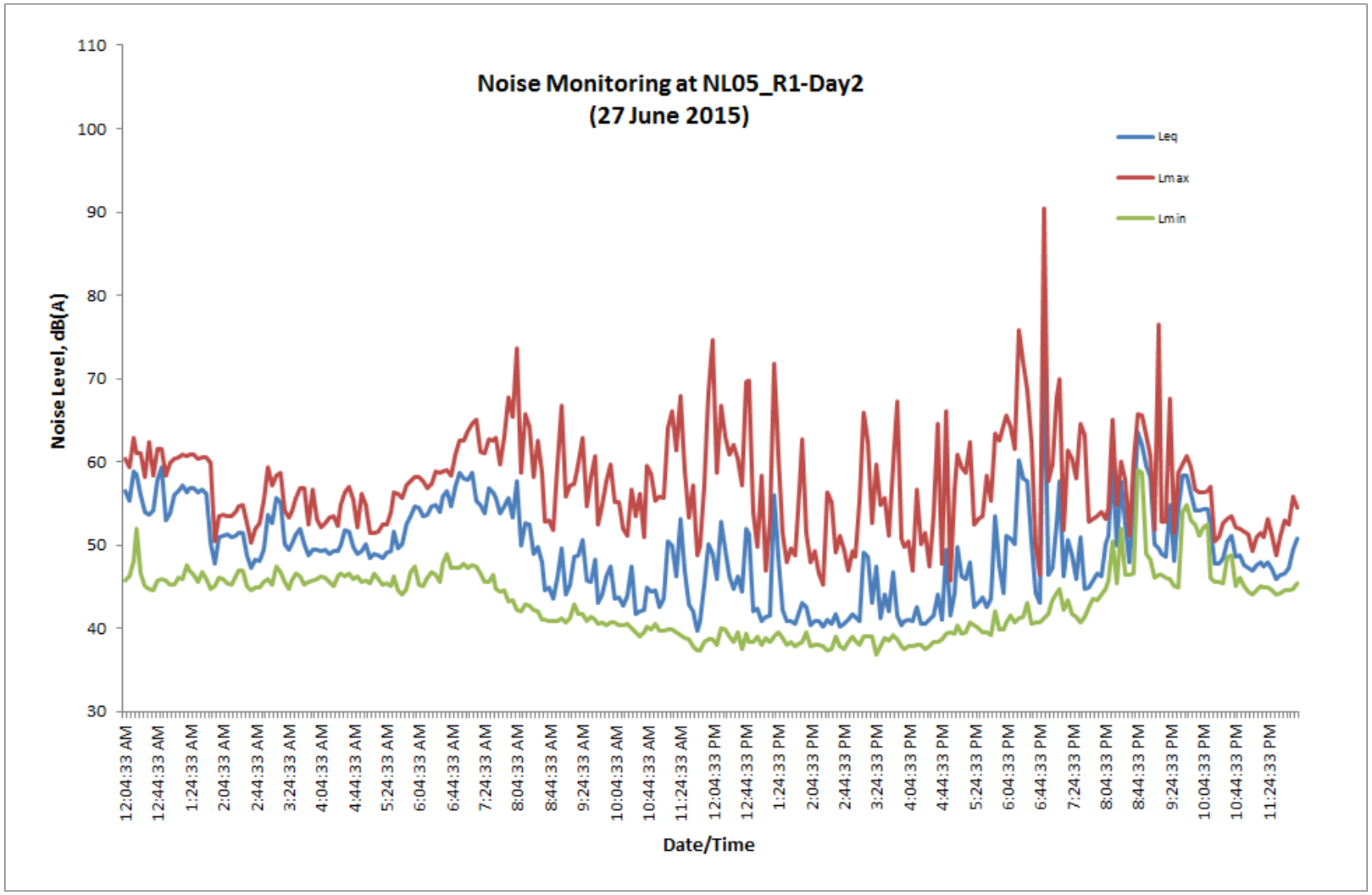

Figure 25: Daily noise level measured at Point NL05_R1 (Day 2)

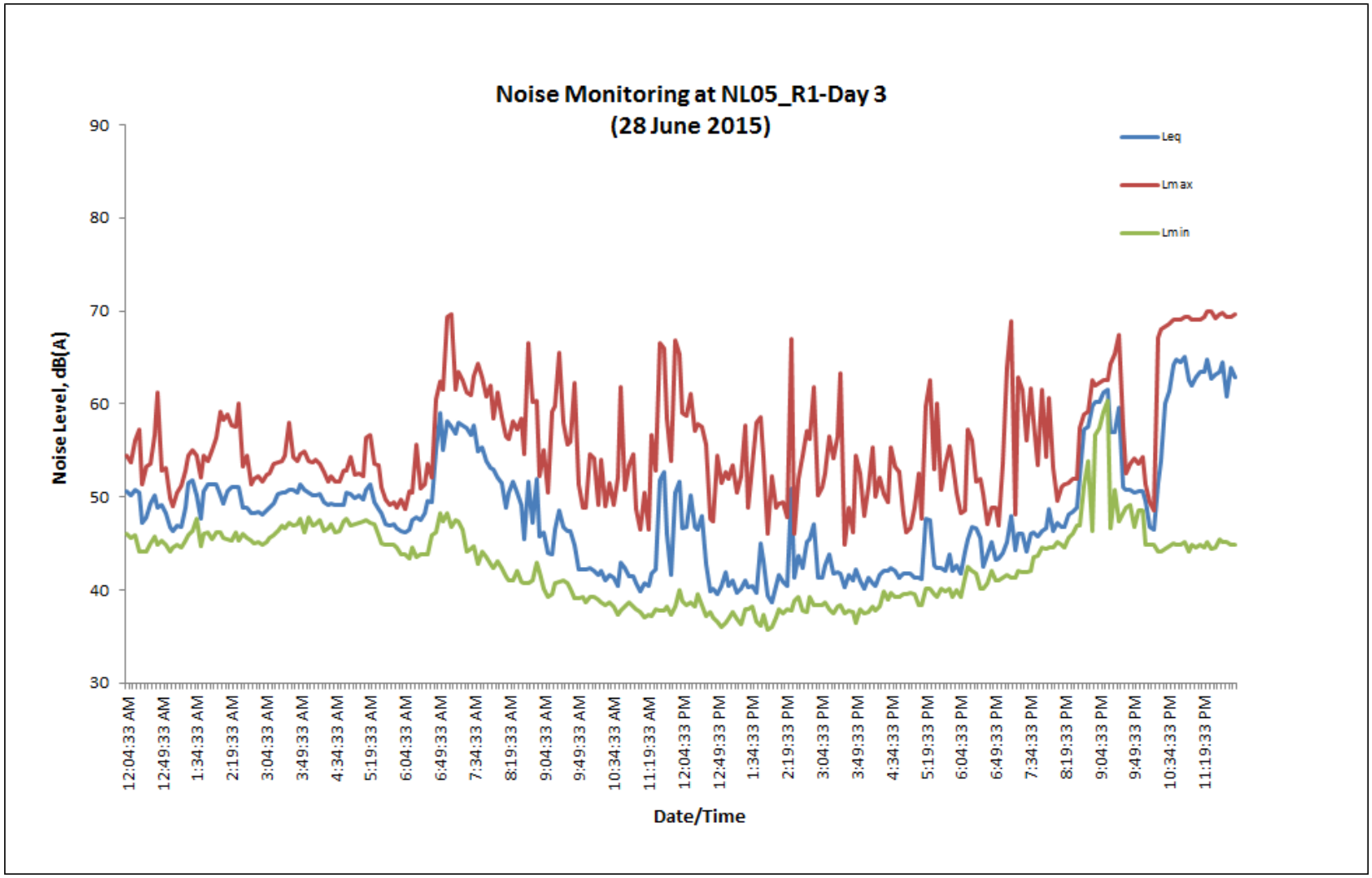

Figure 26: Daily noise level measured at Point NL05_R1 (Day 3)

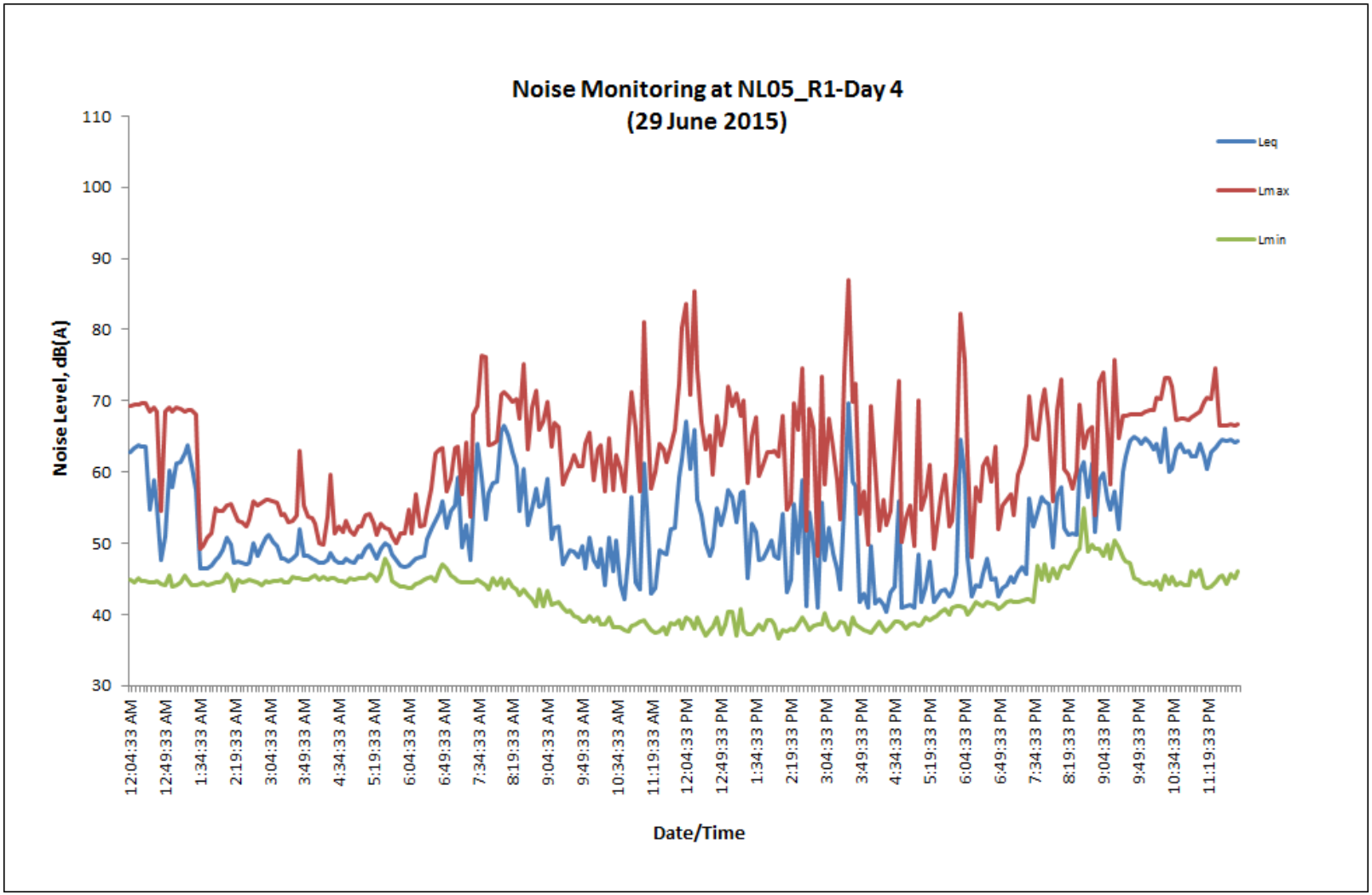

Figure 27: Daily noise level measured at Point NL05_R1 (Day 4)

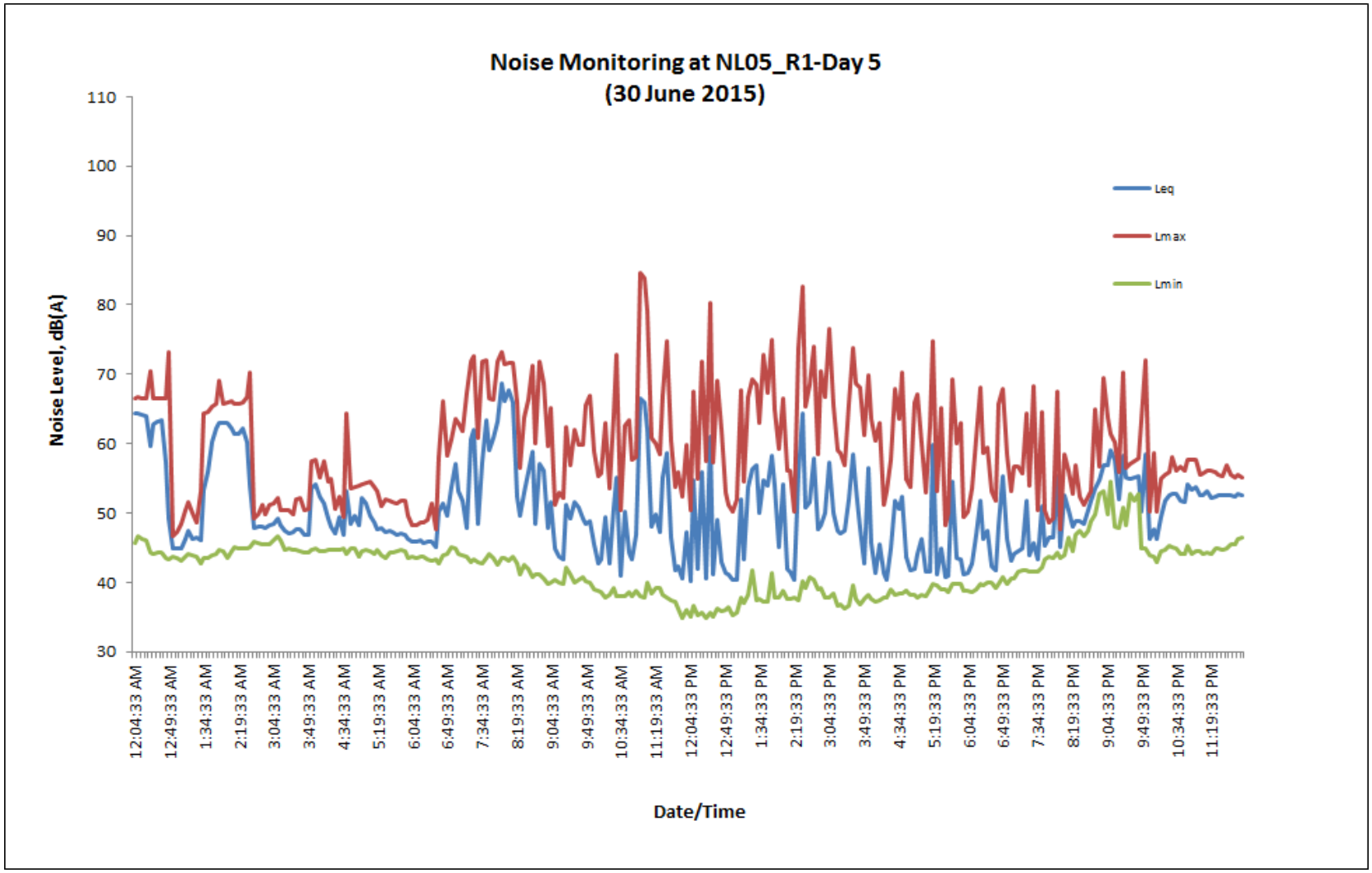

Figure 28: Daily noise level measured at Point NL05_R1 (Day 5)

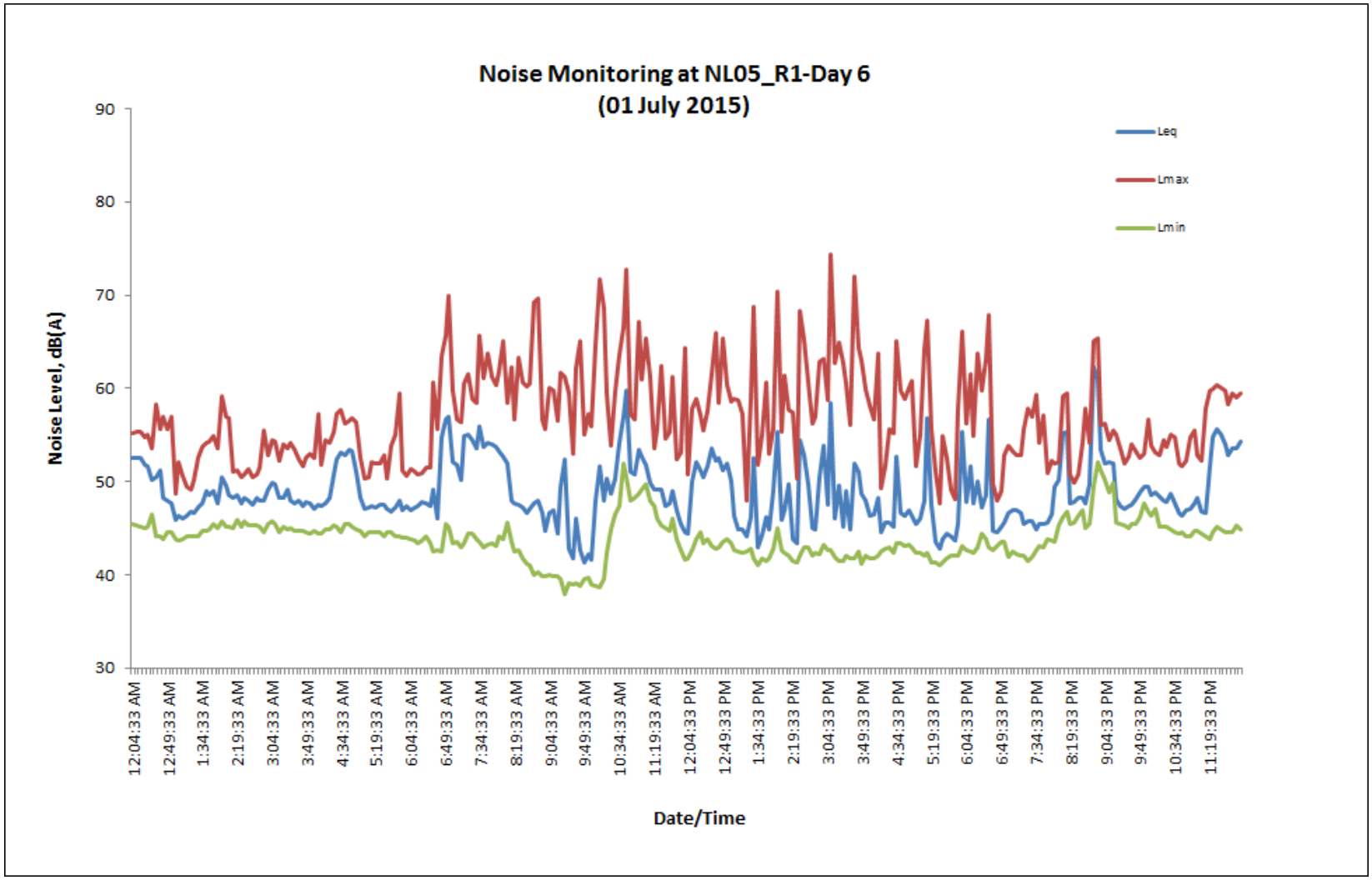

Figure 29: Daily noise level measured at Point NL05_R1 (Day 6)

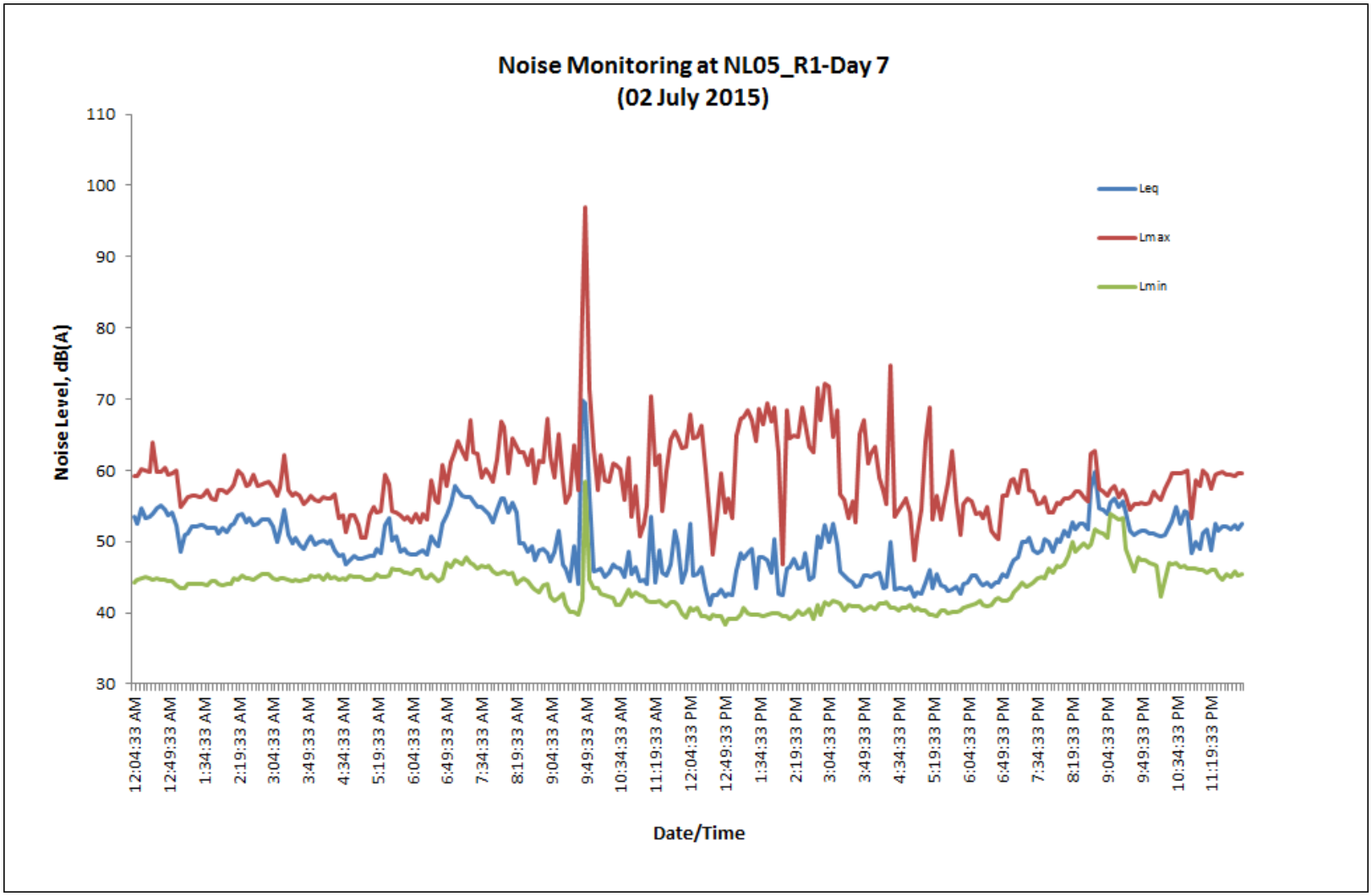

Figure 30: Daily noise level measured at Point NL05_R1 (Day 7)

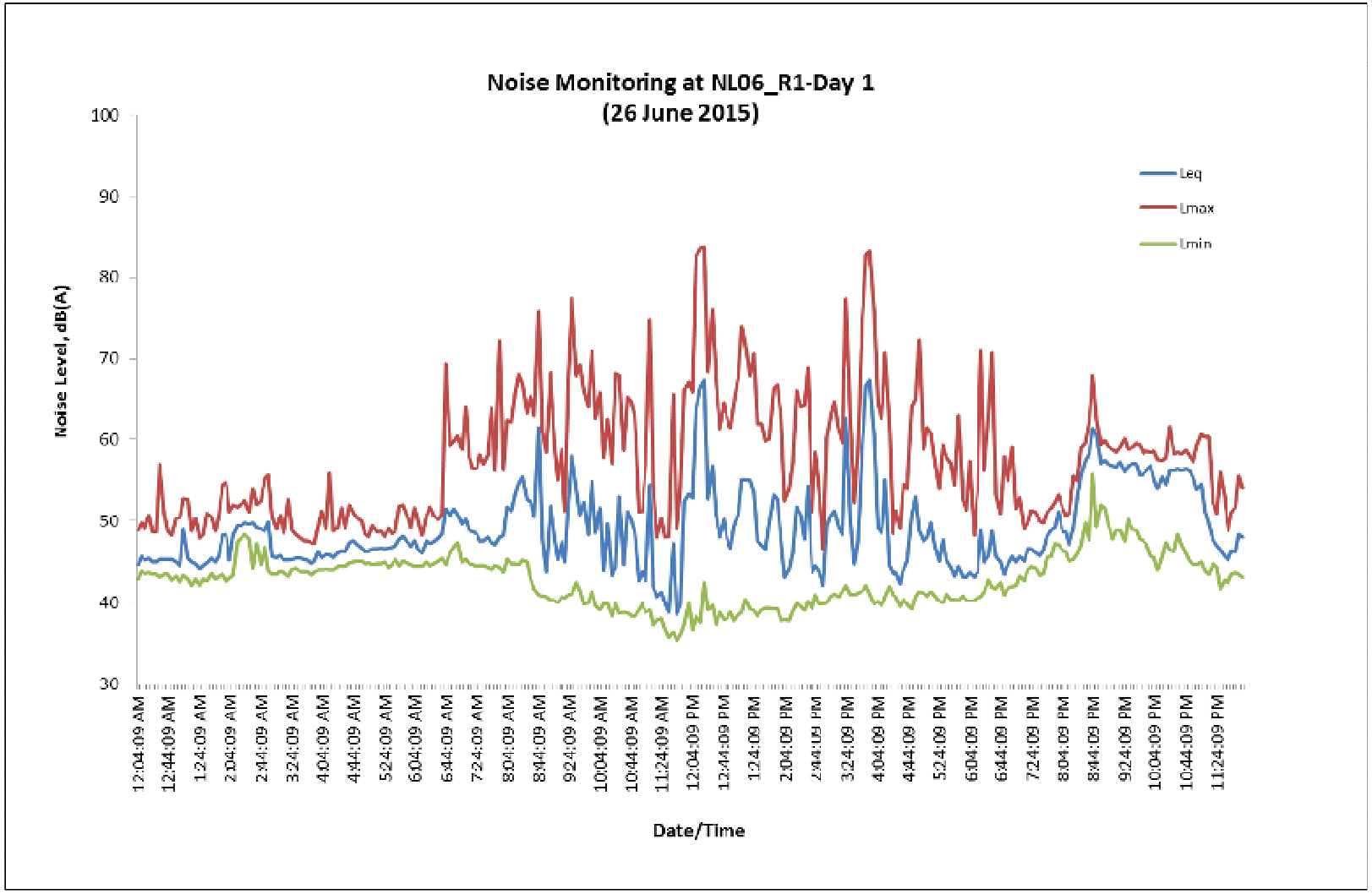

Figure 31: Daily noise level measured at Point NL06_R1 (Day 1)

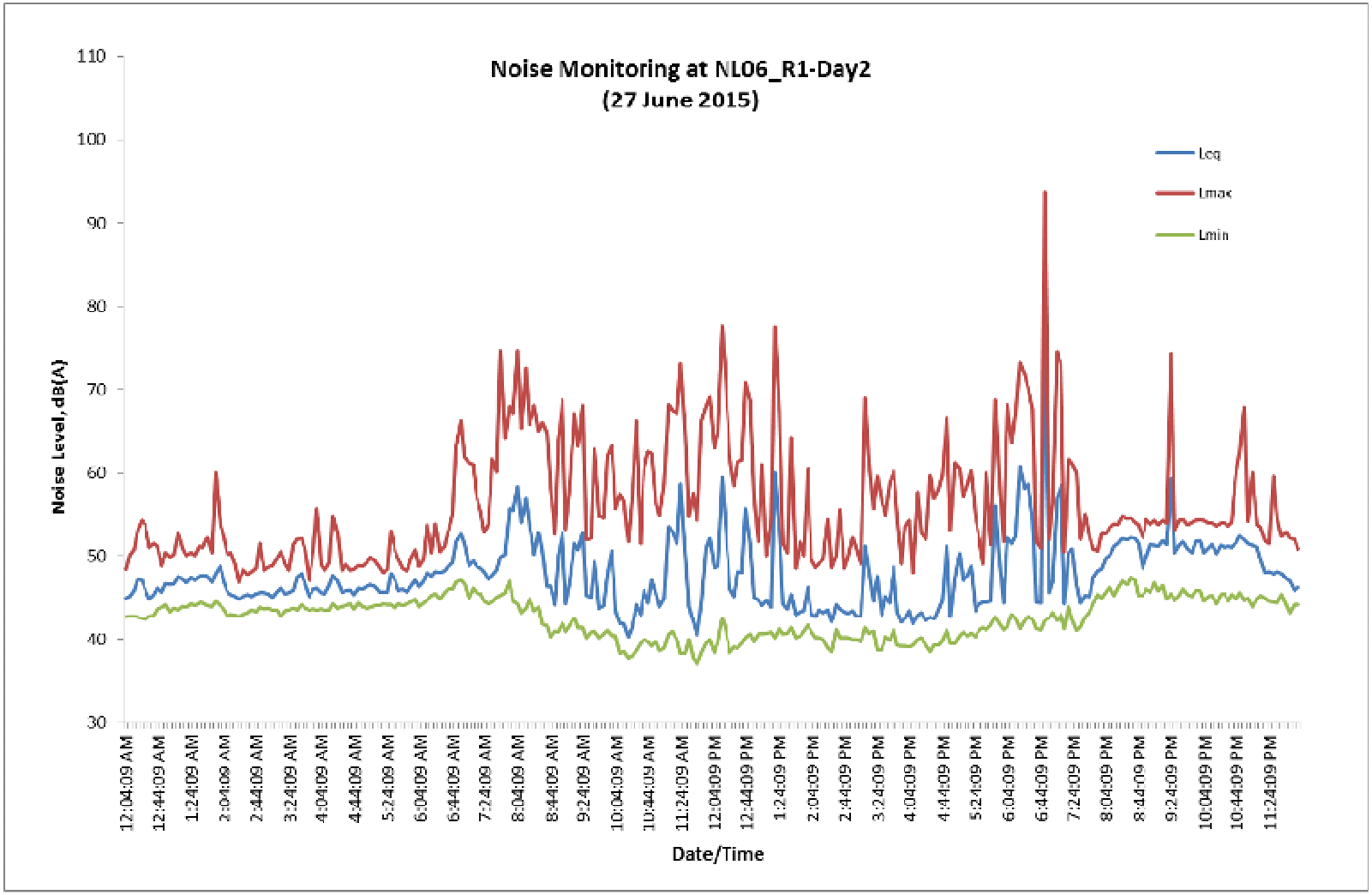

Figure 32: Daily noise level measured at Point NL06_R1 (Day 2)

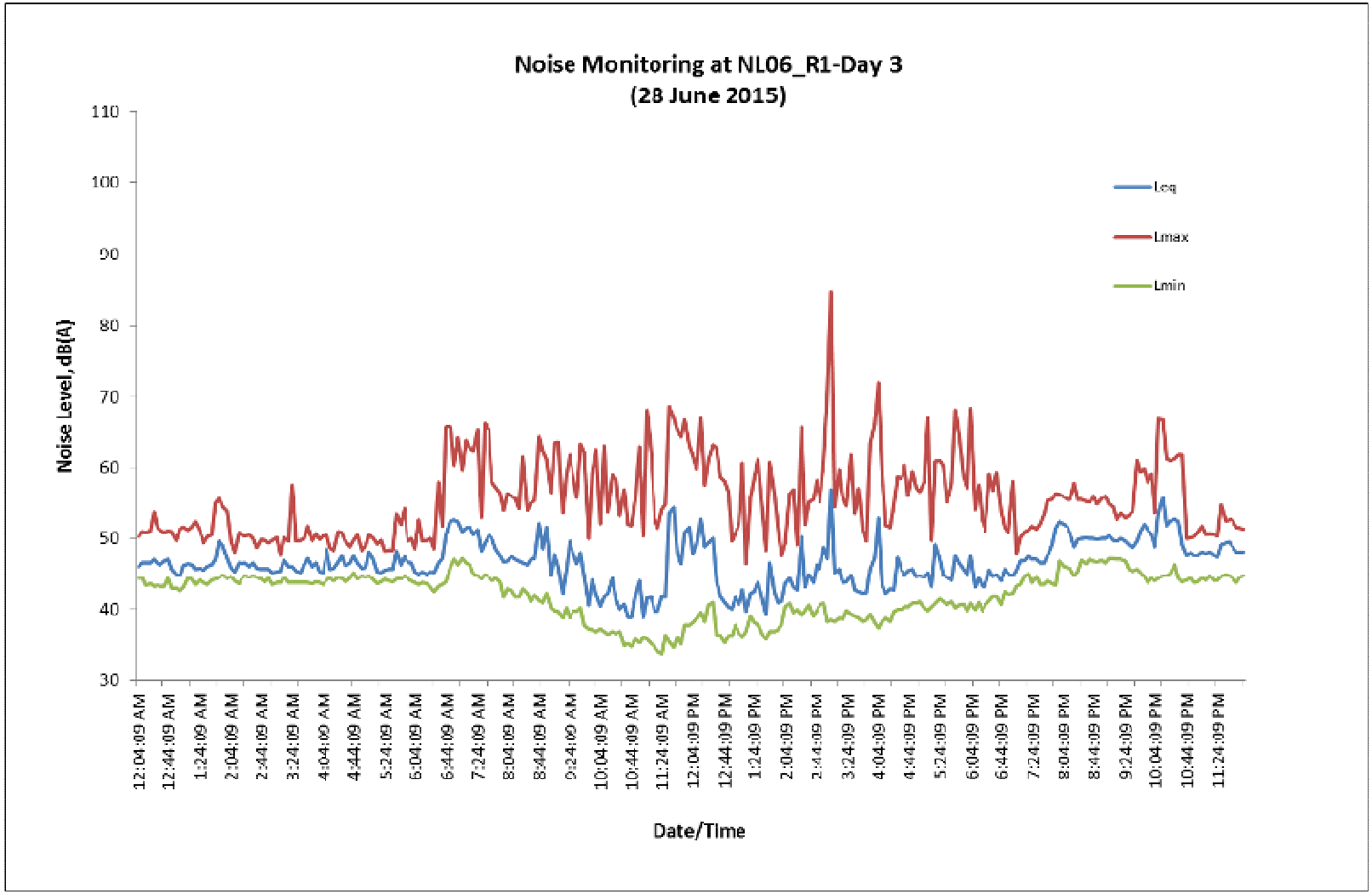

Figure 33: Daily noise level measured at Point NL06_R1 (Day 3)

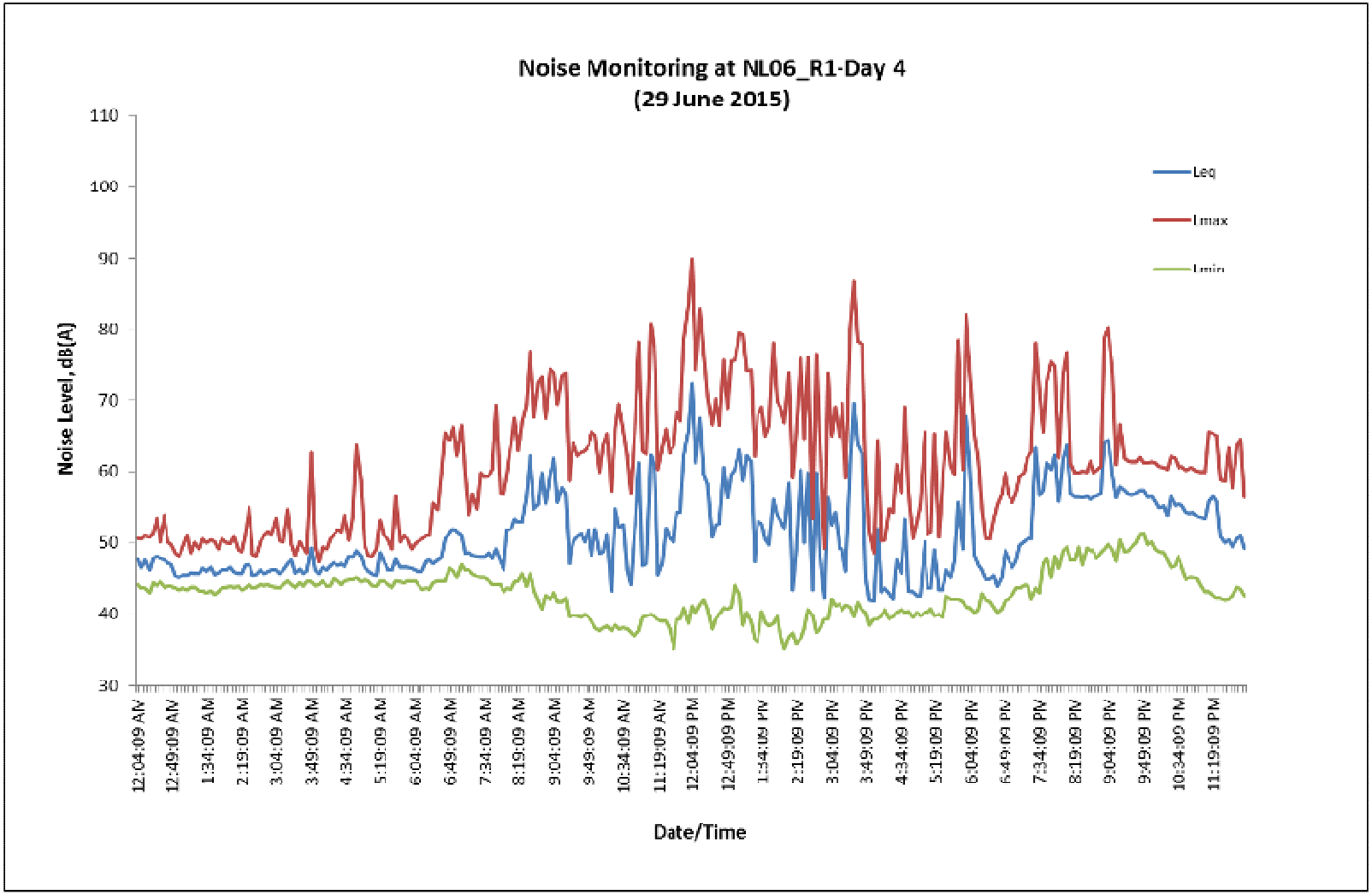

Figure 34: Daily noise level measured at Point NL06_R1 (Day 4)

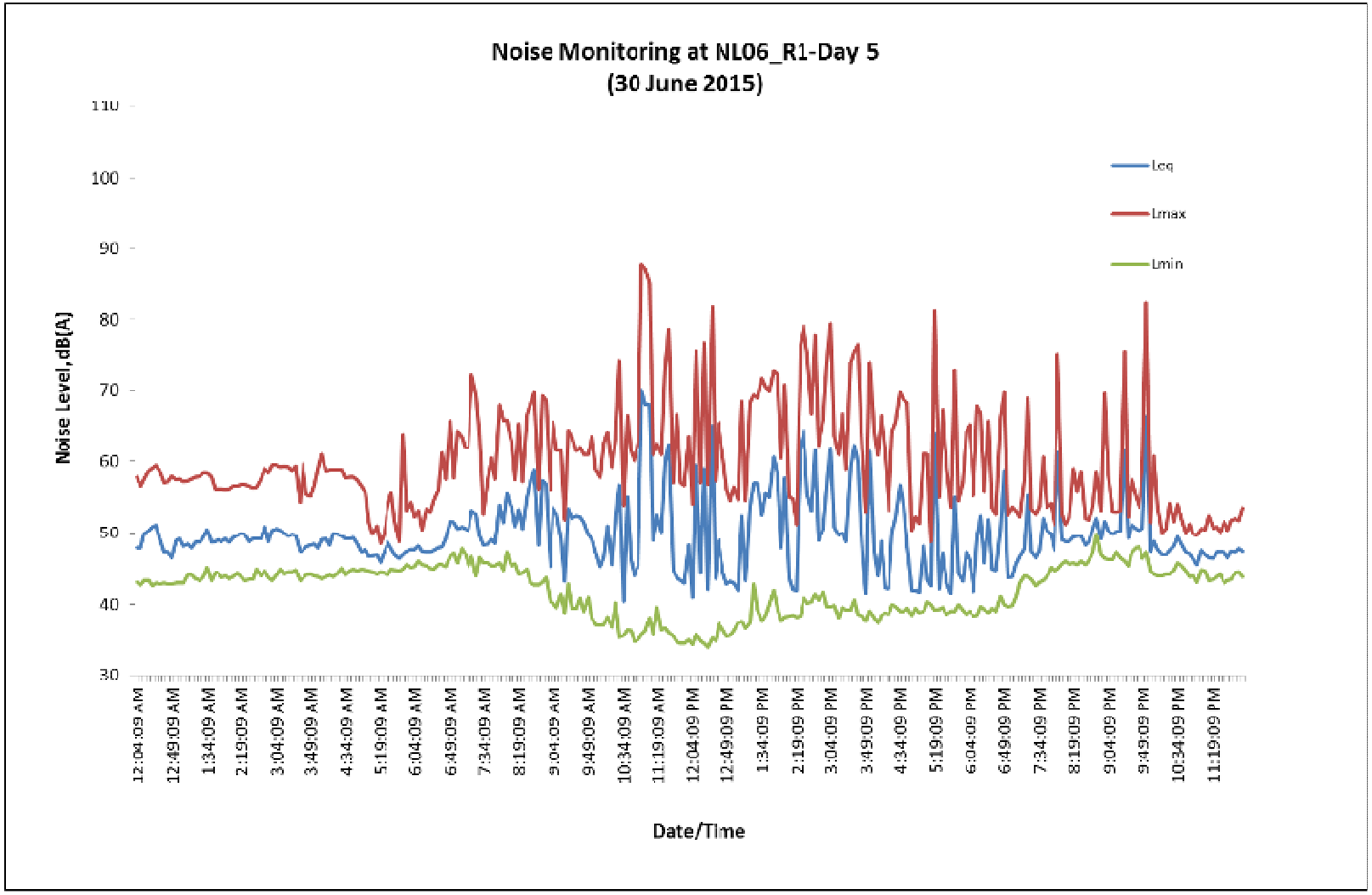

Figure 35: Daily noise level measured at Point NL06_R1 (Day 5)

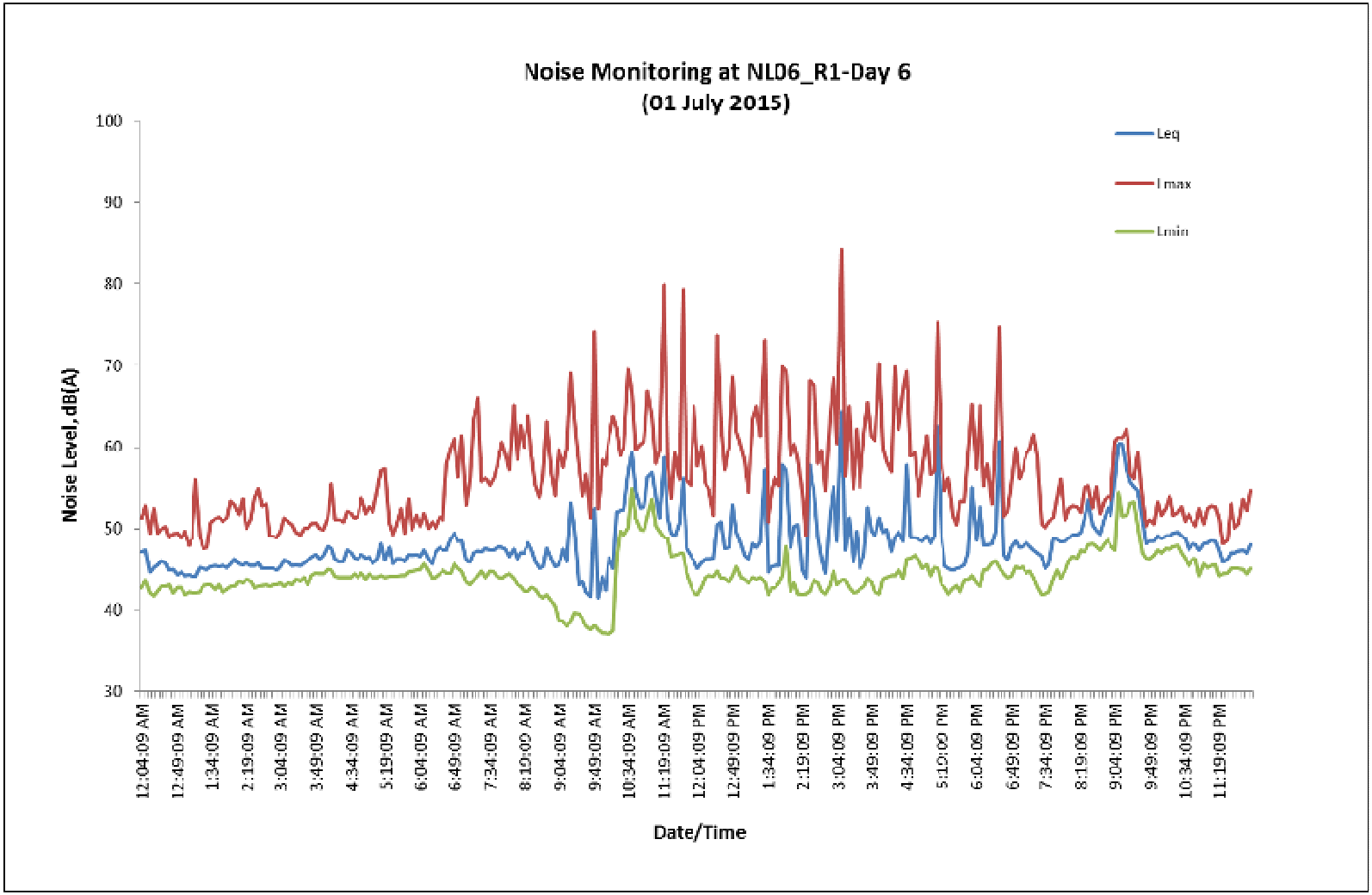

Figure 36: Daily noise level measured at Point NL06_R1 (Day 6)

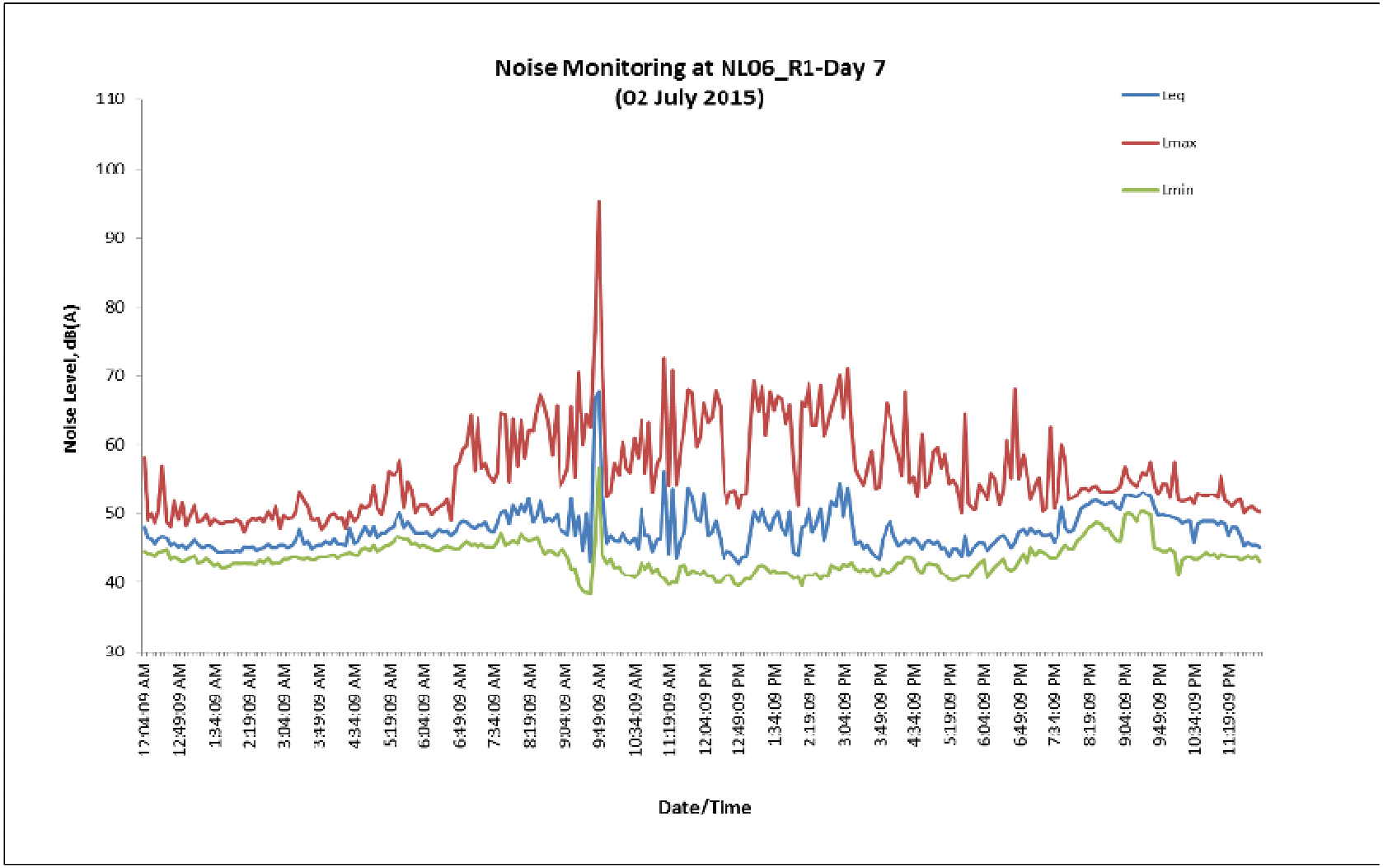

Figure 37: Daily noise level measured at Point NL06_R1 (Day 7)

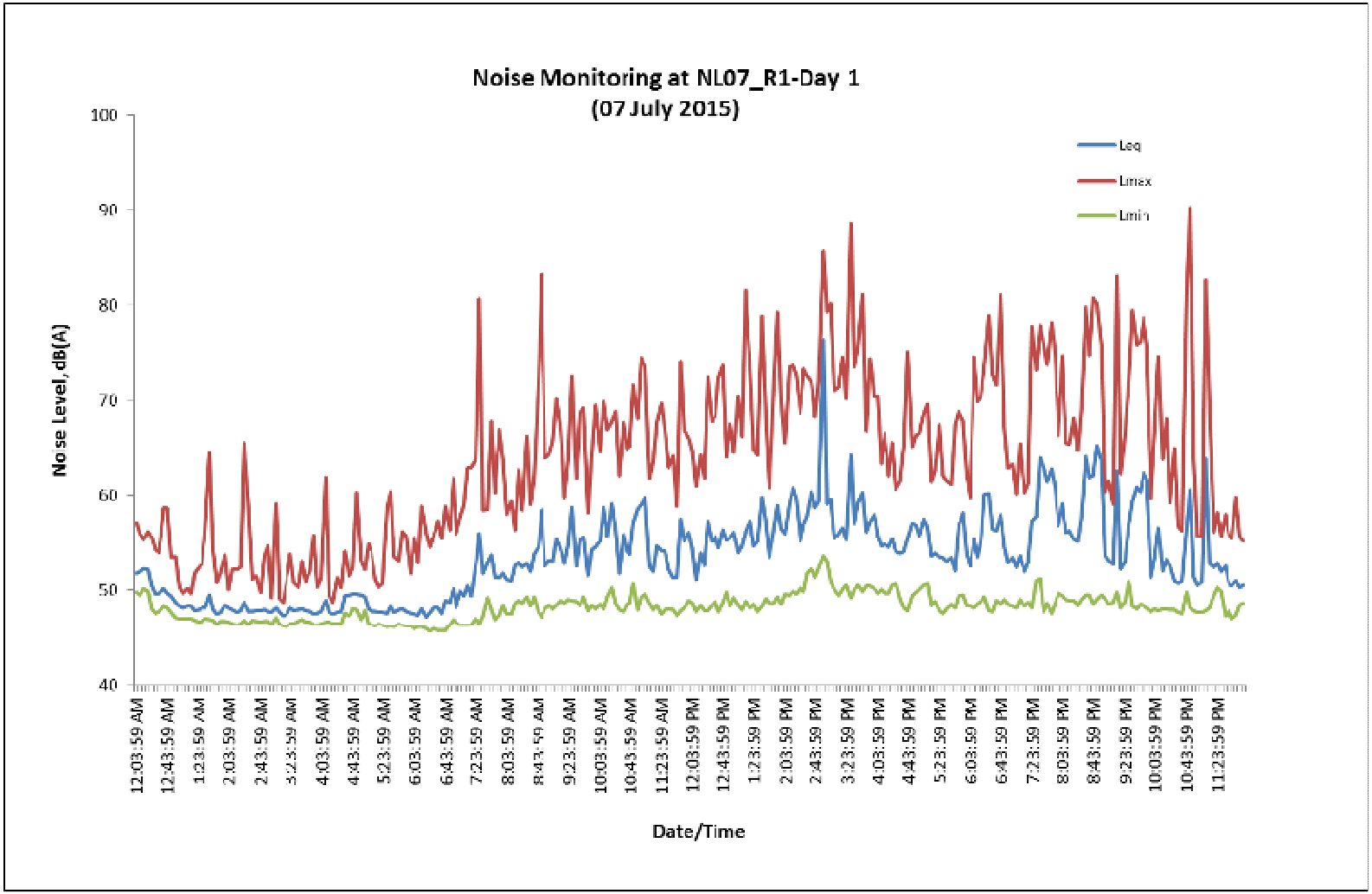

Figure 38: Daily noise level measured at Point NL07_R1 (Day 1)

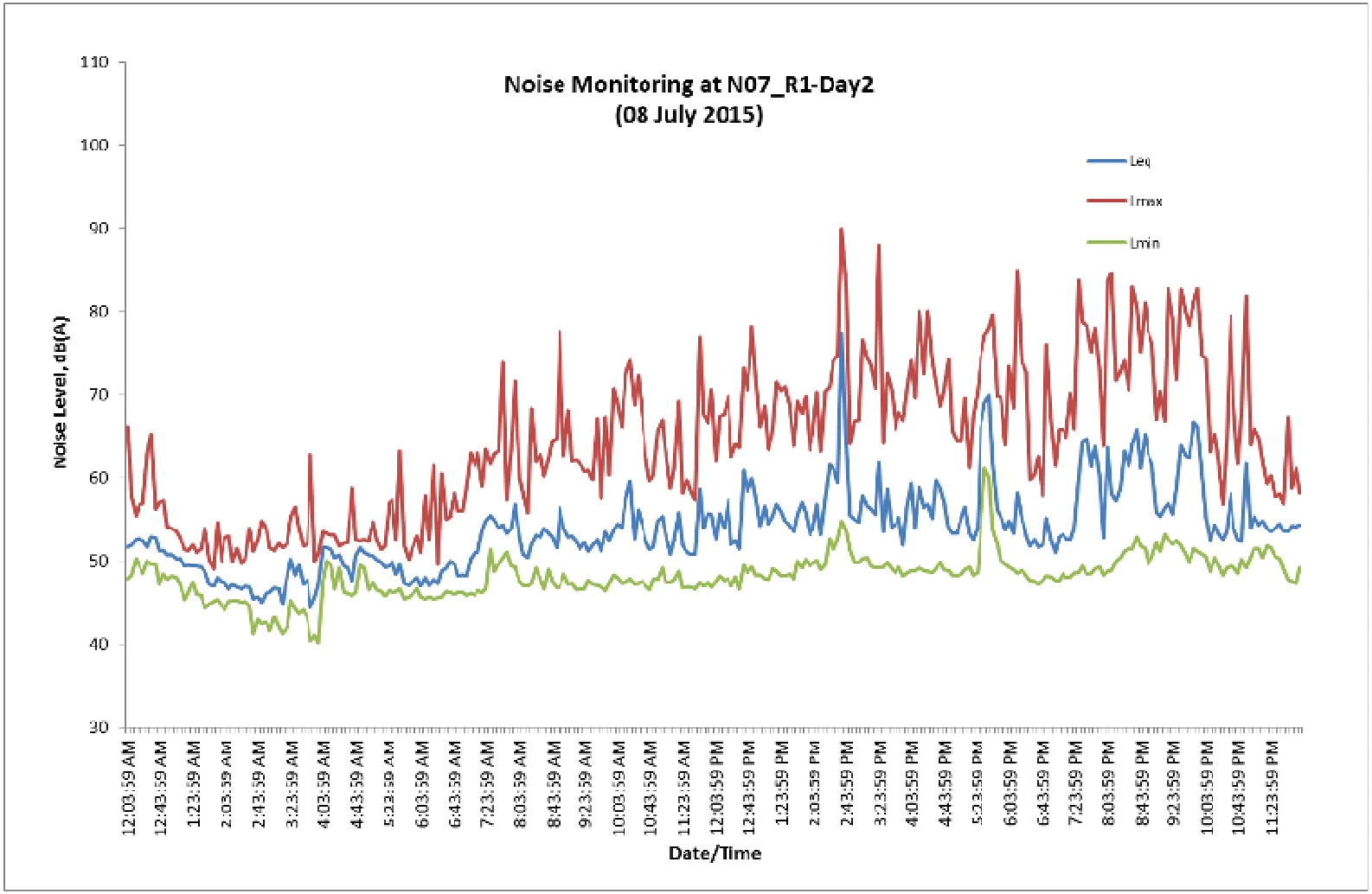

Figure 39: Daily noise level measured at Point NL07_R1 (Day 2)

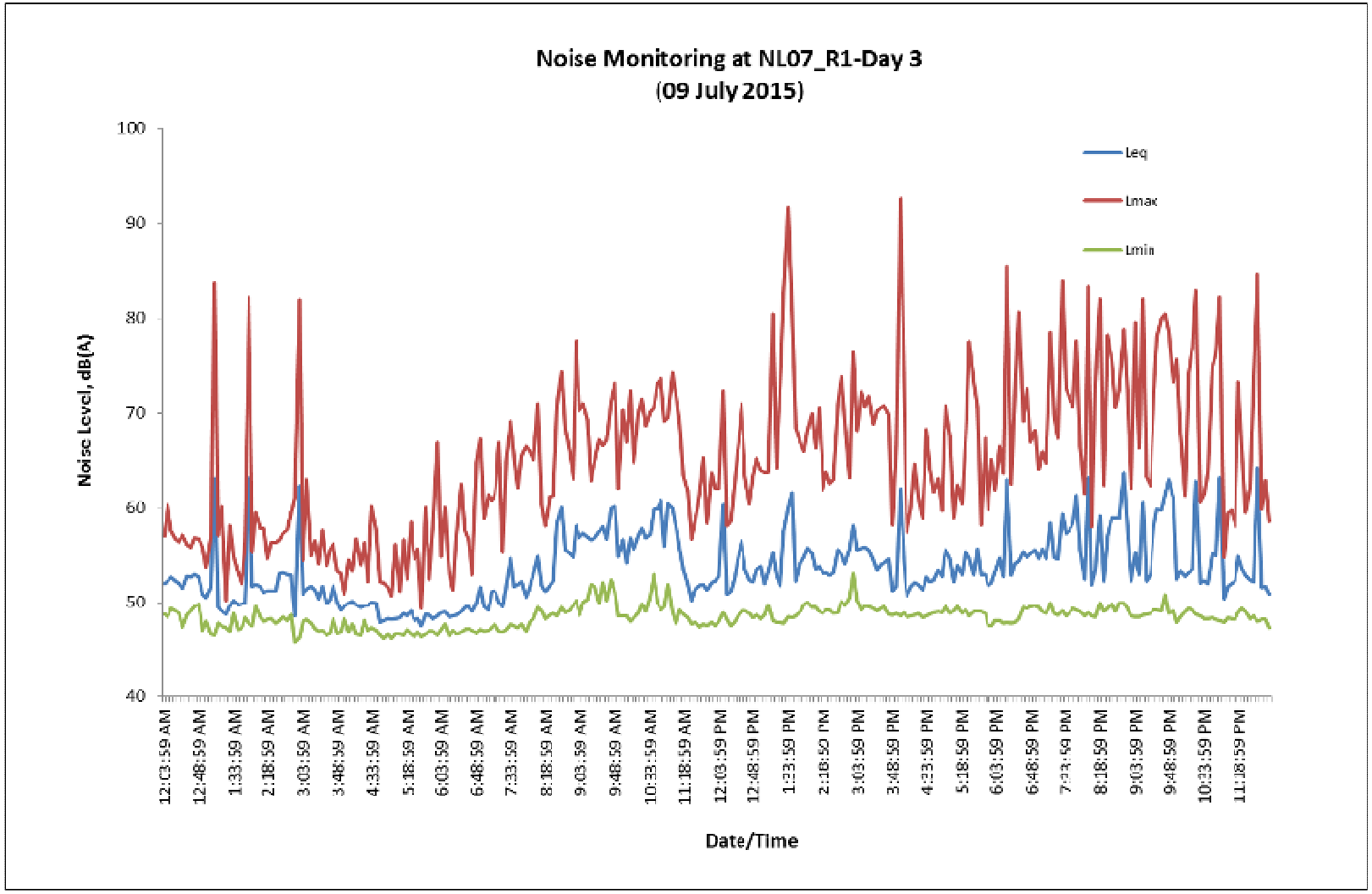

Figure 40: Daily noise level measured at Point NL07_R1 (Day 3)

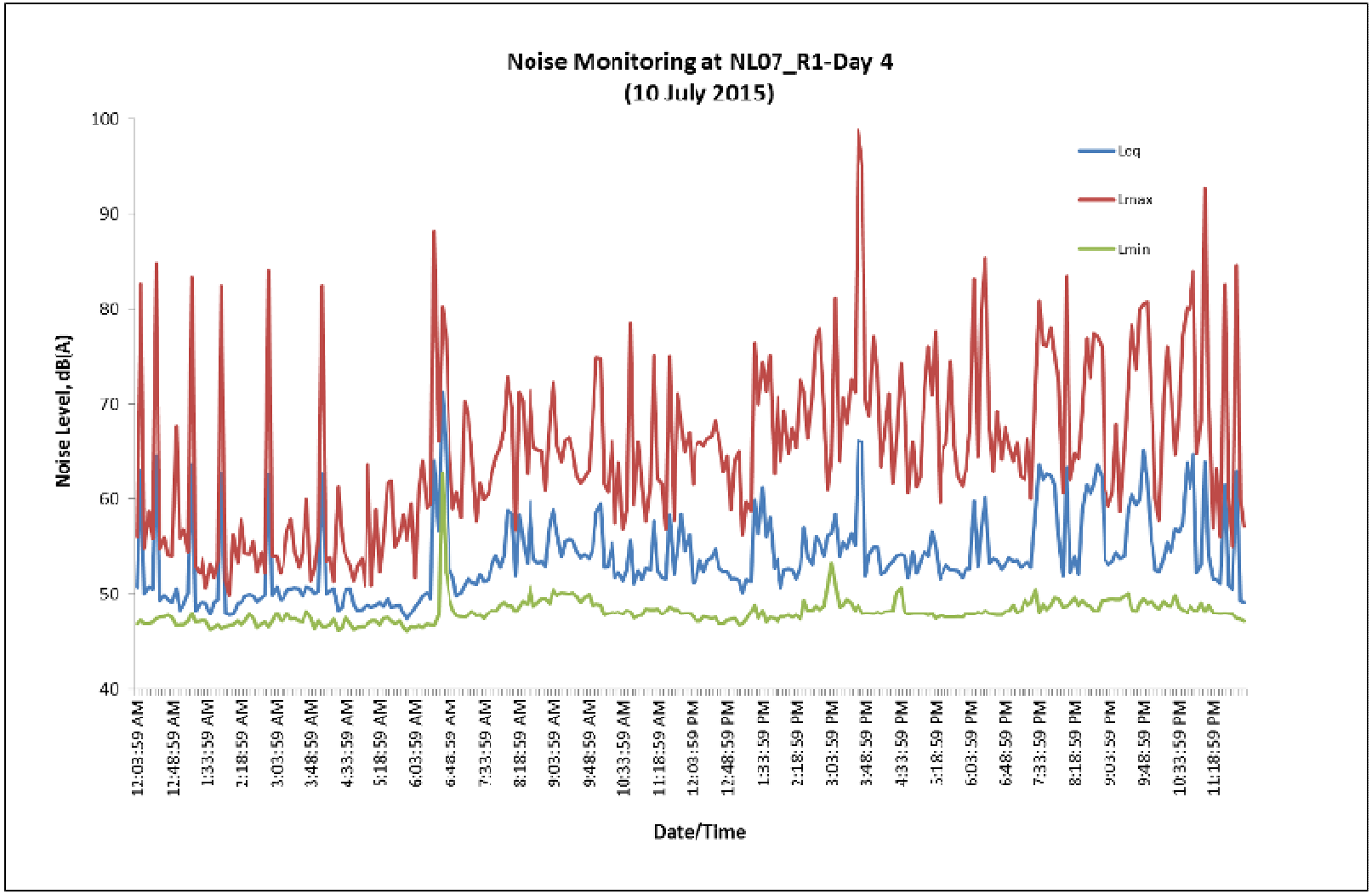

Figure 41: Daily noise level measured at Point NL07_R1 (Day 4)

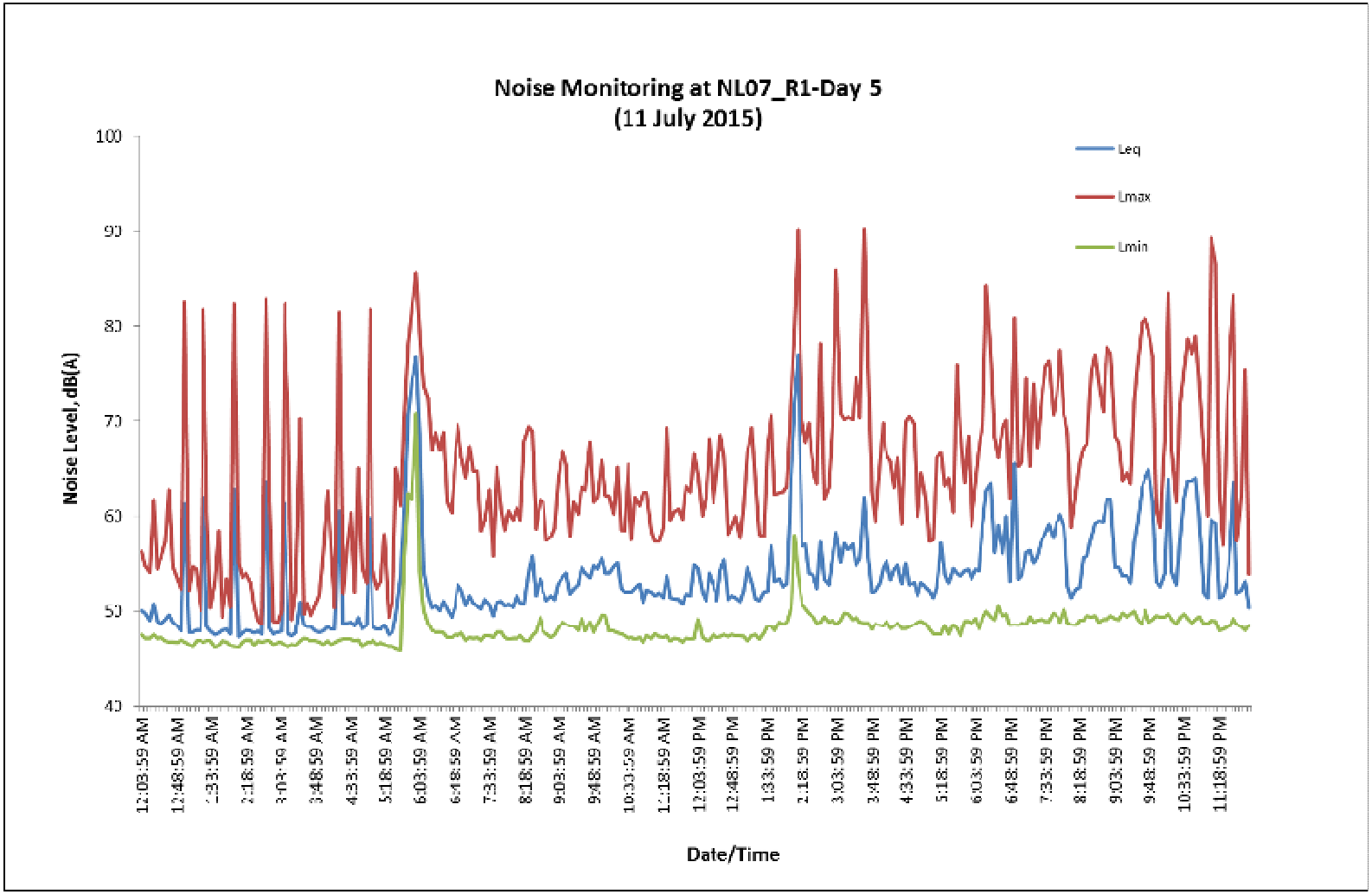

Figure 42: Daily noise level measured at Point NL07_R1 (Day 5)

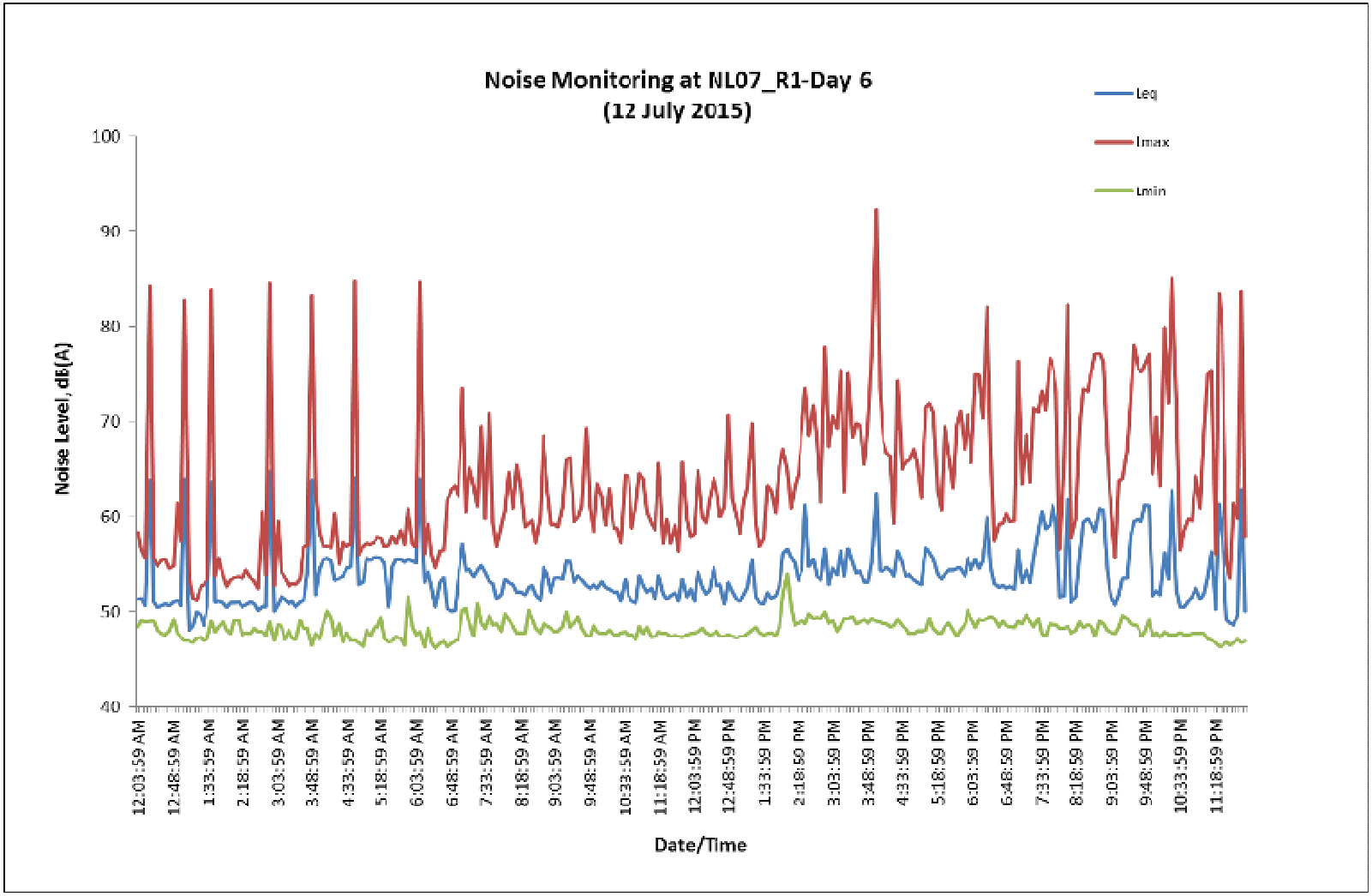

Figure 43: Daily noise level measured at Point NL07_R1 (Day 6)

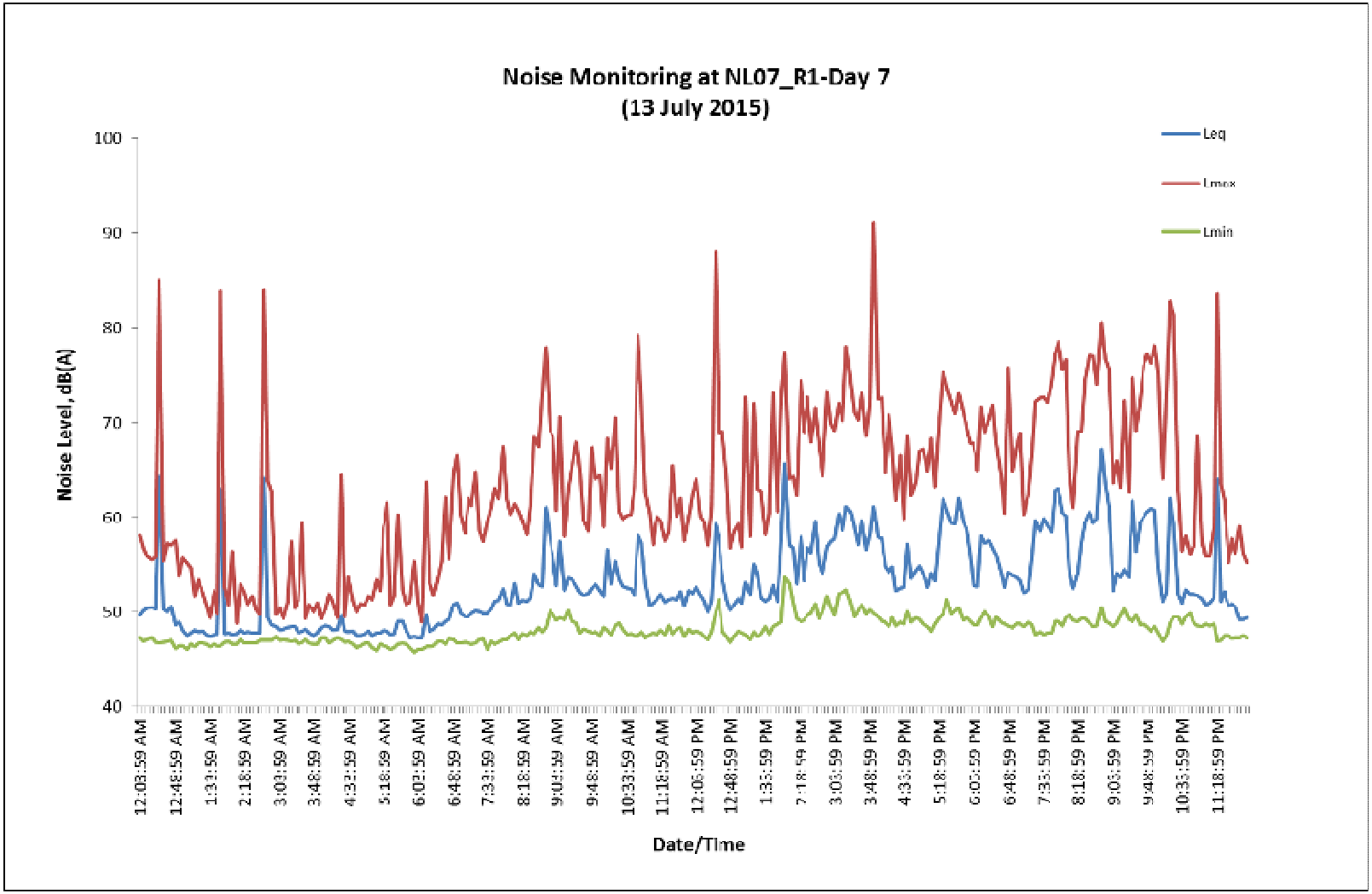

Figure 44: Daily noise level measured at Point NL07_R1 (Day 7)

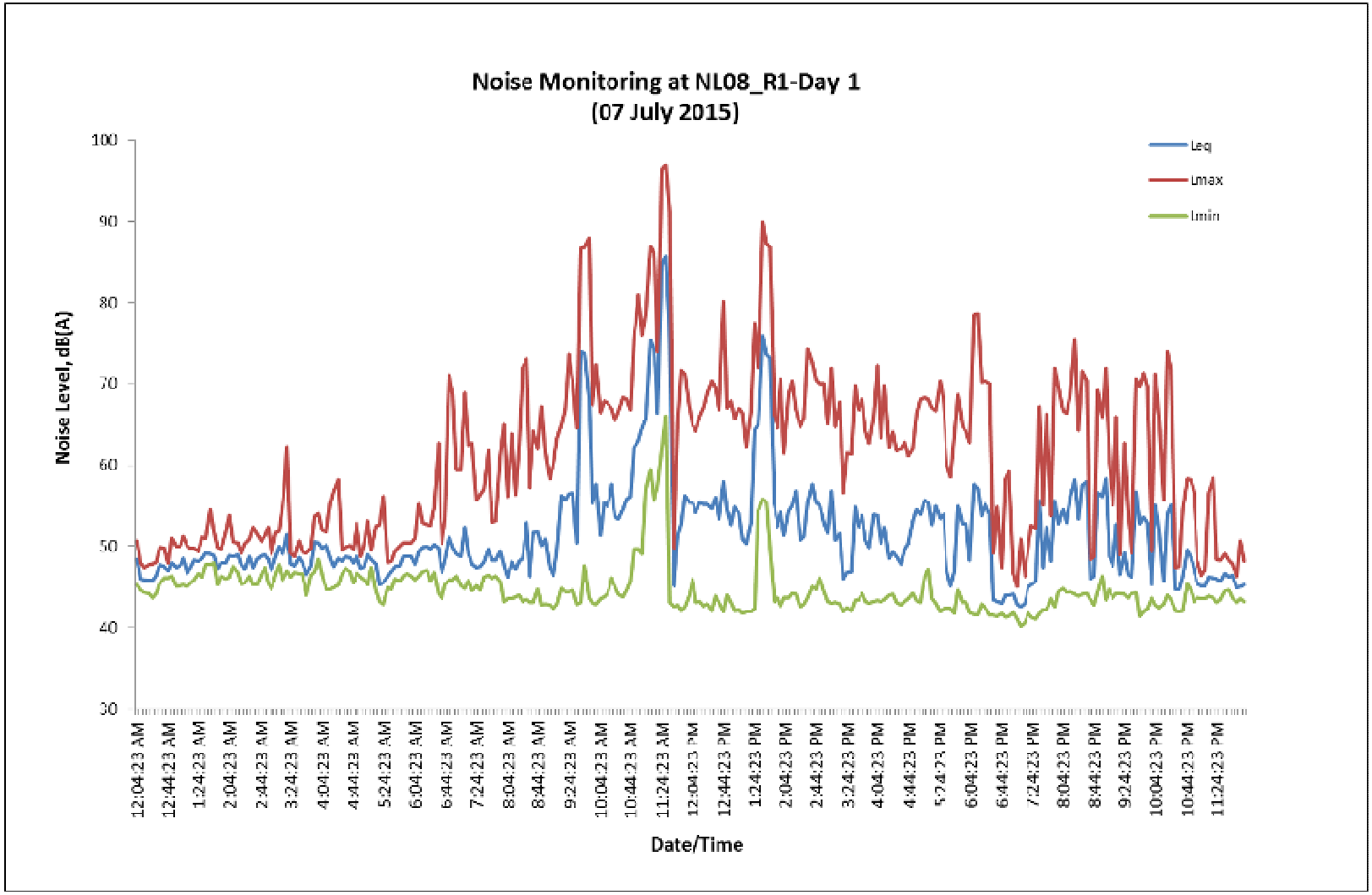

Figure 45: Daily noise level measured at Point NL08_R1 (Day 1)

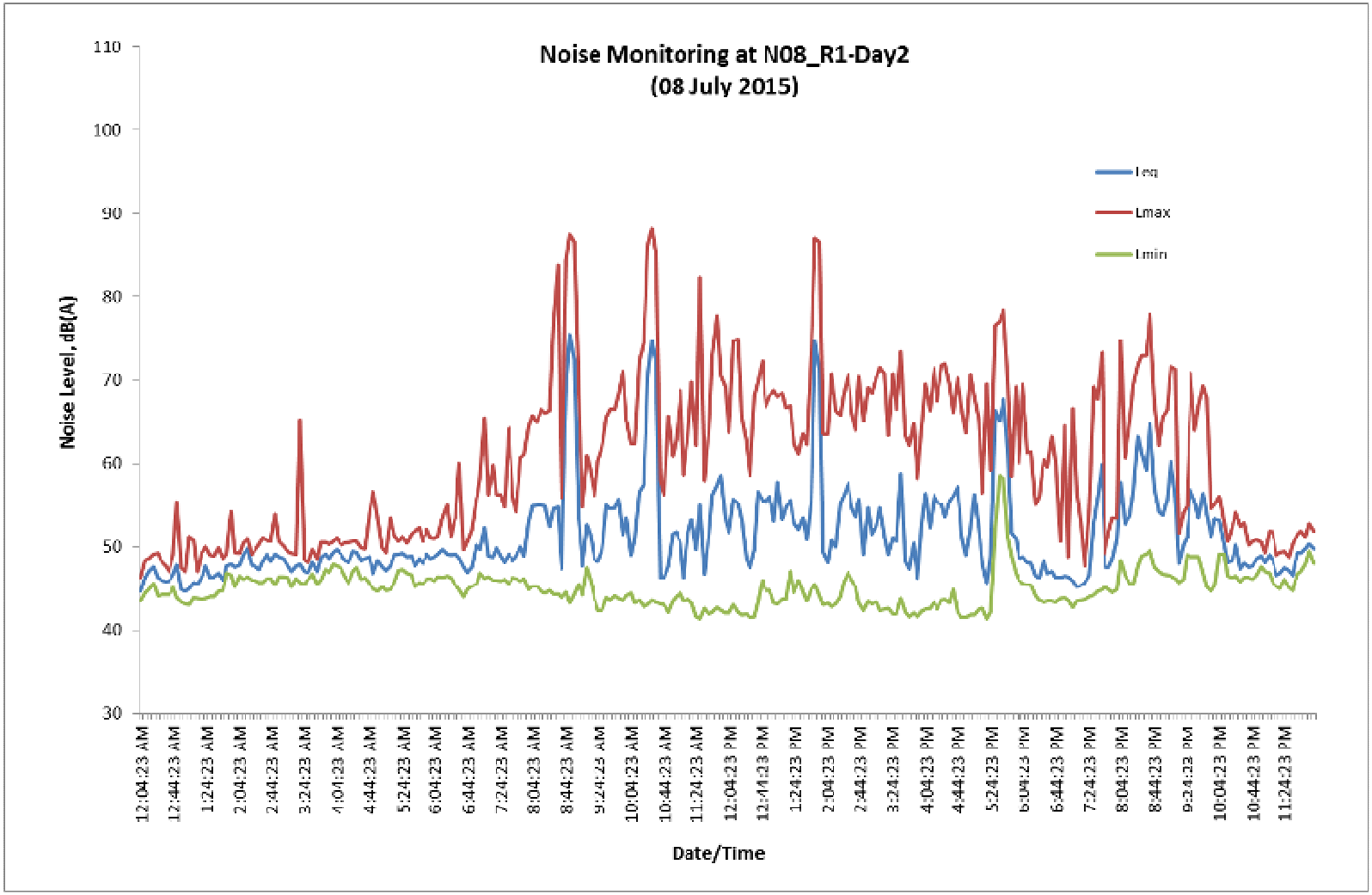

Figure 46: Daily noise level measured at Point NL08_R1 (Day 2)

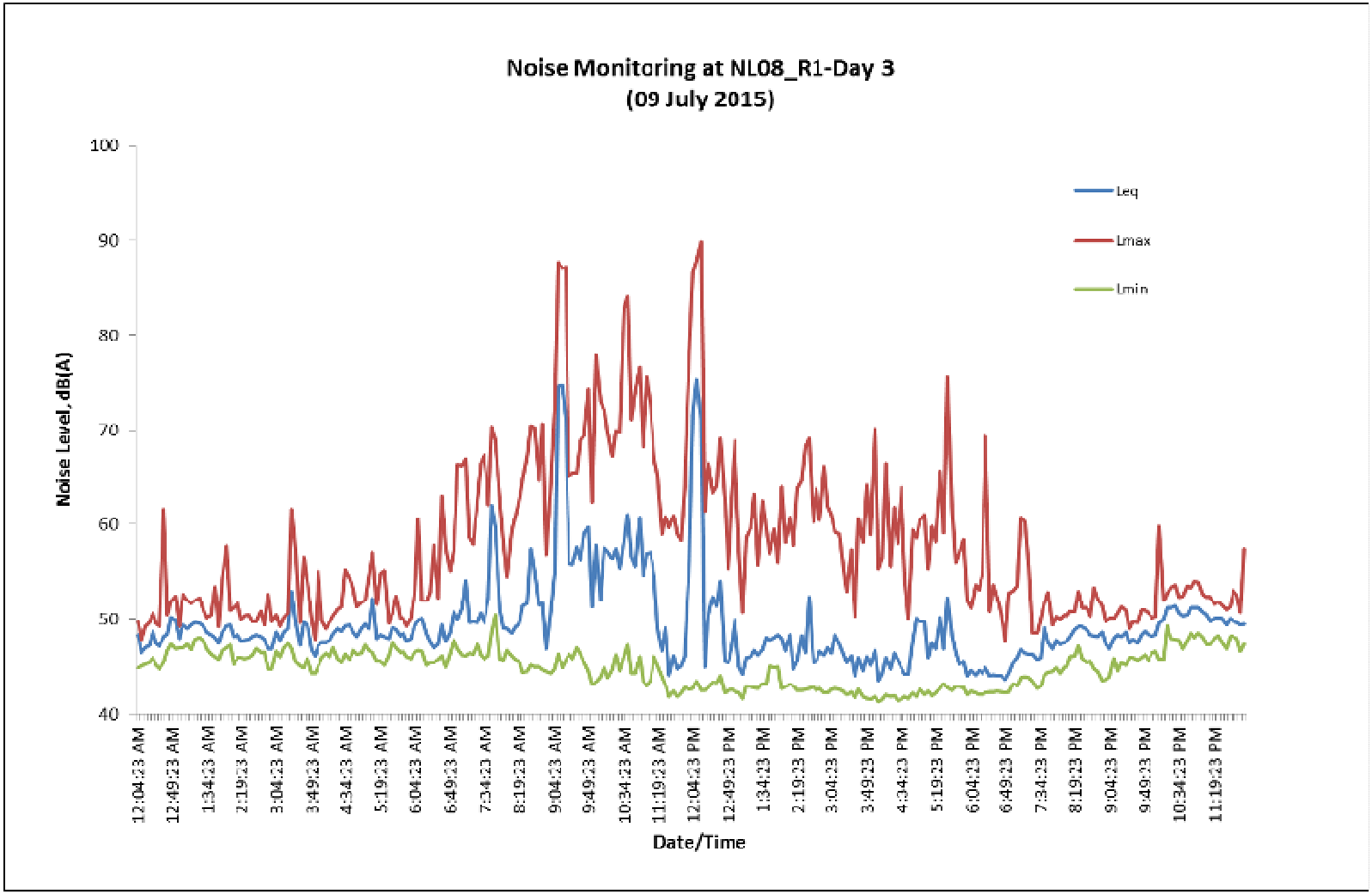

Figure 47: Daily noise level measured at Point NL08_R1 (Day 3)

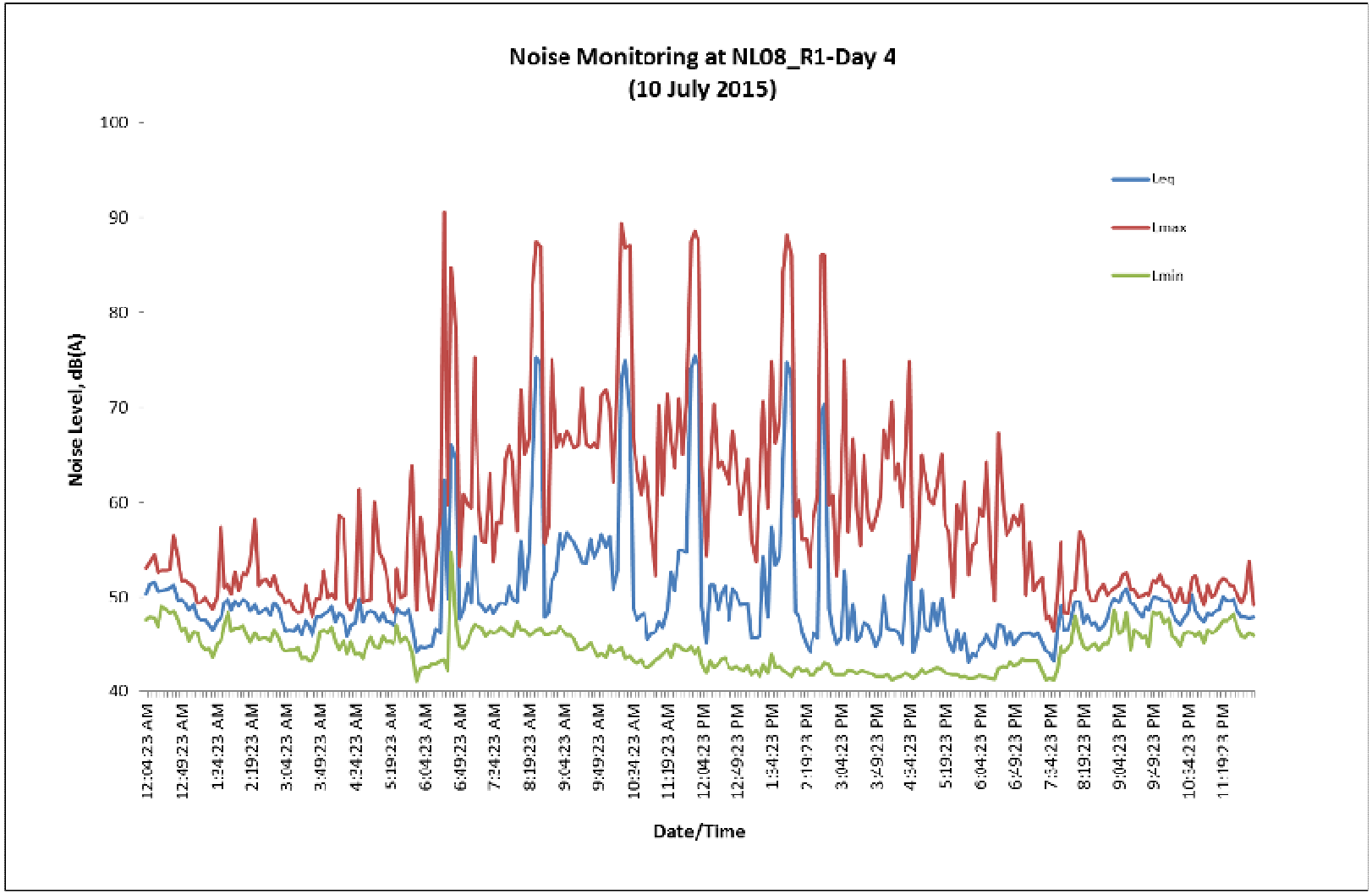

Figure 48: Daily noise level measured at Point NL08_R1 (Day 4)

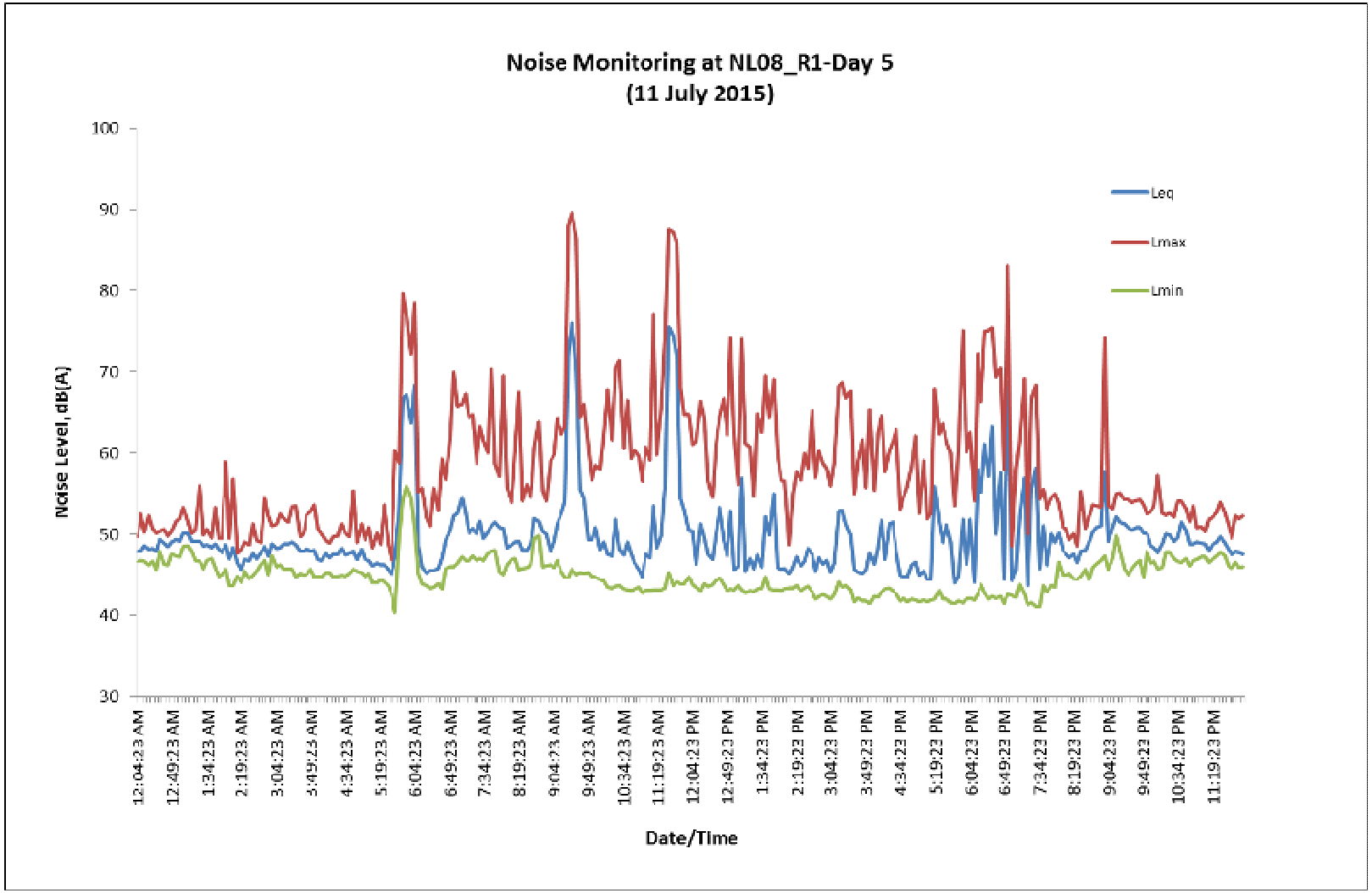

Figure 49: Daily noise level measured at Point NL08_R1 (Day 5)

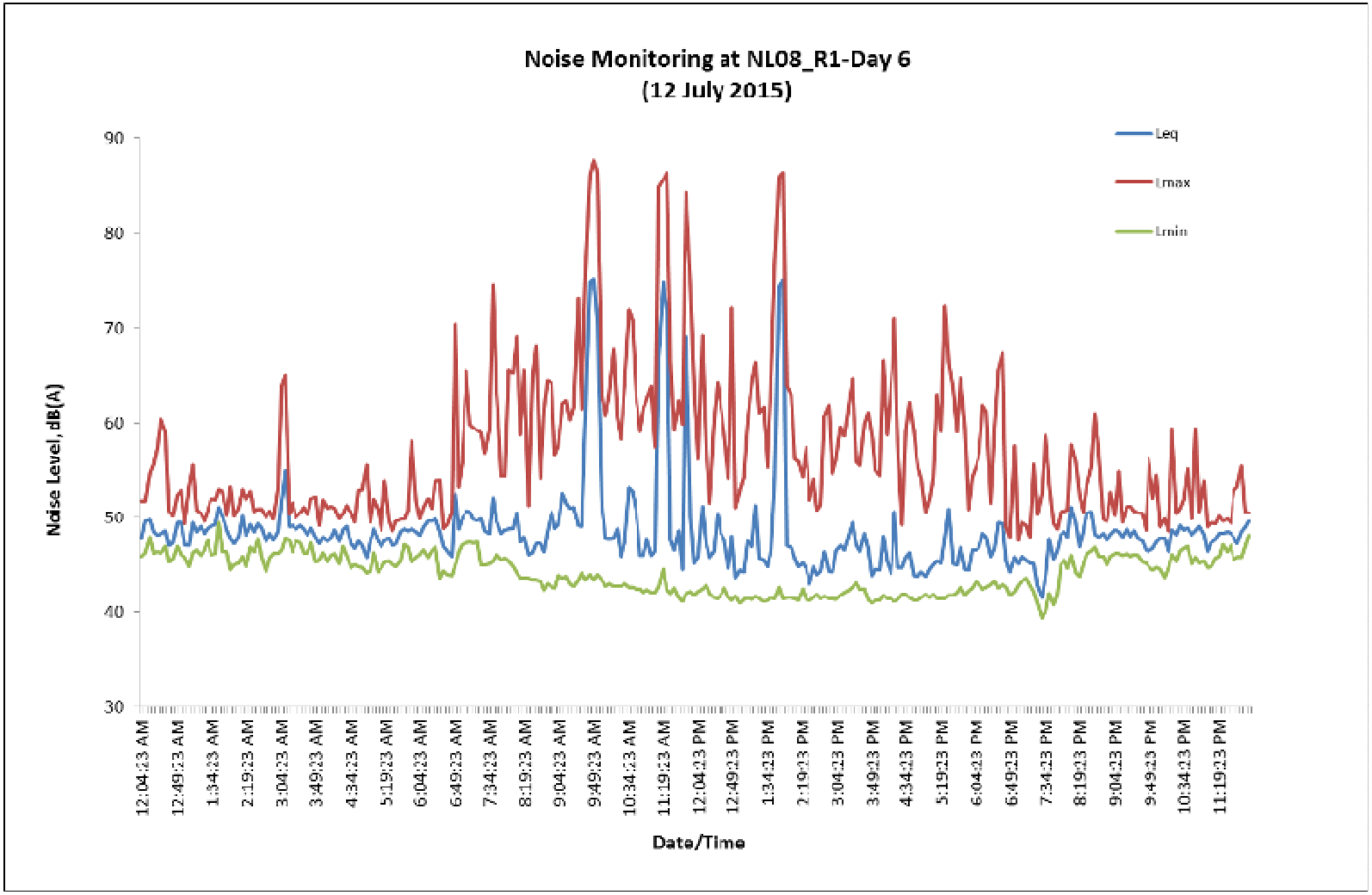

Figure 50: Daily noise level measured at Point NL08_R1 (Day 6)

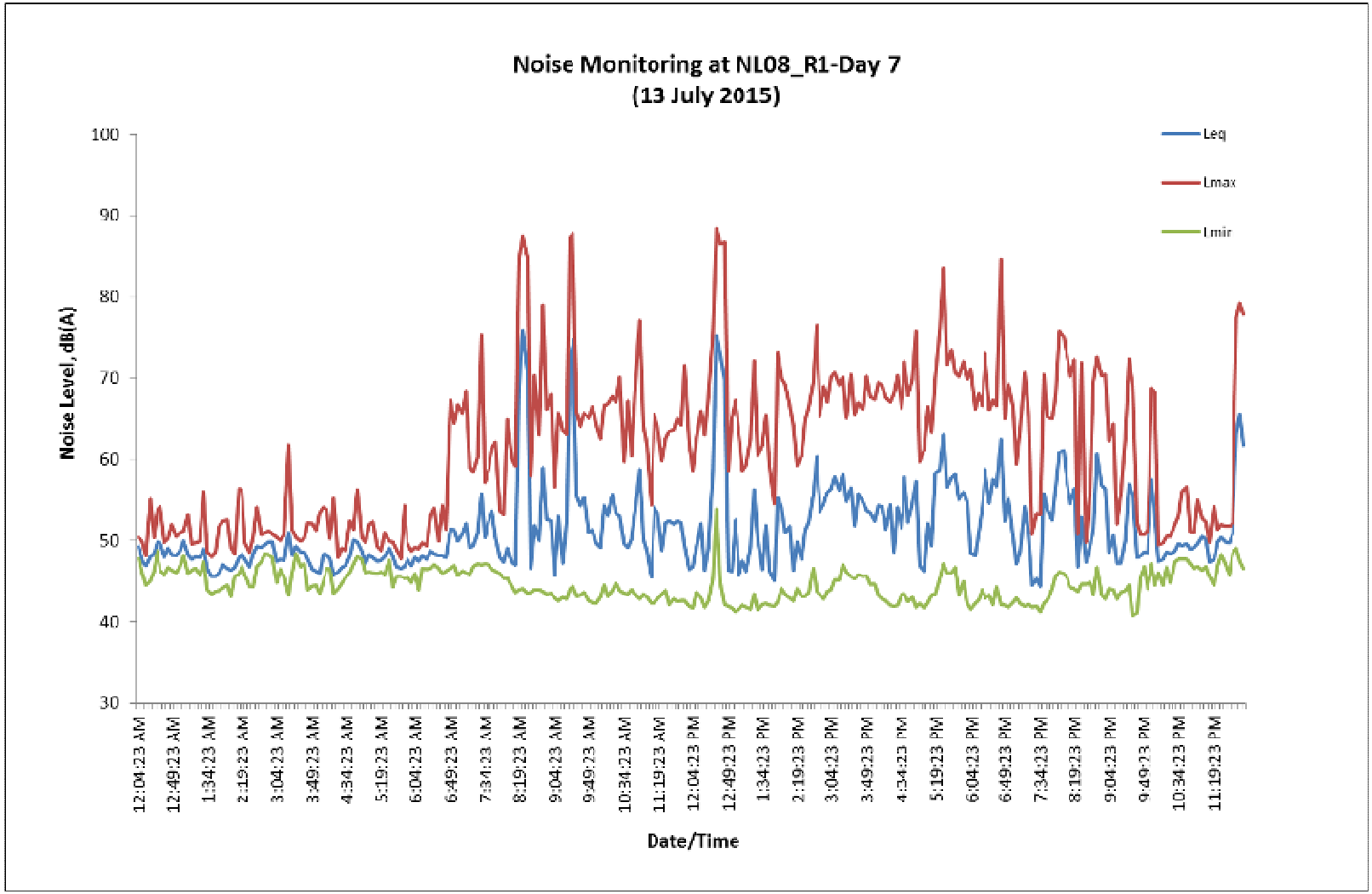

Figure 51: Daily noise level measured at Point NL08_R1 (Day 7)

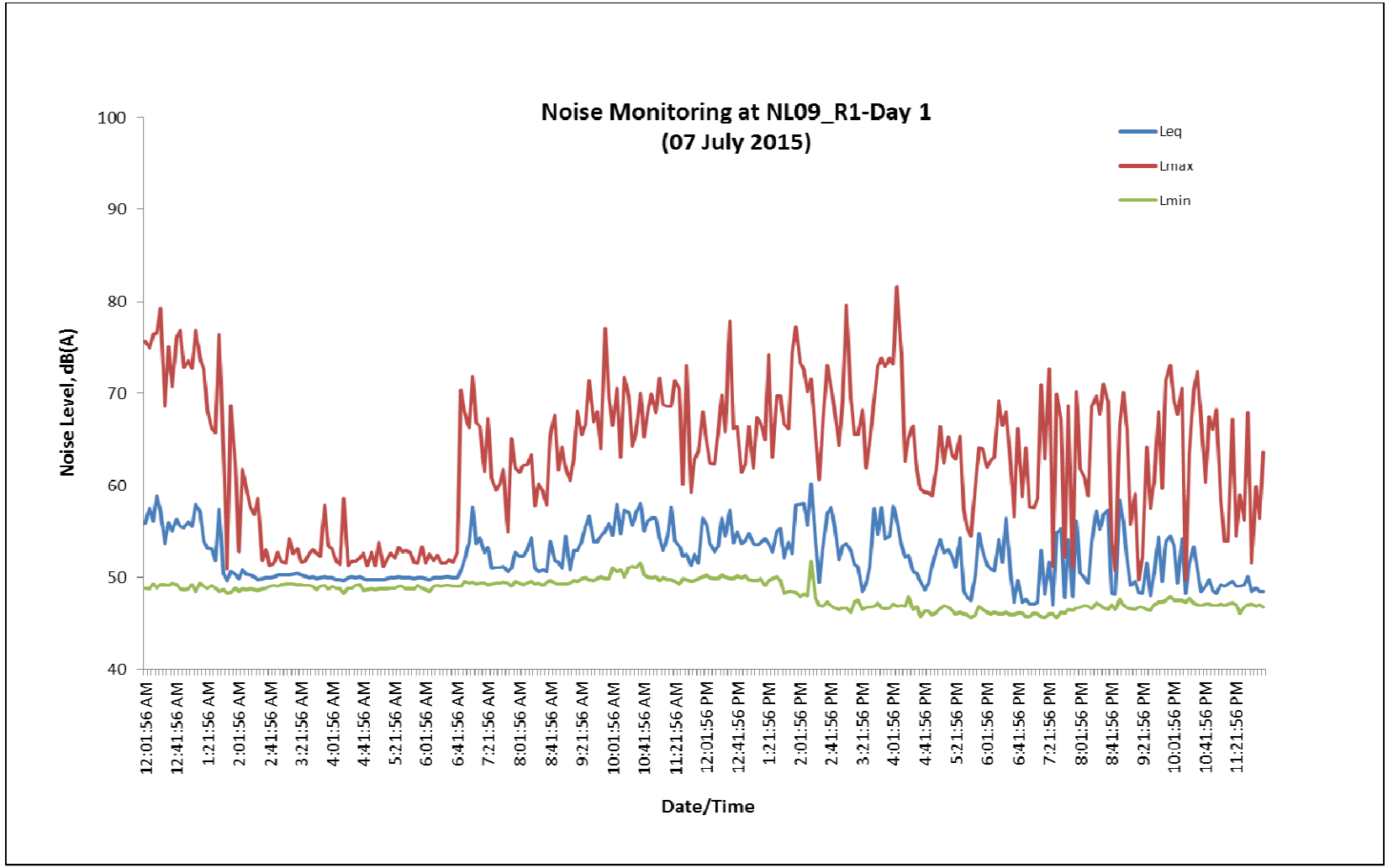

Figure 52: Daily noise level measured at Point NL09_R1 (Day 1)

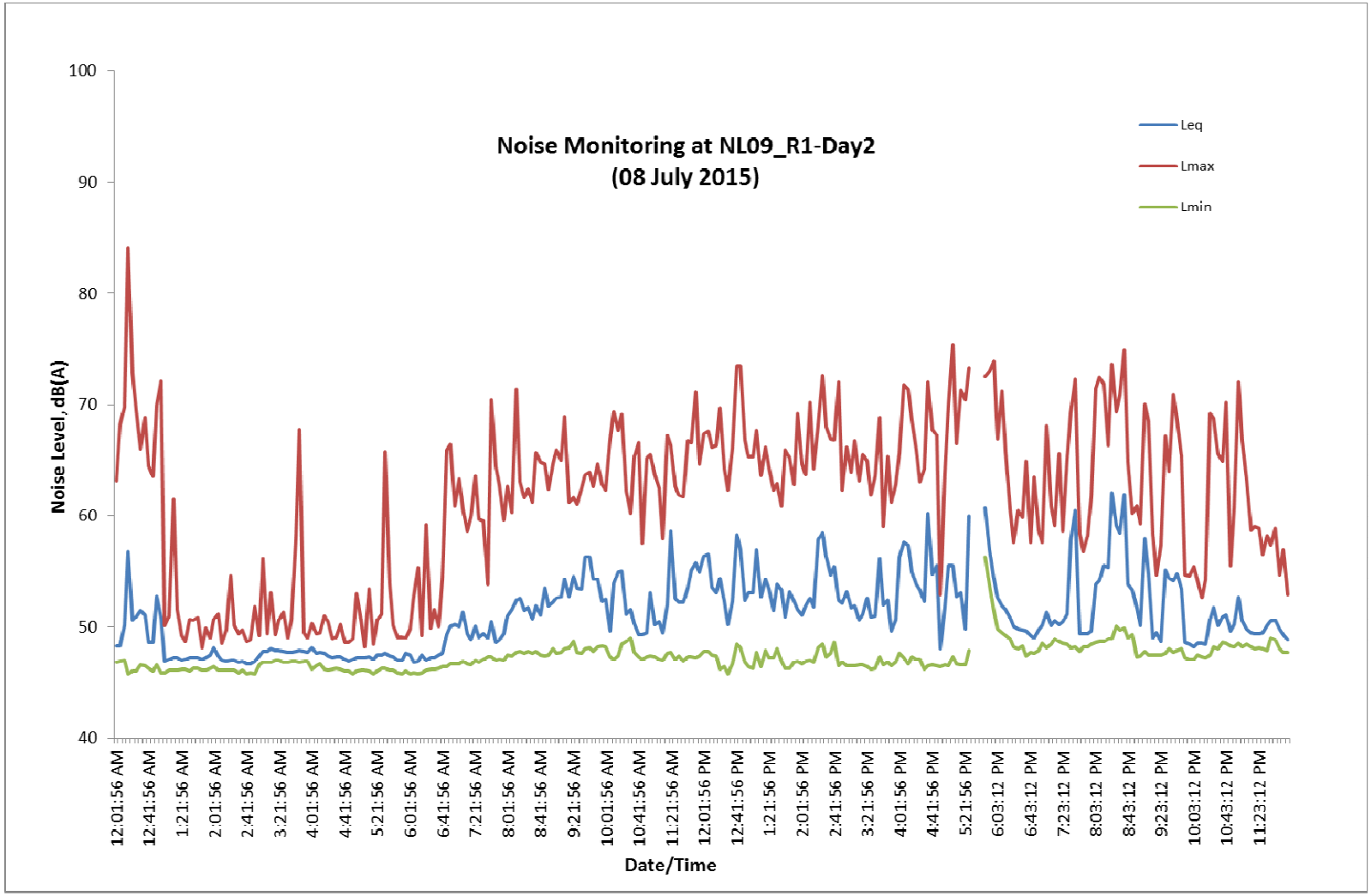

Figure 53: Daily noise level measured at Point NL09_R1 (Day 2)

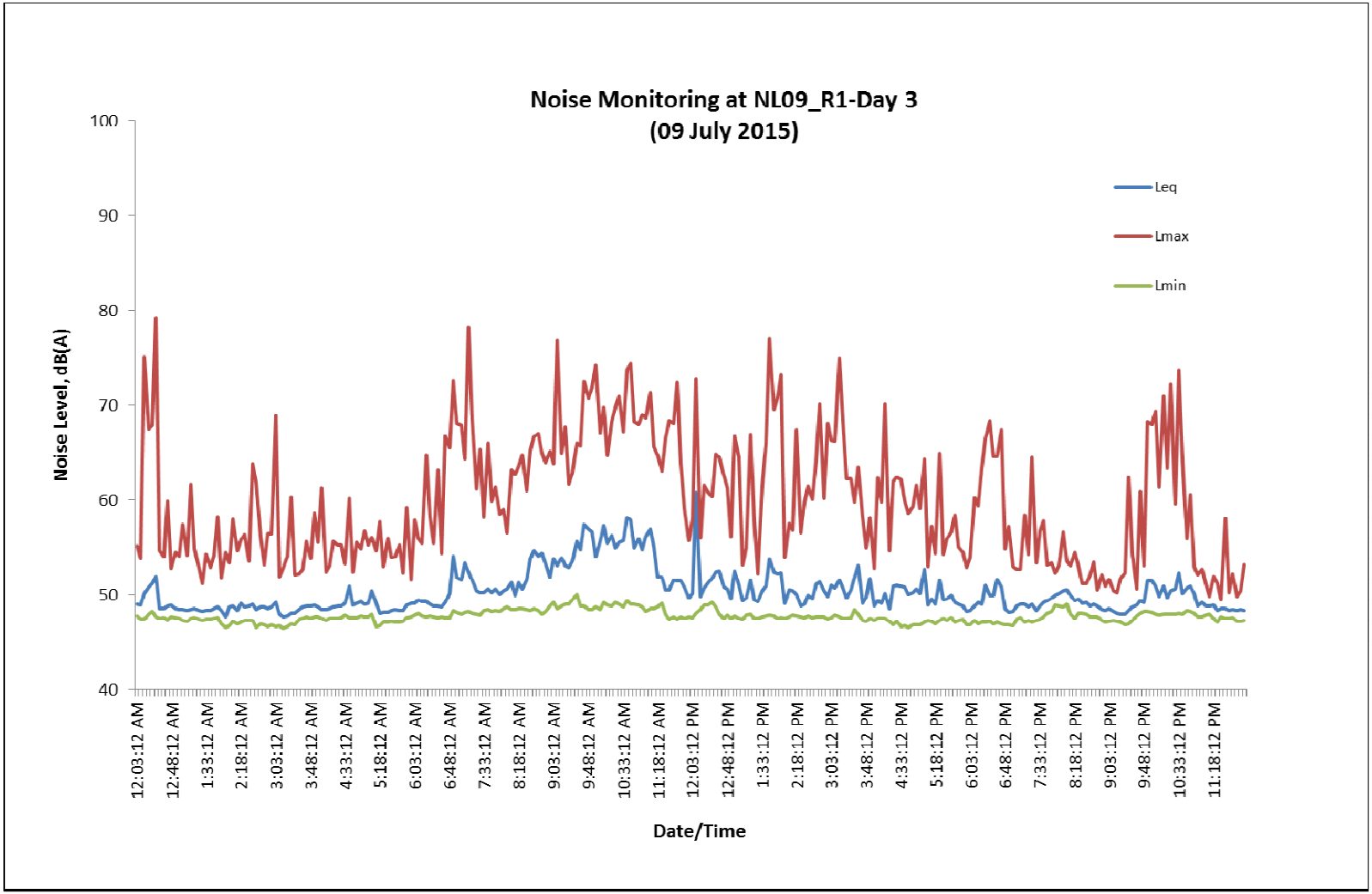

Figure 54: Daily noise level measured at Point NL09_R1 (Day 3)

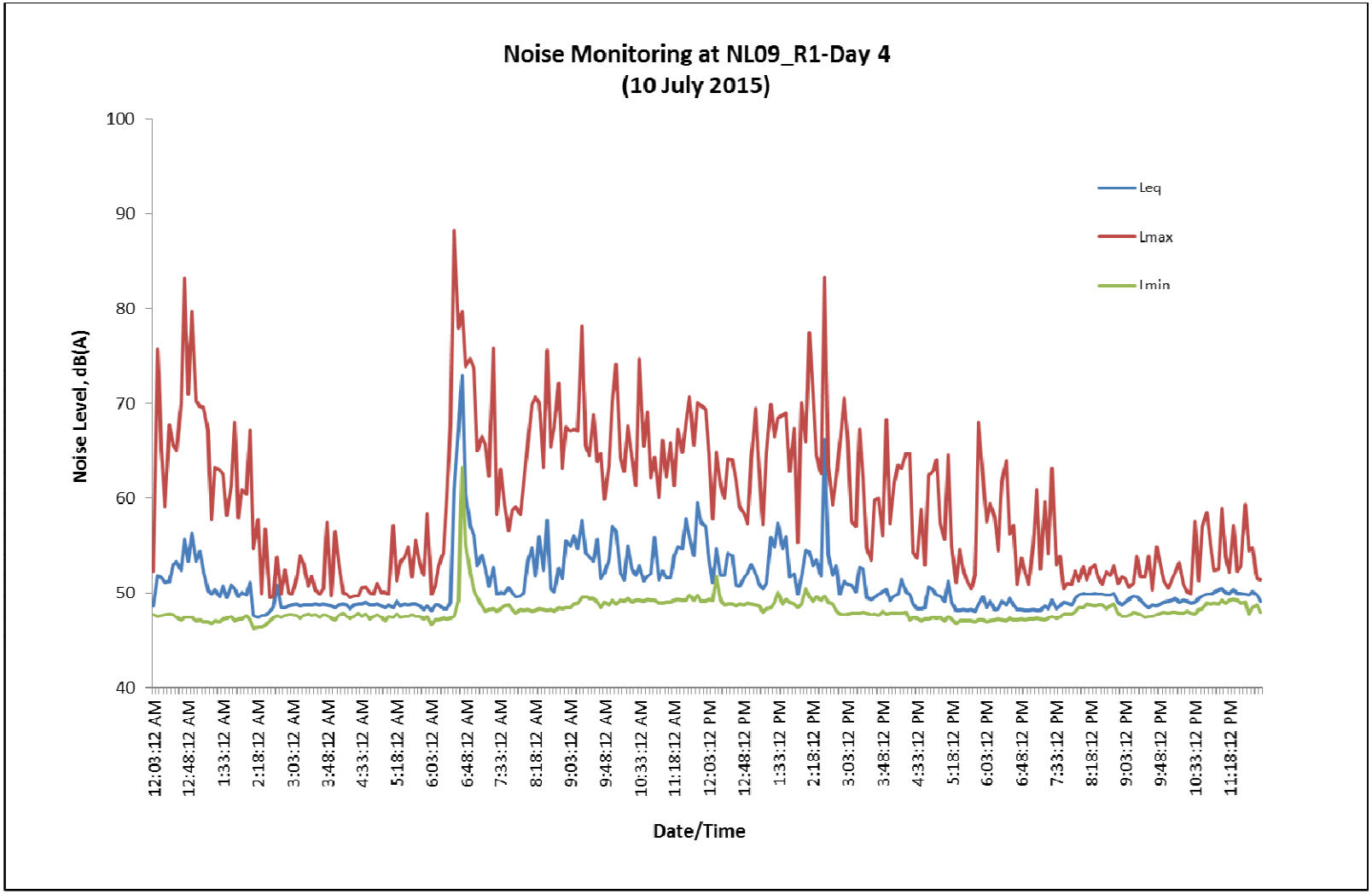

Figure 55: Daily noise level measured at Point NL09_R1 (Day 4)

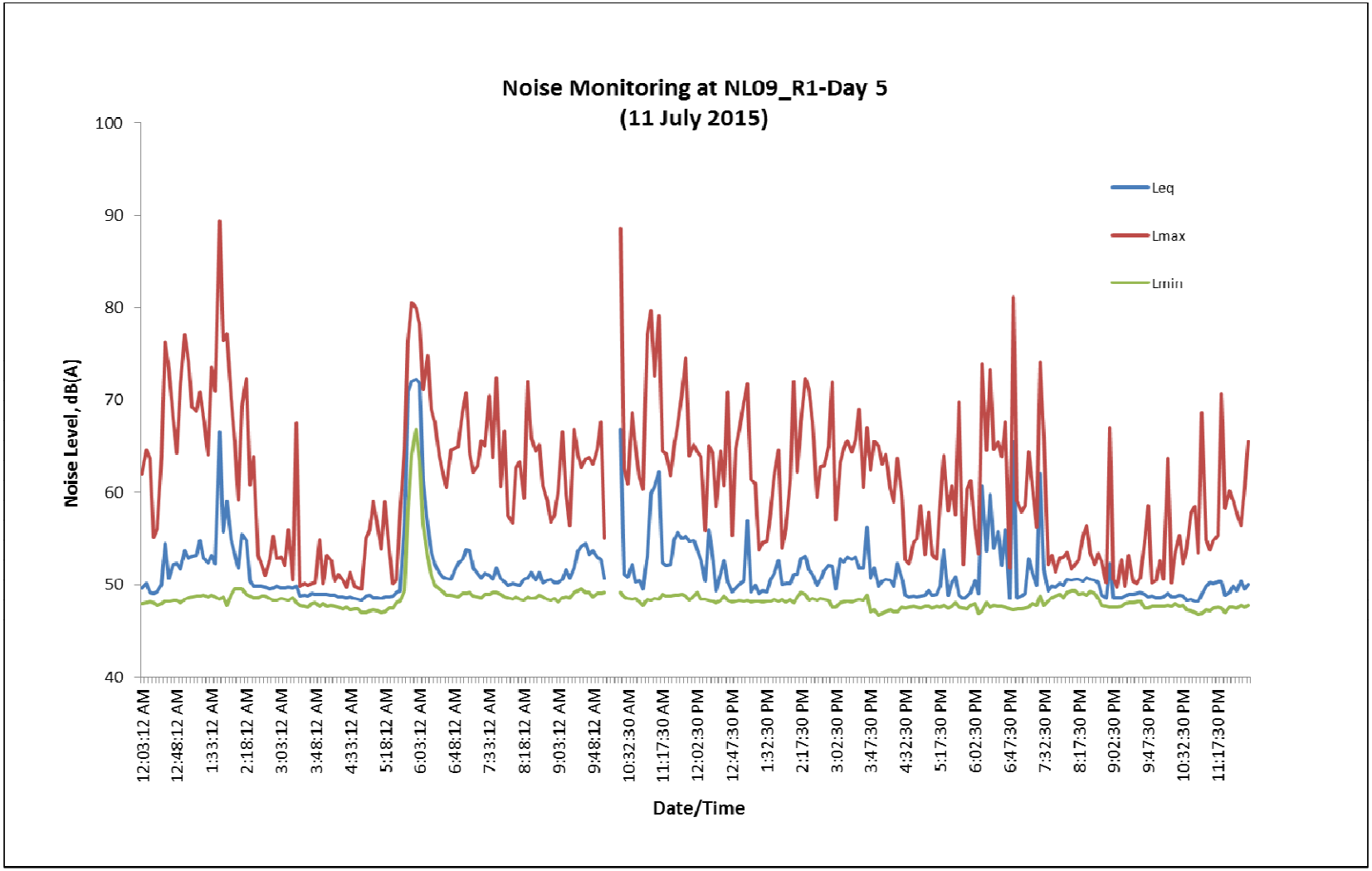

Figure 56: Daily noise level measured at Point NL09_R1 (Day 5)

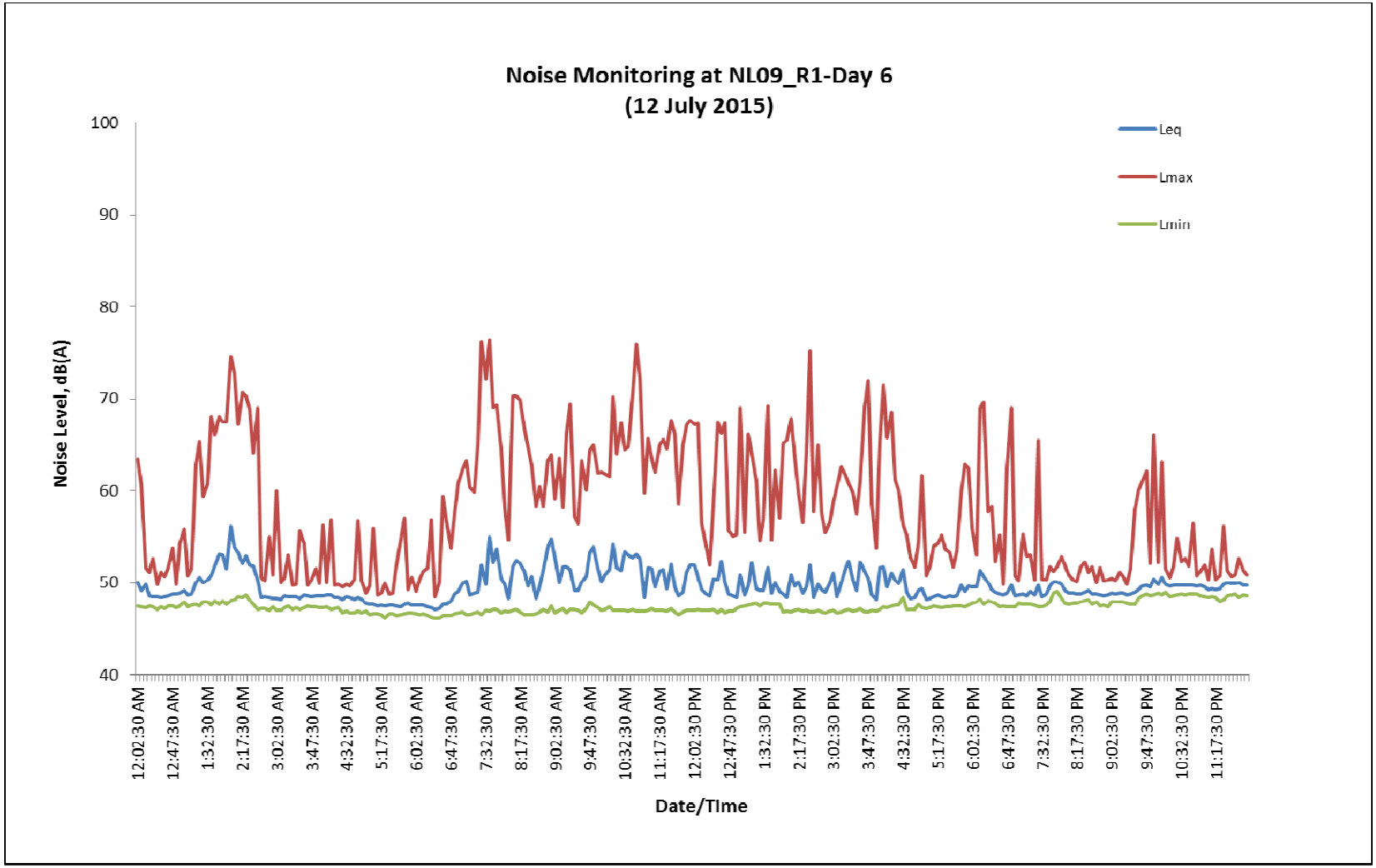

Figure 57: Daily noise level measured at Point NL09_R1 (Day 6)

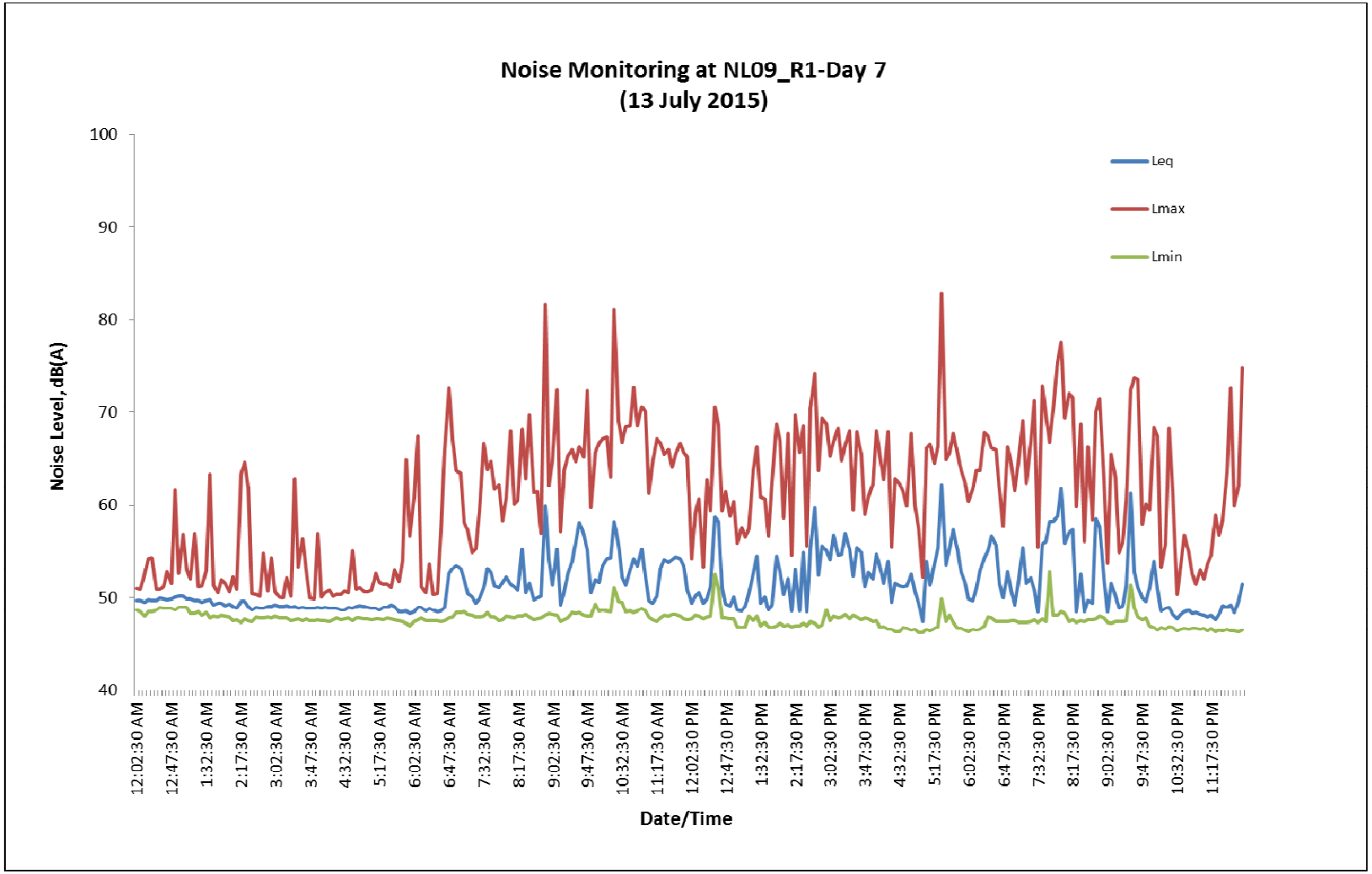

Figure 58: Daily noise level measured at Point NL09_R1 (Day 7)

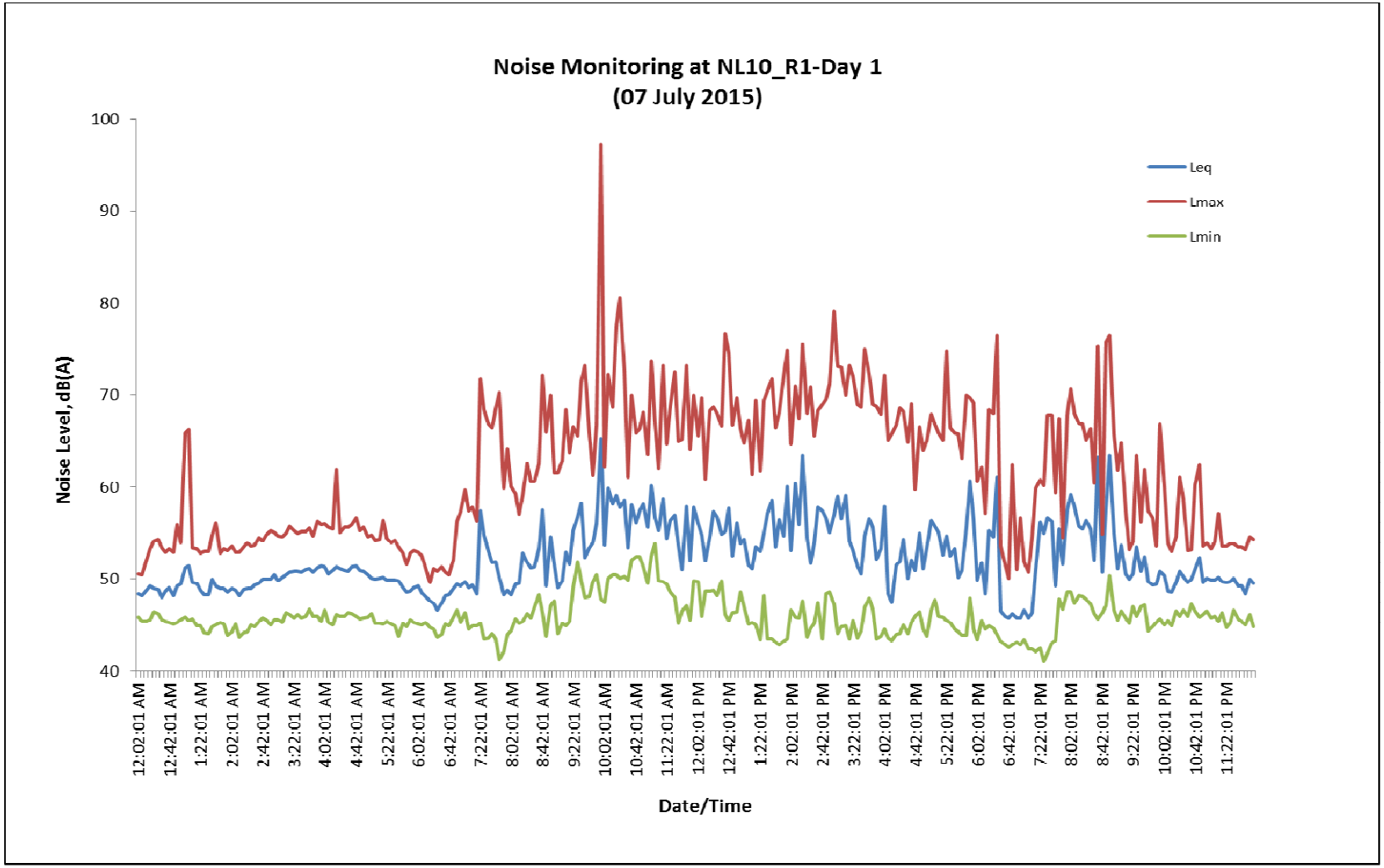

Figure 59: Daily noise level measured at Point NL10_R1 (Day 1)

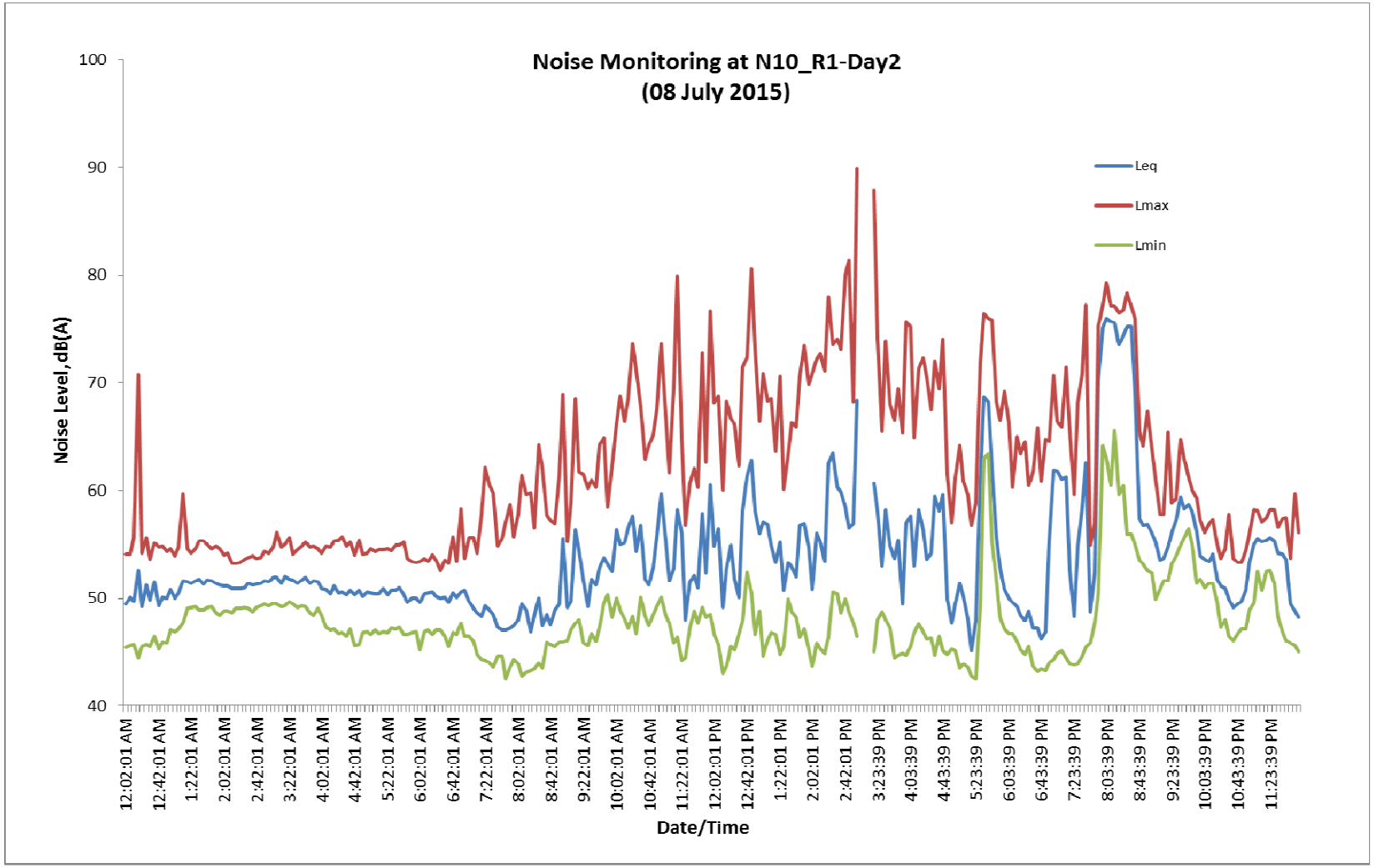

Figure 60: Daily noise level measured at Point NL10_R1 (Day 2)

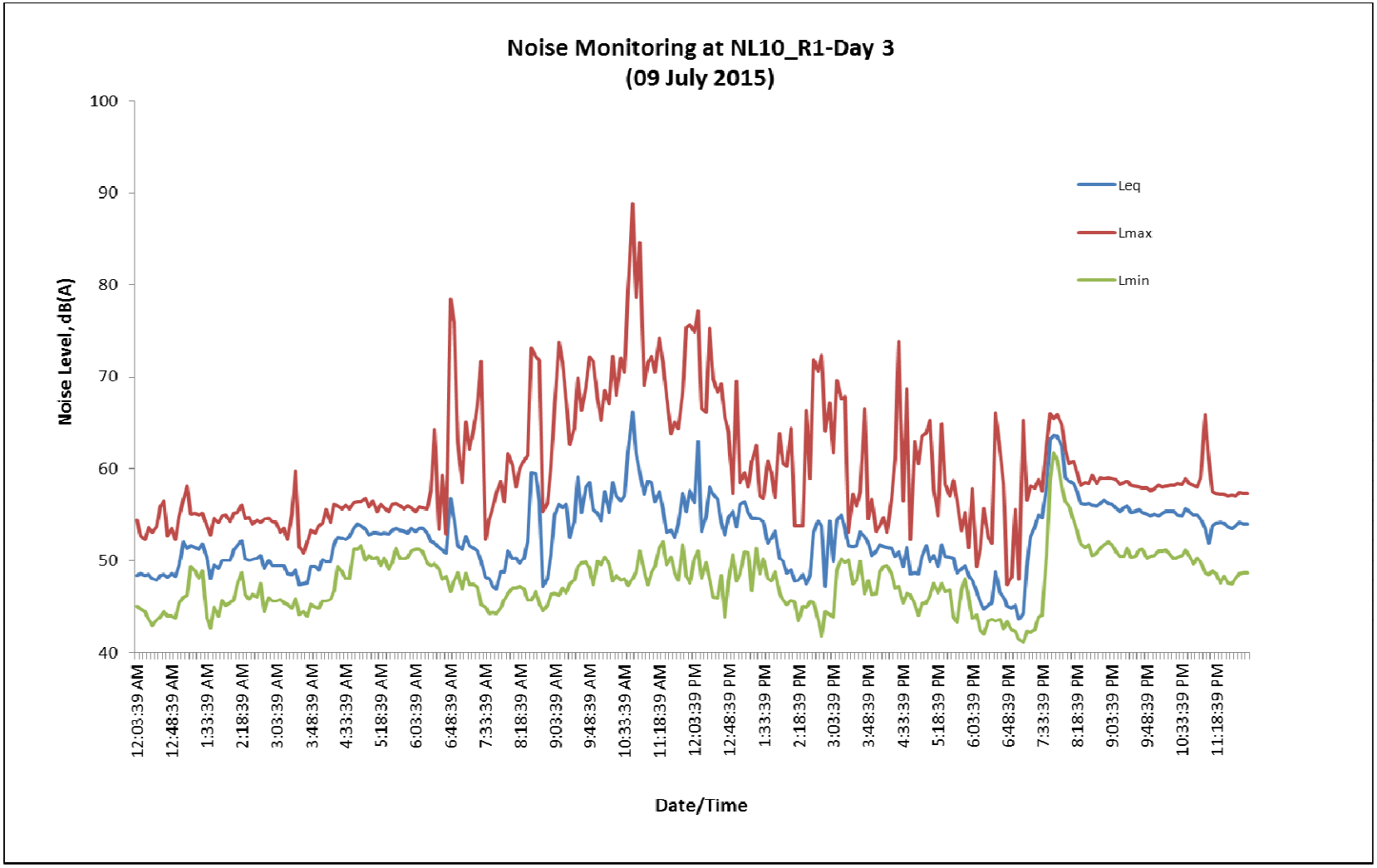

Figure 61: Daily noise level measured at Point NL10_R1 (Day 3)

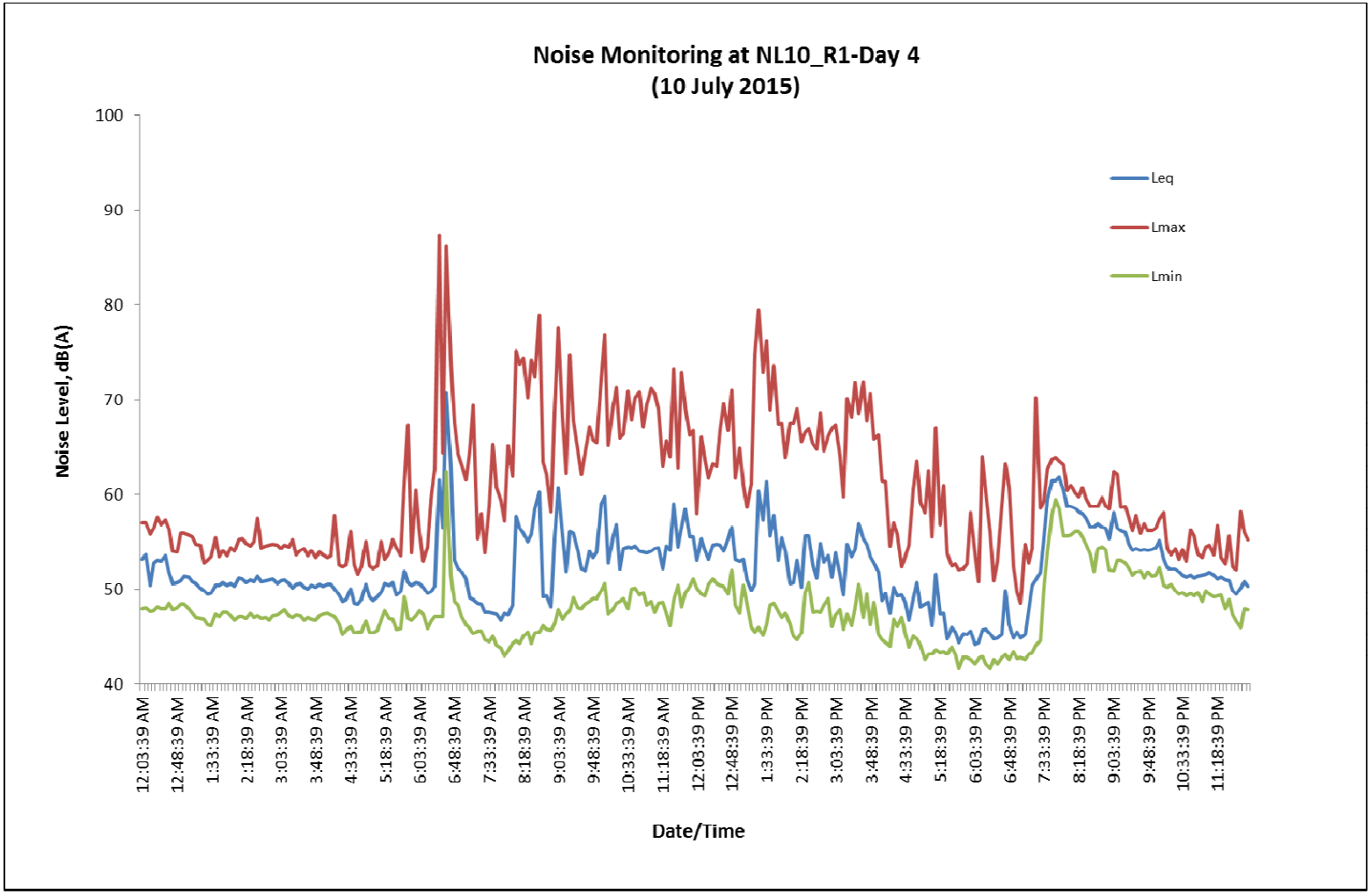

Figure 62: Daily noise level measured at Point NL10_R1 (Day 4)

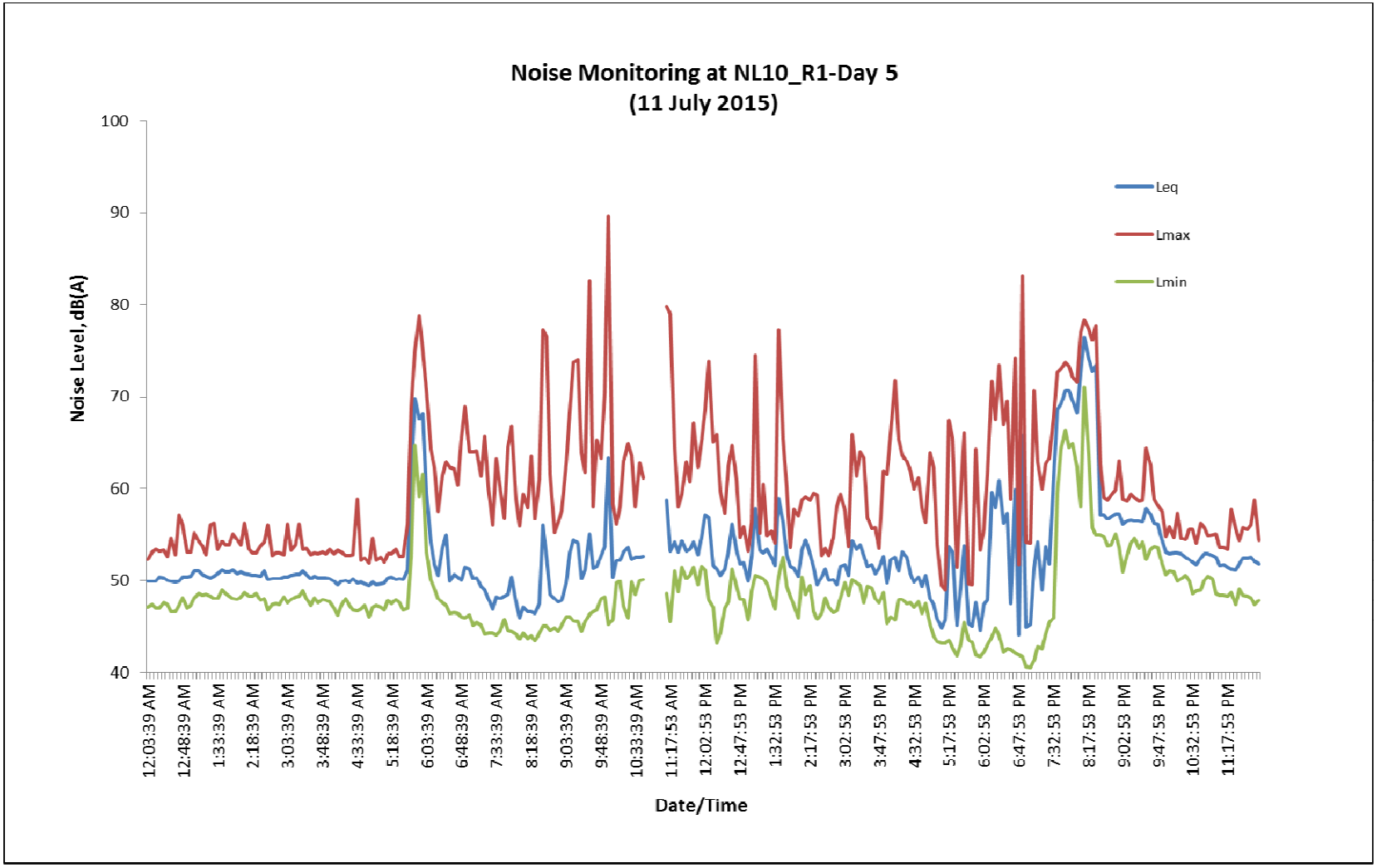

Figure 63: Daily noise level measured at Point NL10_R1 (Day 5)

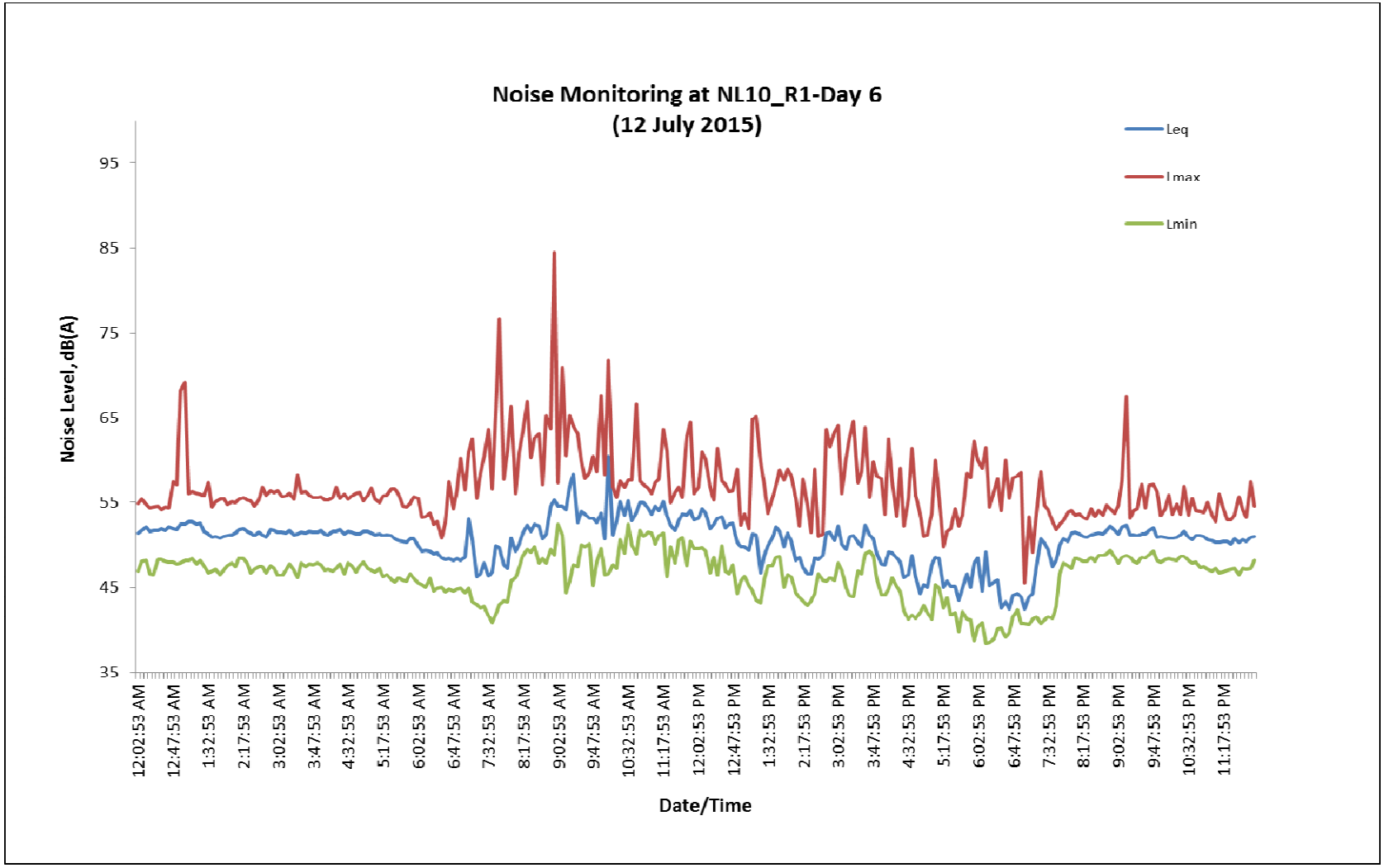

Figure 64: Daily noise level measured at Point NL10_R1 (Day 6)

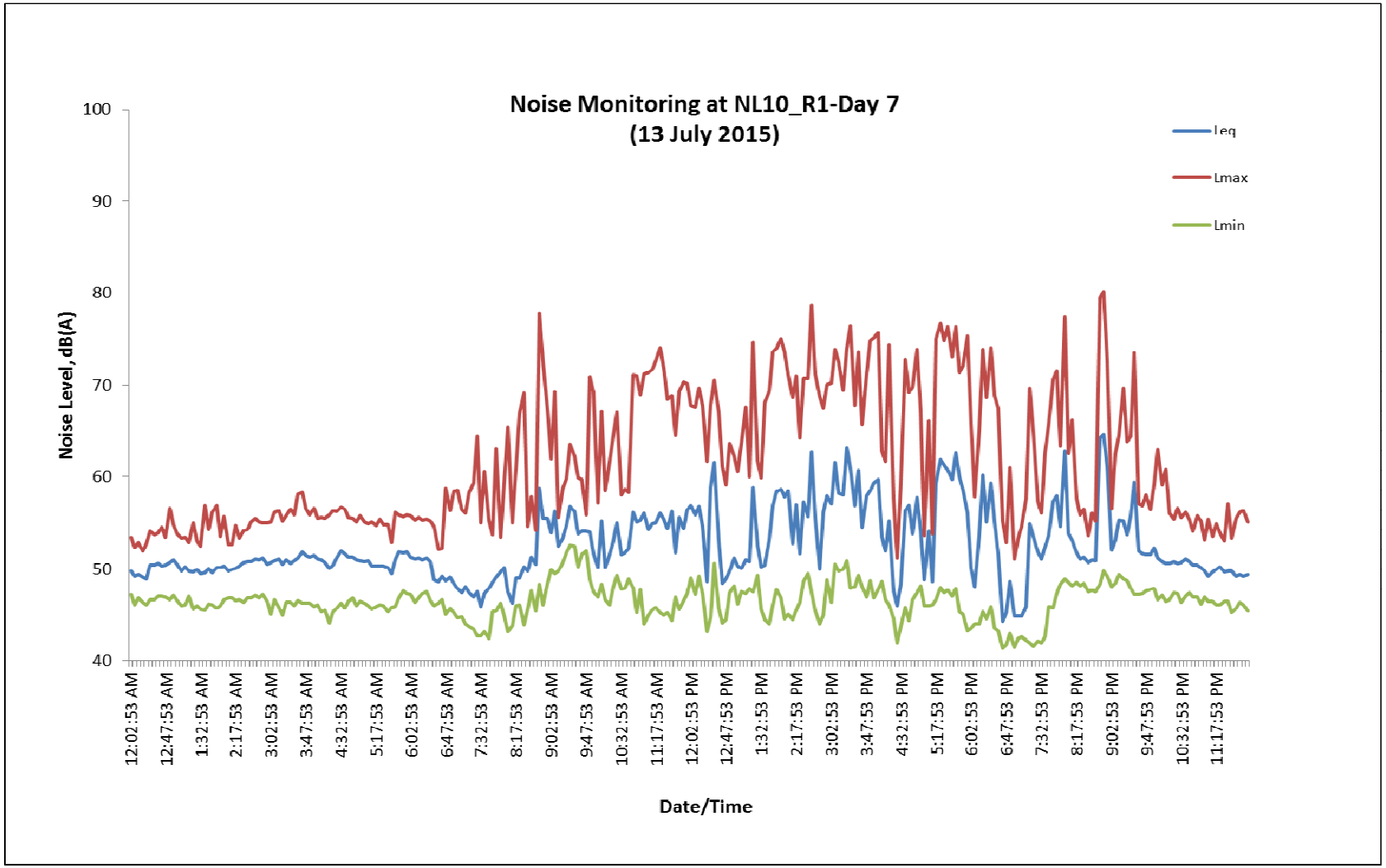

Figure 65: Daily noise level measured at Point NL10_R1 (Day 7)

5.0 Evaluation & discussion

In general, the results obtained at NL07-NL09 were in compliance with the National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites -Buildings other than above Part I & II) Regulations, 2011 Revised Ed. And there are no relevant limits for NL01, NL03-NL06 and NL10.

It should be noted that the Noise Monitoring project was carried out to the best of our knowledge and ability as well as responsibility towards the code of practice in the performance and reliability of our business to be accurate, precise and representative at the date/time and locations sampled so as to achieve a satisfactory baseline study.

6.0 REFERENCES

National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

Quest Technologies SoundPro Models SE/DL User Manual

APPENDIX 1

CALIBRATION CERTIFICATION OF FIELD EQUIPMENT

3M Occnomowoc
Personal Safety Division

3M Detection Solutions
1060 Corporate Center Drive
Occnomowoc, WI 53066-4828
www.3M.com/detection
262 567 9157 800 245 0779
262 567 4047 Fax

An ISO 9001 Registered Company

ATD BAV- 49412

3M

Certificate of Calibration

Certificate Number: 1410271124BJN100031

Model: SoundPro SP DL-1
S/N: BJN100031

Date issued: 27-Oct-2014

On this day of manufacture and calibration, 3M certifies that the above listed product meets or exceeds the performance requirements of the following acoustic standard(s):

ANSI S1.4 1983 (R 2006) - Specification for Sound Level Meters / Type 1
ANSI S1.43 1997 (R 2007) - Specification for Integrating - Averaging Sound Level Meters / Type 1
IEC 61672-1 (2002) - Electro acoustics – Sound Level Meters – Part 1: Specifications / Class 1

Test Conditions: Temp: 18-25°C Humidity: 20-80% R.H. Barometric Pressure: 950-1050 mBar
Test Procedure: S053-899

Subassemblies:

B&K 4936	2861247
SPro Preamp	10140083

Reference Standard(s):

Device	Ref Standard Cal Due	Uncertainty - Estimated at 95% Confidence Level (k=2)
B&K Ensemble	1/23/2015	-/- 2.2% Acoustic (0.19dB)
Fluke 45	2/20/2015	+/- 1.4% AC Voltage, +/-0.1% DC Voltage

Calibrated By: Janet Pompe
Janet Pompe - Assembler

In order to maintain best instrument performance over time, and in the event of inspection, audit or litigation, we recommend the instrument be recalibrated annually. Any number of factors may cause the calibration to drift before the recommended interval has expired. See user manual for more information.

All equipment used in the test and calibration of this instrument is traceable to NIST, and applies only to the unit identified above. This report must not be reproduced, except in its entirety, without the written approval of 3M.

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3M Oconomowoc
Personal Safety Division

3M Detection Solutions
1060 Corporate Center Drive
Oconomowoc, WI 53066-4828
www.3M.com/detection
262 567 9157 800 245 0779
262 567 4047 Fax

An ISO 9001 Registered Company

AIS- ENV-4950

3M

Certificate of Calibration

Certificate Number: 1410271125BJN100032

Model: SoundPro SP DL-1
S/N: BJN100032

Date Issued: 27-Oct-2014

On this day of manufacture and calibration, 3M certifies that the above listed product meets or exceeds the performance requirements of the following acoustic standard(s):

ANSI S1.4 1983 (R 2006) - Specification for Sound Level Meters / Type 1
ANSI S1.43 1997 (R 2007) - Specification for Integrating - Averaging Sound Level Meters / Type 1
IEC 61672-1 (2002) - Electro acoustics – Sound Level Meters – Part 1: Specifications / Class 1

Test Conditions: Temp: 18-25°C Humidity: 20-80% R.H. Barometric Pressure: 950-1050 mBar
Test Procedure: S053-899

Subassemblies:

B&K 4936	2861257
SPro Preamp	10140088

Reference Standard(s):

Device	Ref Standard Cal Due	Uncertainty - Estimated at 95% Confidence Level (k=2)
B&K Ensemble	1/23/2015	+/- 2.2% Acoustic (0.19dB)
Fluke 45	2/20/2015	+/- 1.4% AC Voltage, +/-0.1% DC Voltage

Calibrated By: Janet Pompe
Janet Pompe - Assembler

In order to maintain best instrument performance over time, and in the event of inspection, audit or litigation, we recommend the instrument be recalibrated annually. Any number of factors may cause the calibration to drift before the recommended interval has expired. See user manual for more information.

All equipment used in the test and calibration of this instrument is traceable to NIST, and applies only to the unit identified above. This report must not be reproduced, except in its entirety, without the written approval of 3M.

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ATS-ENV-2630

LEE HUNG TEST SERVICES PTE LTD
(Sister company of Lee Hung Scientific Pte Ltd)
Business Reg. No. 200207653M

Certificate of Calibration

Certificate No. : 14/09/065
Submitted by : ALS TECHNICHEM (S) PTE LTD
121 GENTING LANE,
#04-01 ALS BUILDING,
SINGAPORE 349572

Date Submitted : 11 Sep 2014
Date of Calibration : 18 Sep 2014

Description of Equipment :

Subject : SOUND LEVEL METER TYPE 1
Brand : QUEST
Model No. : SOUNDPRO DL-1
Serial No. : BJH050018
Sub-Assemblies : B & K 4936 2819041

Ambient conditions :

Ambient Temp. : (23 ± 3) °C
Relative Humidity : (50 ± 10) %R.H.
Pressure : (1006.0 ± 4.0) hPa

The above-mentioned product/equipment has been calibrated at LHTS Lab under the ambient conditions stated above for conformity with certain specifications as laid down in the calibration procedure.

Method of Calibration

The method of calibration is Calibration Procedure : LHT-WI-CAL-S11 REV 7, generally as recommended by manufacturer. The calibration was carried out with reference to the following calibration and measurement standards which are traceable to the following below:

Instrument	Serial Number	Cal. Report		Due Date
1. QUEST-CAL	S/N KZE040001	AL000410	NMC(SG)	12-Dec-14
2. 9004 GLOBAL MULTI TESTER	S/N 0229007	RL000749	NMC (SG)	25-May-15
3. HEWLETT PACKARD ATTENUATOR	S/N 1250J01894	RL000748	NMC(SG)	22-May-15

Results of Calibration

The results of the calibration are given on the Calibration Report as per attached.
The expanded uncertainties of measurement stated in this report are estimated at a level of confidence of approximately 95% with a coverage factor k=2.

The results of the above-mentioned instrument shown in the Calibration Report does not cover the full parameters of the Sound Level Meter. The user should determine the suitability of this instrument for its intended use.

* Recommended Next Calibration Date: 17 Sep 2015
* This is only a suggested date, the recalibration interval should be determined based on the user's requirements.

Calibrated By,

Ryan Zhou Ran
Calibration Officer

Reviewed By,

Gavino delos Reyes
Senior Service Engineer

ALS TECHNICHEM (S) PTE LTD Reviewed By

19 Sep 2014

50 Bukit Batok Street 23 #05-10/11/12/13/14 Midview Building Singapore 659578
Tel: +65 6560 6903 Fax: +65 6567 6909
E-mail: service@leehung.com Website: http://www.leehung.com

421 Q

LEE HUNG TEST SERVICES PTE LTD

(Sister company of Lee Hung Scientific Pte Ltd)

Business Reg. No. 200207853M

Certificate of Calibration

Certificate No. : 15/03/168
Submitted by : ALS TECHNICHEM (S) PTE LTD
121 GENTING LANE,
#04-01 ALS BUILDING,
SINGAPORE 349572

Date Submitted : 30 Mar 2015
Date of Calibration : 14 Apr 2015

Description of Equipment :

Subject : SOUND LEVEL METER TYPE 1
Brand : QUEST
Model No. : SOUNDPRO DL-1-1/1
Serial No. : BKM030003
Sub-Assemblies : B & K 4936 2752680

Ambient conditions :

Ambient Temp. : (23 ± 3) °C
Relative Humidity : (50 ± 10) %R.H.
Pressure : (1006.0 ± 4.0) hPa

The above-mentioned product/equipment has been calibrated at LHTS Lab under the ambient conditions stated above for conformity with certain specifications as laid down in the calibration procedure.

Method of Calibration

The method of calibration is Calibration Procedure : LHT-WI-CAL-S11 REV 7, generally as recommended by manufacturer. The calibration was carried out with reference to the following calibration and measurement standards which are traceable to the following below:

Instrument	Serial Number	Cal. Report	Due Date
1. QUEST-CAL	KZE040001	AL000841	18-Dec-15
2. 9004 GLOBAL MULTI TESTER	229007	RL000749	25-May-15
3. HEWLETT PACKARD ATTENUATOR	1250J01894	RL000748	22-May-15

Results of Calibration

The results of the calibration are given on the Calibration Report as per attached.
The expanded uncertainties of measurement stated in this report are estimated at a level of confidence of approximately 95% with a coverage factor k=2.

The results of the above-mentioned instrument shown in the Calibration Report does not cover the full parameters of the Sound Level Meter. The user should determine the suitability of this instrument for its intended use.

* Recommended Next Calibration Date: 13 Apr 2015
* This is only a suggested date, the recalibration interval should be determined based on the user's requirements.

Calibrated By,

Ryan Zhou Ran
Calibration Officer

Reviewed By,

Gavino delos Reyes
Senior Service Engineer

ALS TECHNICHEM (S) PTE LTD Reviewed By 17 Apr 2015

50 Bukit Batok Street 23 #05-10/11/12/13/14 Midview Building Singapore 659578
Tel: +65 6560 6903 Fax: +65 6567 6909
E-mail: service@leehung.com Website: http://www.leehung.com

A33 2

LEE HUNG TEST SERVICES PTE LTD

(Sister company of Lee Hung Scientific Pte Ltd)

Business Reg. No. 200207853M

Certificate of Calibration

Certificate No. : 15/03/167
Submitted by : ALS TECHNICHEM (S) PTE LTD
121 GENTING LANE,
#04-01 ALS BUILDING,
SINGAPORE 349572

Date Submitted : 30 Mar 2015
Date of Calibration : 15 Apr 2015

Description of Equipment :

Subject : SOUND LEVEL METER TYPE 1
Brand : QUEST
Model No. : SOUNDPRO DL-1
Serial No. : BJM030015
Sub-Assemblies : B & K 4936 2785930

Ambient conditions :

Ambient Temp. : (23 ± 3) °C
Relative Humidity : (50 ± 10) %R.H.
Pressure : (1006.0 ± 4.0) hPa

The above-mentioned product/equipment has been calibrated at LHTS Lab under the ambient conditions stated above for conformity with certain specifications as laid down in the calibration procedure.

Method of Calibration

The method of calibration is Calibration Procedure : LHT-WI-CAL-S11 REV 7, generally as recommended by manufacturer. The calibration was carried out with reference to the following calibration and measurement standards which are traceable to the following below:

	Instrument	Serial Number	Cal. Report	Due Date
1	QUEST-CAL	KZE040001	AL000641	18-Dec-15
2	9004 GLOBAL MULTI TESTER	229007	RL000749	25-May-15
3	HEWLETT PACKARD ATTENUATOR	1250J01894	RL000748	22-May-15

Results of Calibration

The results of the calibration are given on the Calibration Report as per attached.
The expanded uncertainties of measurement stated in this report are estimated at a level of confidence of approximately 95% with a coverage factor k=2.

The results of the above-mentioned instrument shown in the Calibration Report does not cover the full parameters of the Sound Level Meter. The user should determine the suitability of this instrument for its intended use.

* Recommended Next Calibration Date: 14 Apr 2016
* This is only a suggested date, the recalibration interval should be determined based on the user's requirements.

Calibrated By,

Ryan Zhou Ran
Calibration Officer

Reviewed By,

Gavino delos Reyes
Senior Service Engineer

ALS TECHNICHEM (S) PTE LTD Reviewed 17 APR 2015

50 Bukit Batok Street 23 #05-10/11/12/13/14 Midview Building Singapore 659578
Tel: +65 6560 6903 Fax: +65 6567 6909
E-mail: service@leehung.com Website: http://www.leehung.com

APPENDIX 2

SITE PHOTO

NL01 R1

NL03 R1

NL04 R1

NL05 R1

NL06_R1

NL07_R1

NL08_R1

NL09_R1

NL10 R1

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

ALS Technichem (S) Pte Ltd
121 Genting Lane #04-01, Singapore 349572
Tel: (65) 6589 0118 Fax : (65) 6283 9689 E-mail: alssg@alsglobal.com
Co. Reg No. 198403076R

Our Ref: ATS/IH/124a/15TTH

Date: 16 November 2015

NOISE MONITORING REPORT

For MANDAI PROJECT (ROUND 2)

ENVIRONMENTAL RESOURCES MANAGEMENT (S) PTE LTD
120 ROBINSON ROAD #10-01,
SINGAPORE 068913

Chai Wai Hang
Field Engineer

Tan Teong Huat
Senior Manager
BSc, MSc (SHE Tech.), MSNIC

EXECUTIVE SUMMARY

ALS Technichem (S) Pte Ltd has carried out noise monitoring covering the areas around the Singapore Zoo and forested area around Mandai Lake Road. The second round of monitoring started on on 06th October to 21st October 2015. The objective of this monitoring is to establish a baseline and to determine whether the noise level at the selected points is in compliance with the limits as per stipulated in the National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

In general, the results obtained at NL07_R2-NL09_R2 were in compliance with the National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites-Buildings other than above Part I & II) Regulations, 2011 Revised Ed. And there are no relevant limits for NL01_R2, NL03_R2-NL06_R2 and NL10_R2.

In conclusion, monitoring of the baseline noise level of these points is recommended when the construction work is commenced. This exercise will help to determine the presence of any nuisance noise contribution on their daily operations and activities to their immediate neighbouring occupants on site.

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LIST OF ABBREVIATION

dB(A)	Decibel A

1.0 INTRODUCTION

ALS TECHNICHEM (S) PTE LTD (hereafter as "ALS") has been appointed as the contractor to perform the Noise Monitoring around the area of Singapore Zoo and the forested area around Mandai Lake Road, as request by Environmental Resources Management (S) Pte Ltd (hereafter as "ERM").

1.1 Objectives

The objective of the monitoring is to determine whether the baseline noise levels emitted from the area of Singapore Zoo and the forested area around Mandai Lake Road were in compliance with the limits stipulated in the National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites -Buildings other than above Part I & II) Regulations, 2011 Revised Ed. The information can be used as a point of reference for future environmental monitoring and decision-making.

1.2 Scope of Work

The scope of works for the noise monitoring included:

1. Preparation of Noise Monitoring Plan;

2. Noise Monitoring station setup and sampling at selected nine sampling points, namely Point NL01_R2 and NL03_R2 to NL10_R2(sampling points were dictated by ERM);

3. Determination of equivalent noise level (L_{Aeq}) over a period of 24 hour period on a 5 minutes interval as a baseline to be conducted over a week. Measured noise level of NL07-NL09 were analyzed according to regulatory limit:

    - Two specified period according to the Part I, Second Schedule, Maximum Permissible Noise Levels For Construction Work Commenced On or After 1st October 2007, National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.
    - Three specified period according to the Part II, Second Schedule, Maximum Permissible Noise Levels For Construction Work Commenced On or After 1st October 2007, National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.
    - Three specified period according to the Part III, Second Schedule, Maximum Permissible Noise Levels For Construction Work Commenced On or After 1st October 2007, National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

4. Determination of noise level ($L_{Aeq,}$ L_{max} and L_{90}) over a period of 15 minutes at NL01_R2, NL04_R2 and NL07_R2 monitoring points on a weekday and weekend (Saturday);

5. Assessing the noise level against the adopted standard; and

6. Providing a report outlining the findings and results of the study.

1.2.1 Monitoring Requirement

Noise is measured in decibel (dB) with reference to the frequency of noise, 'A' weighting was selected for this entire monitoring. The 'FAST' response was selected to measure the noise levels. It is used for the measurement of time-varying sounds with a response time of 0.125 seconds which is similar to human ear response.

Table 1 lists the maximum permitted noise level of specified period based on type of affected buildings as per Second Schedule of National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

Table 1: Maximum permitted noise level for construction work commenced after 1st October 2007

PART I			
Type of affected Buildings	***Maximum permitted noise level in decibels (A)**		
	7am – 7pm	**7pm – 7am**	
Hospital, Schools, Institutions of higher learning, homes for the aged sick etc.	60	50	
Residential buildings located less than 150m from the construction site where the noise is being emitted	75	-	
Buildings (other than above)	75	65	
*reckoned as an equivalent continuous noise level over a period of 12 hours			
PART II			
	7am – 7pm	**7pm – 10pm**	**10pm – 7am**
Hospital, Schools, Institutions of higher learning, homes for the aged sick etc.	-	-	-
Residential buildings located less than 150m from the construction site where the noise is being emitted	-	65	55
Buildings (other than above)	-	-	-
*reckoned as an equivalent continuous noise level over a period of 1 hour			
PART III			
	7am – 7pm	**7pm – 10pm**	**10pm – 7am**
Hospital, Schools, Institutions of higher learning, homes for the aged sick etc.	75	55	55
Residential buildings located less than 150m from the construction site where the noise is being emitted:- (i) on Monday to Saturday	90	70	55
(ii) on Sundays & Public Holiday	75	55	55
Buildings (other than above)	90	70	70
*reckoned as an equivalent continuous noise level over a period of 5 minutes			

2.0 SAMPLING AND FIELD MONITORING

ALS has performed all the required sampling for noise level monitoring at selected locations.

2.1 Sampling Equipment

A portable Quest SoundPro SP DL-1 Sound Level Meter (Class 1) was used to measure noise levels of the selected points. This instrument is complies with the standards as specified in the International Electrotechnical Commission Publication 651 (Class 1) and Publication 804 (Type 1).

2.2 Sampling Locations

Figures 1 – 2 illustrate the sampling locations for this monitoring program.

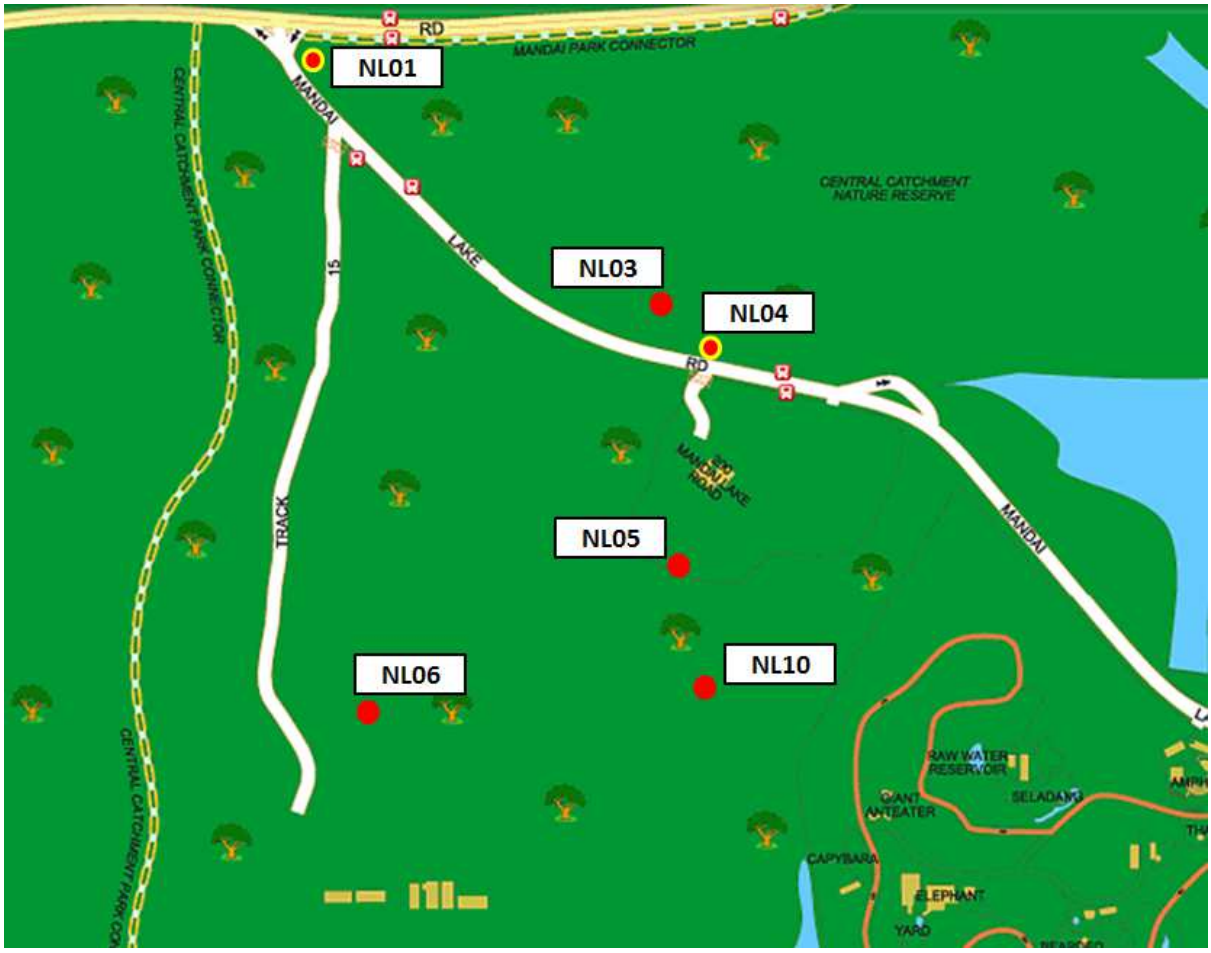

Figure 1: Sampling Locations

Remarks: ● Denote traffic counts and short-term measurement were taken

Figure 2: Sampling Locations

Remarks: Denote traffic counts and short-term measurement were taken

Noise Monitoring
(Second Round of Survey)

Date of Survey: 06th October to 21st October 2015

2.3 Detail of Noise Monitoring Point

There were a total of nine noise monitoring points have been selected, namely NL01_R2 and NL03_R2 - NL10_R2. The monitoring points were dictated by ERM. During the noise measurement, it was noted a range of possible noise sources at the respective monitoring points that may contribute to the overall ambient noise levels. The detail of the monitoring points and identified noise sources near to the monitoring points are listed in Table 2 on the day of monitoring. In addition, Table 3 and 4 lists the number of vehicles/motorbikes and short-term noise measurement which traveled along the respective areas of concerned during the 2 periods (peak and off peak hours) for each individual location on selected date is listed as below.

Table 2: Identified noise sources near to the monitoring points

Monitoring Point	Date		Time (hr)		Noise Sources
	Start	Stop	Start	Stop	
NL01_R2	06/10/15	12/10/15	0000	1157	Traffic noise (vehicles) from Mandai Road and Mandai Lake Road, military aircraft/helicopter overflight
NL03_R2	06/10/15	12/10/15	0003	1156	Insect noise, military aircraft/helicopter overflight
NL04_R2	06/10/15	12/10/15	0003	1159	Traffic noise (vehicles) from Mandai Lake Road, military aircraft/helicopter overflight, insect noise
NL05_R2	06/10/15	12/10/15	0003	1158	Insect noise, military aircraft/helicopter overflight, shooting training at Mandai camp
NL06_R2	06/10/15	12/10/15	0003	1158	Insect noise, military aircraft/helicopter overflight, shooting training at Mandai camp, grass cutting activities were heard in the direction of the military firing range on 6 Oct morning
NL07_R2	15/10/15	21/10/15	0003	1158	Traffic noise (vehicles) from Mandai Lake Road, construction activities within Night Safari
NL08_R2	15/10/15	21/10/15	0002	1156	Human activities around the palm park (Crane operations observed on 15 Oct, approximately 60m away), screech sound from monkey (the cage located near to the monitoring area)
NL09_R2	15/10/15	21/10/15	0000	1157	Insect noise, human activities near to the staff dormitory
NL10_R2	15/10/15	21/10/15	0000	1159	Insect noise, military aircraft/helicopter overflight, shooting training at Mandai camp

Table 3: Vehicular Traffic volume for peak and off peak hour

Location	Weekend / Weekday	Peak Hour			Off Peak hour		
		Vehicles	Heavy Vehicles	Motor-bikes	Vehicles	Heavy Vehicles	Motor-bikes
NL01_R2	Weekend	347	172	45	344	205	34
	Weekday	590	295	105	234	163	31
NL04_R2	Weekend	108	18	4	105	10	4
	Weekday	87	21	8	51	18	4
NL07_R2	Weekend	110	18	10	143	19	2
	Weekday	73	25	7	72	10	10

Remarks:

a) Traffic volume was noted based on 15 minutes duration of each period;
b) The heavy vehicles included trucks, vans, lorries, buses, in general, all heavy vehicle which involve in business. The vehicles included house use car, four-wheel car, in general, all the small vehicle which is non commercial.
c) Peak Hour - (7.30am – 9.30am) & (5.00pm-8.00pm) for weekday
- 12pm-2pm for weekend
Non-Peak Hour - Hours other than above

Table 4: Summary of results for short term noise level measurement (Lmax, LAeq & L90) over 15 minutes

Monitoring Point	Date	Weekend / Weekday	Peak Hour					Off-Peak Hour					Noise Sourse
			Time		Noise Level, dB(A)			Time		Noise Level, dB(A)			
			Start	Stop	L_{max}	L_{Aeq}	L_{90}	Start	Stop	L_{max}	L_{Aeq}	L_{90}	
NL01_R2	10/10/15	Weekend	1245	1300	86.6	70.7	61.7	1035	1050	82.1	68.6	57.9	Traffic noise (vehicles) from Mandai Road and Mandai Lake Road, military aircraft/helicopter overflight
	07/10/15	Weekday	1720	1735	83.1	70.4	60.2	1235	1250	80.5	67.9	59.2	
NL04_R2	10/10/15	Weekend	1220	1235	85.3	70.3	51.4	1145	1200	80.4	70.5	53.9	Traffic noise (vehicles) from Mandai Lake Road, military aircraft/helicopter overflight
	07/10/15	Weekday	1700	1715	80.6	69.9	49.6	1205	1220	82.1	68.7	50.3	
NL07_R2	17/10/15	Weekend	1200	1215	81.5	68.9	57.2	1045	1100	87.0	68.9	52.4	Traffic noise (vehicles) from Mandai Lake Road
	20/10/15	Weekday	1715	1730	82.8	66.8	48.1	1545	1600	83.1	66.1	48.2	

3.0 SAMPLING METHODOLOGY

The measuring instruments were installed in such a way so that the measurements were not affected by external factors (draft, vibration, wind, magnetic field, etc). Measurement were carried out at 1.2-1.5m from the ground or working level.

The equivalent continuous noise level (L_{Aeq}) was measured by using the sound level meter for 5 minutes interval datalog over 24 hours sampling period at the selected monitoring point. Table 5 summarized the sound level meter set up in this study. To determine the noise level on specified period, the recorded noise data was then analyzed by using *QuestSuite* Software.

Table 5: Summary of sound level meter setting

Parameter	Setting
Response	Fast
Frequency weighting for RMS	A
Measurement range	30 – 120 dB
Exchange Rate (Q)	3

3.1 Calibration of Sound Level Meter

All sound level meters were calibrated by an accredited laboratory under ISO/IEC 17025 standard. The certificates of field equipment's calibrations were attached in Appendix 1. Sound level meter used for ambient noise survey shall have its calibration certified by an authorized calibration laboratory within one year of the actual measurement sessions.

4.0 LOCATION INDEX / SAMPLING SCHEDULE / TEST RESULTS

Location index, sampling schedule and their respective test results obtained were tabulated and reflected our findings on 06th October to 21th October 2015.

Please refer to Table 6 to 76 and the daily noise level at all monitoring points were illustrated in Figure 3 to 65 and sampling locations at Figure 1 to 2.

Table 6: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours

Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL01_R2	Day 1	71.2	67.2
	Day 2	71.3	68.4
	Day 3	71.5	67.3
	Day 4	71.1	67.3
	Day 5 (weekend)	70.9	67.4
	Day 6 (weekend)	70.1	66.6
	Day 7	70.1	66.8
NL03_R2	Day 1	57.3	51.5
	Day 2	59.2	59.2
	Day 3	58.7	53.0
	Day 4	58.1	51.0
	Day 5 (weekend)	56.1	52.1
	Day 6 (weekend)	54.3	53.0
	Day 7	56.4	51.1
Limit		NA	NA

Remark: NA denote Not Available

Table 7: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours

Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL04_R2	Day 1	71.0	67.4
	Day 2	71.4	68.3
	Day 3	71.3	67.2
	Day 4	71.8	67.9
	Day 5 (weekend)	72.2	68.4
	Day 6 (weekend)	72.4	67.6
	Day 7	70.6	66.8
NL05_R2	Day 1	53.2	51.2
	Day 2	55.9	56.2
	Day 3	54.6	54.9
	Day 4	53.4	55.3
	Day 5 (weekend)	46.7	51.9
	Day 6 (weekend)	46.3	51.7
	Day 7	56.4	54.2
NL06_R2	Day 1	56.0	54.1
	Day 2	57.5	60.0
	Day 3	56.2	54.5
	Day 4	55.3	52.7
	Day 5 (weekend)	47.6	59.8
	Day 6 (weekend)	46.9	53.2
	Day 7	58.9	51.5
Limit		NA	NA

Remark: NA denote Not Available

Table 8: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours

Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL07_R2	Day 1	63.1	53.9
	Day 2	56.7	54.2
	Day 3 (weekend)	54.7	54.6
	Day 4 (weekend)	57.8	55.1
	Day 5	58.9	55.9
	Day 6	59.7	55.4
	Day 7	60.9	54.9
NL08_R2	Day 1	60.3	46.9
	Day 2	58.1	46.8
	Day 3 (weekend)	54.4	46.7
	Day 4 (weekend)	56.9	46.1
	Day 5	59.9	48.3
	Day 6	57.5	49.6
	Day 7	60.3	47.8
NL09_R2	Day 1	59.8	49.2
	Day 2	54.6	49.0
	Day 3 (weekend)	50.6	49.0
	Day 4 (weekend)	49.0	48.5
	Day 5	52.3	49.9
	Day 6	51.8	50.2
	Day 7	54.4	49.6
***Limit of Affected Buildings (other than those above)**		75	65

Remark: * Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)

Table 9: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours

Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL10_R2	Day 1	53.1	47.9
	Day 2	51.8	47.8
	Day 3 (Weekend)	49.6	47.7
	Day 4 (Weekend)	50.5	48.2
	Day 5	51.7	48.0
	Day 6	52.7	49.5
	Day 7	52.0	47.7
Limit		NA	NA

Remark: NA denote Not Available

Table 10: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes

Monitoring Point	Day	Noise levels Leq in dB (A)		
		7am – 7pm	7pm – 10pm	10pm – 7am
NL01_R2	Day 1	71.2	70.1	65.4
	Day 2	71.3	71.2	66.8
	Day 3	71.5	70.4	65.6
	Day 4	71.1	70.3	65.6
	Day 5 (weekend)	70.9	69.9	66.0
	Day 6 (weekend)	70.1	69.6	64.8
	Day 7	70.1	69.7	65.2
NL03_R2	Day 1	57.3	54.1	50.1
	Day 2	59.2	58.4	59.4
	Day 3	58.7	56.5	50.7
	Day 4	58.1	53.7	49.6
	Day 5 (weekend)	56.1	55.1	50.4
	Day 6 (weekend)	54.3	56.9	50.0
	Day 7	56.4	55.0	48.4
Limit		NA	NA	NA

Remark: NA denote Not Available

Table 11: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes

Monitoring Point	Day	Noise levels Leq in dB (A)		
		7am – 7pm	7pm – 10pm	10pm – 7am
NL04_R2	Day 1	71.0	70.9	65.0
	Day 2	71.5	72.0	65.8
	Day 3	71.3	70.9	64.7
	Day 4	71.8	71.4	65.5
	Day 5(weekend)	72.2	71.6	66.5
	Day 6 (weekend)	72.4	70.9	65.6
	Day 7	70.6	70.6	64.1
NL05_R2	Day 1	53.1	51.8	51.0
	Day 2	55.9	57.0	55.9
	Day 3	54.6	57.2	53.7
	Day 4	53.4	58.5	53.4
	Day 5 (weekend)	46.7	50.8	52.2
	Day 6 (weekend)	46.3	50.6	52.0
	Day 7	56.4	52.9	54.6
NL06_R2	Day 1	55.9	59.1	48.5
	Day 2	57.5	65.0	54.4
	Day 3	56.2	59.3	50.0
	Day 4	55.2	50.1	53.3
	Day 5 (weekend)	47.6	64.1	56.1
	Day 6 (weekend)	46.9	55.4	52.2
	Day 7	58.9	55.6	48.1
Limit		NA	NA	NA

Remark: NA denote Not Available

Table 12: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes

Monitoring Point	Day	Noise levels Leq in dB (A)		
		7am – 7pm	7pm – 10pm	10pm – 7am
NL07_R2	Day 1	63.1	56.6	52.4
	Day 2	56.7	56.4	53.2
	Day 3 (Weekend)	54.7	56.6	53.6
	Day 4 (Weekend)	57.8	57.5	54.0
	Day 5	58.9	60.1	52.3
	Day 6	59.7	59.6	52.1
	Day 7	60.9	57.7	53.4
NL08_R2	Day 1	60.3	46.6	47.1
	Day 2	58.2	46.0	47.0
	Day 3 (Weekend)	54.4	45.2	47.1
	Day 4 (Weekend)	56.9	44.8	46.5
	Day 5	59.9	51.9	46.0
	Day 6	57.5	53.5	46.7
	Day 7	60.3	50.4	46.4
NL09_R2	Day 1	59.8	49.6	49.0
	Day 2	54.6	48.3	49.2
	Day 3 (Weekend)	50.6	48.6	49.2
	Day 4 (Weekend)	49.0	47.6	48.8
	Day 5	52.3	52.2	48.8
	Day 6	51.8	53.0	48.7
	Day 7	54.4	51.3	48.8
***Limit of Affected Buildings (other than those above)**		90	70	70

Remark: * Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)

Table 13: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes

Monitoring Point	Day	Noise levels Leq in dB (A)		
		7am – 7pm	7pm – 10pm	10pm – 7am
NL10_R2	Day 1	53.1	50.6	46.5
	Day 2	51.8	49.4	47.1
	Day 3 (Weekend)	49.6	49.9	46.6
	Day 4 (Weekend)	50.6	50.4	47.2
	Day 5	51.7	51.3	46.0
	Day 6	52.7	53.4	46.7
	Day 7	52.0	49.8	46.7
Limit		NA	NA	NA

Remark: NA denote Not Available

Table 14: Sum mary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL01_R2 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	71.4	NA	NA
0800 – 0900	73.1		
0900 – 1000	70.5		
1000 – 1100	70.5		
1100 – 1200	69.6		
1200 – 1300	69.7		
1300 – 1400	70.2		
1400 – 1500	71.4		
1500 – 1600	71.4		
1600 – 1700	71.2		
1700 – 1800	71.5		
1800 – 1900	72.6		
1900 – 2000	71.0	NA	NA
2000 – 2100	69.8		
2100 – 2200	69.4		
2200 – 2300	68.8	NA	NA
2300 – 0000	67.8		
0000 – 0100	65.3		
0100 – 0200	61.5		
0200 – 0300	59.8		
0300 – 0400	61.9		
0400 – 0500	60.4		
0500 – 0600	63.7		
0600 – 0700	68.6		

Remark: NA denote Not Available

Table 15: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL01_R2 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	71.3	NA	NA
0800 – 0900	71.0		
0900 – 1000	72.1		
1000 – 1100	71.1		
1100 – 1200	69.8		
1200 – 1300	70.2		
1300 – 1400	70.6		
1400 – 1500	70.5		
1500 – 1600	70.1		
1600 – 1700	71.3		
1700 – 1800	71.2		
1800 – 1900	74.3		
1900 – 2000	71.3	NA	NA
2000 – 2100	71.0		
2100 – 2200	71.5		
2200 – 2300	68.9	NA	NA
2300 – 0000	68.8		
0000 – 0100	64.6		
0100 – 0200	61.6		
0200 – 0300	60.6		
0300 – 0400	59.3		
0400 – 0500	60.4		
0500 – 0600	68.9		
0600 – 0700	71.0		

Remark: NA denote Not Available

Table 16: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL01_R2 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	71.6	NA	NA
0800 – 0900	71.4		
0900 – 1000	73.0		
1000 – 1100	70.8		
1100 – 1200	70.3		
1200 – 1300	69.0		
1300 – 1400	71.5		
1400 – 1500	74.1		
1500 – 1600	70.7		
1600 – 1700	71.0		
1700 – 1800	70.7		
1800 – 1900	72.0		
1900 – 2000	71.0	NA	NA
2000 – 2100	70.6		
2100 – 2200	69.3		
2200 – 2300	69.1	NA	NA
2300 – 0000	68.0		
0000 – 0100	65.1		
0100 – 0200	62.2		
0200 – 0300	60.4		
0300 – 0400	59.8		
0400 – 0500	60.4		
0500 – 0600	63.5		
0600 – 0700	69.0		

Remark: NA denote Not Available

Table 17: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL01_R2 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	71.7	NA	NA
0800 – 0900	72.6		
0900 – 1000	71.2		
1000 – 1100	71.4		
1100 – 1200	71.8		
1200 – 1300	70.0		
1300 – 1400	70.2		
1400 – 1500	70.8		
1500 – 1600	70.5		
1600 – 1700	70.5		
1700 – 1800	70.6		
1800 – 1900	71.4		
1900 – 2000	70.7	NA	NA
2000 – 2100	69.9		
2100 – 2200	70.3		
2200 – 2300	68.7	NA	NA
2300 – 0000	68.3		
0000 – 0100	64.9		
0100 – 0200	62.1		
0200 – 0300	61.2		
0300 – 0400	59.5		
0400 – 0500	60.1		
0500 – 0600	63.9		
0600 – 0700	69.0		

Remark: NA denote Not Available

Table 18: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL01_R2 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	69.9	NA	NA
0800 – 0900	71.4		
0900 – 1000	70.9		
1000 – 1100	70.8		
1100 – 1200	71.2		
1200 – 1300	70.4		
1300 – 1400	70.7		
1400 – 1500	70.7		
1500 – 1600	70.5		
1600 – 1700	70.3		
1700 – 1800	71.3		
1800 – 1900	72.2		
1900 – 2000	70.1	NA	NA
2000 – 2100	70.1		
2100 – 2200	69.5		
2200 – 2300	69.0	NA	NA
2300 – 0000	69.0		
0000 – 0100	66.0		
0100 – 0200	62.7		
0200 – 0300	61.9		
0300 – 0400	61.5		
0400 – 0500	62.1		
0500 – 0600	63.2		
0600 – 0700	68.8		

Remark: NA denote Not Available

Table 19: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL01_R2 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	68.2	NA	NA
0800 – 0900	69.9		
0900 – 1000	71.4		
1000 – 1100	70.4		
1100 – 1200	69.8		
1200 – 1300	70.0		
1300 – 1400	69.8		
1400 – 1500	70.4		
1500 – 1600	69.8		
1600 – 1700	69.4		
1700 – 1800	70.6		
1800 – 1900	71.2		
1900 – 2000	69.8	NA	NA
2000 – 2100	70.1		
2100 – 2200	68.9		
2200 – 2300	68.6	NA	NA
2300 – 0000	67.4		
0000 – 0100	65.4		
0100 – 0200	63.1		
0200 – 0300	61.7		
0300 – 0400	61.7		
0400 – 0500	60.7		
0500 – 0600	61.6		
0600 – 0700	65.4		

Remark: NA denote Not Available

Table 20: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL01_R2 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	68.6	NA	NA
0800 – 0900	68.8		
0900 – 1000	70.3		
1000 – 1100	70.3		
1100 – 1200	70.1		
1200 – 1300	69.0		
1300 – 1400	69.8		
1400 – 1500	70.0		
1500 – 1600	70.2		
1600 – 1700	71.4		
1700 – 1800	70.8		
1800 – 1900	71.0		
1900 – 2000	70.3	NA	NA
2000 – 2100	69.2		
2100 – 2200	69.6		
2200 – 2300	68.9	NA	NA
2300 – 0000	67.8		
0000 – 0100	65.1		
0100 – 0200	61.0		
0200 – 0300	58.6		
0300 – 0400	59.3		
0400 – 0500	59.0		
0500 – 0600	63.0		
0600 – 0700	68.5		

Remark: NA denote Not Available

Table 21: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL03_R2 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	49.6	NA	NA
0800 – 0900	51.3		
0900 – 1000	59.2		
1000 – 1100	61.0		
1100 – 1200	54.9		
1200 – 1300	54.7		
1300 – 1400	57.9		
1400 – 1500	62.2		
1500 – 1600	50.1		
1600 – 1700	57.4		
1700 – 1800	53.2		
1800 – 1900	55.5		
1900 – 2000	54.2	NA	NA
2000 – 2100	54.6		
2100 – 2200	53.3		
2200 – 2300	52.6	NA	NA
2300 – 0000	51.2		
0000 – 0100	49.7		
0100 – 0200	49.4		
0200 – 0300	50.2		
0300 – 0400	50.1		
0400 – 0500	48.4		
0500 – 0600	48.1		
0600 – 0700	48.9		

Remark: NA denote Not Available

Table 22: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL03_R2 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	48.9	NA	NA
0800 – 0900	56.2		
0900 – 1000	59.7		
1000 – 1100	60.0		
1100 – 1200	53.9		
1200 – 1300	57.7		
1300 – 1400	56.7		
1400 – 1500	58.6		
1500 – 1600	58.9		
1600 – 1700	60.1		
1700 – 1800	55.0		
1800 – 1900	65.3		
1900 – 2000	57.2	NA	NA
2000 – 2100	60.3		
2100 – 2200	56.8		
2200 – 2300	55.5	NA	NA
2300 – 0000	54.2		
0000 – 0100	49.6		
0100 – 0200	49.2		
0200 – 0300	48.6		
0300 – 0400	50.5		
0400 – 0500	49.5		
0500 – 0600	67.8		
0600 – 0700	59.4		

Remark: NA denote Not Available

Table 23: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL03_R2 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	50.1	NA	NA
0800 – 0900	53.4		
0900 – 1000	58.8		
1000 – 1100	61.6		
1100 – 1200	57.8		
1200 – 1300	61.3		
1300 – 1400	59.5		
1400 – 1500	64.6		
1500 – 1600	50.8		
1600 – 1700	51.1		
1700 – 1800	51.0		
1800 – 1900	55.1		
1900 – 2000	56.7	NA	NA
2000 – 2100	58.1		
2100 – 2200	53.9		
2200 – 2300	53.3	NA	NA
2300 – 0000	51.5		
0000 – 0100	53.2		
0100 – 0200	51.4		
0200 – 0300	49.8		
0300 – 0400	48.6		
0400 – 0500	47.3		
0500 – 0600	47.4		
0600 – 0700	49.1		

Remark: NA denote Not Available

Table 24: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL03_R2 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	54.3	NA	NA
0800 – 0900	55.0		
0900 – 1000	62.1		
1000 – 1100	61.7		
1100 – 1200	57.0		
1200 – 1300	60.1		
1300 – 1400	58.2		
1400 – 1500	56.2		
1500 – 1600	59.0		
1600 – 1700	55.8		
1700 – 1800	51.9		
1800 – 1900	51.7		
1900 – 2000	52.7	NA	NA
2000 – 2100	54.8		
2100 – 2200	53.2		
2200 – 2300	52.1	NA	NA
2300 – 0000	51.9		
0000 – 0100	49.6		
0100 – 0200	48.0		
0200 – 0300	47.6		
0300 – 0400	46.3		
0400 – 0500	45.2		
0500 – 0600	48.5		
0600 – 0700	51.7		

Remark: NA denote Not Available

Table 25: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL03_R2 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	52.9	NA	NA
0800 – 0900	52.3		
0900 – 1000	58.0		
1000 – 1100	62.7		
1100 – 1200	59.8		
1200 – 1300	51.1		
1300 – 1400	50.4		
1400 – 1500	50.7		
1500 – 1600	53.1		
1600 – 1700	52.1		
1700 – 1800	51.7		
1800 – 1900	53.0		
1900 – 2000	54.4	NA	NA
2000 – 2100	56.3		
2100 – 2200	54.2		
2200 – 2300	52.9	NA	NA
2300 – 0000	53.0		
0000 – 0100	50.7		
0100 – 0200	52.2		
0200 – 0300	48.0		
0300 – 0400	47.4		
0400 – 0500	46.0		
0500 – 0600	46.7		
0600 – 0700	49.9		

Remark: NA denote Not Available

Table 26: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL03_R2 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	49.3	NA	NA
0800 – 0900	52.4		
0900 – 1000	57.6		
1000 – 1100	54.7		
1100 – 1200	53.1		
1200 – 1300	58.2		
1300 – 1400	57.4		
1400 – 1500	50.9		
1500 – 1600	51.6		
1600 – 1700	51.4		
1700 – 1800	50.7		
1800 – 1900	51.6		
1900 – 2000	56.6	NA	NA
2000 – 2100	58.4		
2100 – 2200	55.1		
2200 – 2300	51.7	NA	NA
2300 – 0000	51.2		
0000 – 0100	52.3		
0100 – 0200	50.1		
0200 – 0300	49.4		
0300 – 0400	49.2		
0400 – 0500	47.2		
0500 – 0600	47.0		
0600 – 0700	48.8		

Remark: NA denote Not Available

Table 27: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL03_R2 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	51.3	NA	NA
0800 – 0900	52.2		
0900 – 1000	53.0		
1000 – 1100	52.4		
1100 – 1200	54.0		
1200 – 1300	55.1		
1300 – 1400	56.5		
1400 – 1500	56.5		
1500 – 1600	60.8		
1600 – 1700	60.9		
1700 – 1800	56.9		
1800 – 1900	51.0		
1900 – 2000	54.3	NA	NA
2000 – 2100	55.9		
2100 – 2200	54.4		
2200 – 2300	51.0	NA	NA
2300 – 0000	49.6		
0000 – 0100	49.7		
0100 – 0200	48.0		
0200 – 0300	47.5		
0300 – 0400	46.0		
0400 – 0500	44.3		
0500 – 0600	45.9		
0600 – 0700	49.3		

Remark: NA denote Not Available

Table 28: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL04_R2 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	68.3	NA	NA
0800 – 0900	70.6		
0900 – 1000	70.9		
1000 – 1100	71.0		
1100 – 1200	70.9		
1200 – 1300	69.2		
1300 – 1400	70.2		
1400 – 1500	72.3		
1500 – 1600	71.2		
1600 – 1700	71.6		
1700 – 1800	71.4		
1800 – 1900	72.5		
1900 – 2000	70.8	NA	NA
2000 – 2100	70.6		
2100 – 2200	71.3		
2200 – 2300	70.7	NA	NA
2300 – 0000	69.4		
0000 – 0100	65.1		
0100 – 0200	55.6		
0200 – 0300	56.9		
0300 – 0400	56.6		
0400 – 0500	54.5		
0500 – 0600	57.8		
0600 – 0700	64.3		

Remark: NA denote Not Available

Table 29: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL04_R2 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	69.5	NA	NA
0800 – 0900	72.3		
0900 – 1000	71.3		
1000 – 1100	71.0		
1100 – 1200	69.8		
1200 – 1300	69.9		
1300 – 1400	70.8		
1400 – 1500	70.2		
1500 – 1600	70.6		
1600 – 1700	71.0		
1700 – 1800	72.1		
1800 – 1900	75.2		
1900 – 2000	71.7	NA	NA
2000 – 2100	72.0		
2100 – 2200	72.2		
2200 – 2300	71.0	NA	NA
2300 – 0000	69.2		
0000 – 0100	66.0		
0100 – 0200	56.0		
0200 – 0300	55.7		
0300 – 0400	55.2		
0400 – 0500	55.2		
0500 – 0600	65.5		
0600 – 0700	66.2		

Remark: NA denote Not Available

Table 30: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL04_R2 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	68.1	NA	NA
0800 – 0900	71.0		
0900 – 1000	71.5		
1000 – 1100	70.6		
1100 – 1200	70.5		
1200 – 1300	69.6		
1300 – 1400	71.4		
1400 – 1500	73.8		
1500 – 1600	71.2		
1600 – 1700	70.9		
1700 – 1800	71.3		
1800 – 1900	72.7		
1900 – 2000	70.9	NA	NA
2000 – 2100	70.9		
2100 – 2200	71.0		
2200 – 2300	71.2	NA	NA
2300 – 0000	68.0		
0000 – 0100	64.6		
0100 – 0200	55.2		
0200 – 0300	54.3		
0300 – 0400	51.8		
0400 – 0500	53.8		
0500 – 0600	59.0		
0600 – 0700	63.8		

Remark: NA denote Not Available

Table 31: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL04_R2 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	68.5	NA	NA
0800 – 0900	72.7		
0900 – 1000	72.8		
1000 – 1100	72.8		
1100 – 1200	72.4		
1200 – 1300	70.7		
1300 – 1400	71.2		
1400 – 1500	71.3		
1500 – 1600	71.1		
1600 – 1700	71.1		
1700 – 1800	72.0		
1800 – 1900	73.0		
1900 – 2000	71.5	NA	NA
2000 – 2100	71.1		
2100 – 2200	71.5		
2200 – 2300	71.4	NA	NA
2300 – 0000	70.4		
0000 – 0100	64.9		
0100 – 0200	56.6		
0200 – 0300	56.5		
0300 – 0400	51.2		
0400 – 0500	54.4		
0500 – 0600	57.8		
0600 – 0700	63.3		

Remark: NA denote Not Available

Table 32: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL04_R2 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	67.8	NA	NA
0800 – 0900	71.3		
0900 – 1000	72.2		
1000 – 1100	72.7		
1100 – 1200	72.0		
1200 – 1300	71.8		
1300 – 1400	71.9		
1400 – 1500	72.3		
1500 – 1600	71.9		
1600 – 1700	72.4		
1700 – 1800	73.6		
1800 – 1900	74.1		
1900 – 2000	71.7	NA	NA
2000 – 2100	71.5		
2100 – 2200	71.5		
2200 – 2300	71.6	NA	NA
2300 – 0000	70.9		
0000 – 0100	67.6		
0100 – 0200	56.0		
0200 – 0300	56.9		
0300 – 0400	56.2		
0400 – 0500	56.6		
0500 – 0600	56.8		
0600 – 0700	67.1		

Remark: NA denote Not Available

Table 33: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL04_R2 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	68.0	NA	NA
0800 – 0900	71.0		
0900 – 1000	74.3		
1000 – 1100	73.3		
1100 – 1200	72.6		
1200 – 1300	72.4		
1300 – 1400	72.4		
1400 – 1500	72.2		
1500 – 1600	72.1		
1600 – 1700	71.9		
1700 – 1800	72.9		
1800 – 1900	73.5		
1900 – 2000	71.4	NA	NA
2000 – 2100	70.6		
2100 – 2200	70.7		
2200 – 2300	72.5	NA	NA
2300 – 0000	68.0		
0000 – 0100	66.3		
0100 – 0200	54.1		
0200 – 0300	52.3		
0300 – 0400	55.0		
0400 – 0500	57.8		
0500 – 0600	58.1		
0600 – 0700	63.2		

Remark: NA denote Not Available

Table 34: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL04_R2 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	68.1	NA	NA
0800 – 0900	71.1		
0900 – 1000	70.4		
1000 – 1100	70.7		
1100 – 1200	70.1		
1200 – 1300	69.6		
1300 – 1400	70.2		
1400 – 1500	70.2		
1500 – 1600	70.5		
1600 – 1700	71.0		
1700 – 1800	71.9		
1800 – 1900	71.9		
1900 – 2000	70.5	NA	NA
2000 – 2100	69.8		
2100 – 2200	71.3		
2200 – 2300	69.7	NA	NA
2300 – 0000	67.6		
0000 – 0100	65.9		
0100 – 0200	56.9		
0200 – 0300	52.5		
0300 – 0400	57.4		
0400 – 0500	54.8		
0500 – 0600	58.3		
0600 – 0700	63.1		

Remark: NA denote Not Available

Table 35: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL05_R2 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	48.6	NA	NA
0800 – 0900	47.6		
0900 – 1000	43.9		
1000 – 1100	43.6		
1100 – 1200	43.3		
1200 – 1300	52.0		
1300 – 1400	52.0		
1400 – 1500	59.3		
1500 – 1600	44.7		
1600 – 1700	57.9		
1700 – 1800	52.7		
1800 – 1900	55.1		
1900 – 2000	51.1	NA	NA
2000 – 2100	48.9		
2100 – 2200	53.9		
2200 – 2300	49.6	NA	NA
2300 – 0000	49.4		
0000 – 0100	50.0		
0100 – 0200	52.1		
0200 – 0300	49.6		
0300 – 0400	52.0		
0400 – 0500	51.3		
0500 – 0600	50.0		
0600 – 0700	53.2		

Remark: NA denote Not Available

Table 36: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL05_R2 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	49.4	NA	NA
0800 – 0900	49.5		
0900 – 1000	56.0		
1000 – 1100	49.9		
1100 – 1200	48.9		
1200 – 1300	51.3		
1300 – 1400	51.5		
1400 – 1500	52.0		
1500 – 1600	55.4		
1600 – 1700	58.9		
1700 – 1800	56.2		
1800 – 1900	62.9		
1900 – 2000	55.3	NA	NA
2000 – 2100	57.7		
2100 – 2200	57.7		
2200 – 2300	54.8	NA	NA
2300 – 0000	56.5		
0000 – 0100	51.9		
0100 – 0200	51.0		
0200 – 0300	51.3		
0300 – 0400	50.8		
0400 – 0500	51.1		
0500 – 0600	62.7		
0600 – 0700	54.1		

Remark: NA denote Not Available

Table 37: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL05_R2 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	55.7	NA	NA
0800 – 0900	46.9		
0900 – 1000	52.7		
1000 – 1100	57.9		
1100 – 1200	53.3		
1200 – 1300	48.9		
1300 – 1400	56.6		
1400 – 1500	59.8		
1500 – 1600	49.2		
1600 – 1700	50.7		
1700 – 1800	50.2		
1800 – 1900	53.4		
1900 – 2000	57.9	NA	NA
2000 – 2100	59.3		
2100 – 2200	50.5		
2200 – 2300	51.4	NA	NA
2300 – 0000	51.5		
0000 – 0100	54.3		
0100 – 0200	53.4		
0200 – 0300	54.3		
0300 – 0400	53.9		
0400 – 0500	51.3		
0500 – 0600	51.3		
0600 – 0700	57.6		

Remark: NA denote Not Available

Table 38: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL05_R2 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	58.1	NA	NA
0800 – 0900	52.7		
0900 – 1000	49.2		
1000 – 1100	52.3		
1100 – 1200	55.2		
1200 – 1300	53.4		
1300 – 1400	54.4		
1400 – 1500	53.0		
1500 – 1600	54.2		
1600 – 1700	48.2		
1700 – 1800	50.2		
1800 – 1900	49.4		
1900 – 2000	53.8	NA	NA
2000 – 2100	60.2		
2100 – 2200	59.2		
2200 – 2300	57.7	NA	NA
2300 – 0000	53.4		
0000 – 0100	50.9		
0100 – 0200	52.3		
0200 – 0300	51.7		
0300 – 0400	53.5		
0400 – 0500	51.7		
0500 – 0600	52.1		
0600 – 0700	53.3		

Remark: NA denote Not Available

Table 39: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL05_R2 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	51.6	NA	NA
0800 – 0900	47.4		
0900 – 1000	46.4		
1000 – 1100	42.3		
1100 – 1200	41.2		
1200 – 1300	42.4		
1300 – 1400	39.9		
1400 – 1500	45.9		
1500 – 1600	48.8		
1600 – 1700	43.3		
1700 – 1800	47.8		
1800 – 1900	48.3		
1900 – 2000	48.4	NA	NA
2000 – 2100	51.2		
2100 – 2200	52.0		
2200 – 2300	49.2	NA	NA
2300 – 0000	50.1		
0000 – 0100	51.8		
0100 – 0200	52.1		
0200 – 0300	48.1		
0300 – 0400	53.2		
0400 – 0500	53.4		
0500 – 0600	51.6		
0600 – 0700	55.5		

Remark: NA denote Not Available

Table 40: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL05_R2 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	50.5	NA	NA
0800 – 0900	46.4		
0900 – 1000	49.2		
1000 – 1100	42.7		
1100 – 1200	44.5		
1200 – 1300	48.2		
1300 – 1400	39.5		
1400 – 1500	46.0		
1500 – 1600	44.3		
1600 – 1700	41.3		
1700 – 1800	44.5		
1800 – 1900	46.8		
1900 – 2000	47.7	NA	NA
2000 – 2100	51.1		
2100 – 2200	52.0		
2200 – 2300	50.5	NA	NA
2300 – 0000	51.7		
0000 – 0100	51.0		
0100 – 0200	53.0		
0200 – 0300	51.8		
0300 – 0400	49.5		
0400 – 0500	51.2		
0500 – 0600	52.2		
0600 – 0700	54.8		

Remark: NA denote Not Available

Table 41: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL05_R2 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	54.1	NA	NA
0800 – 0900	51.7		
0900 – 1000	47.0		
1000 – 1100	46.9		
1100 – 1200	49.7		
1200 – 1300	55.1		
1300 – 1400	56.8		
1400 – 1500	57.0		
1500 – 1600	60.9		
1600 – 1700	61.7		
1700 – 1800	57.3		
1800 – 1900	47.6		
1900 – 2000	52.4	NA	NA
2000 – 2100	53.5		
2100 – 2200	52.6		
2200 – 2300	54.6	NA	NA
2300 – 0000	53.8		
0000 – 0100	53.7		
0100 – 0200	54.6		
0200 – 0300	52.5		
0300 – 0400	51.1		
0400 – 0500	52.3		
0500 – 0600	55.5		
0600 – 0700	58.5		

Remark: NA denote Not Available

Table 42: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL06_R2 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	53.6	NA	NA
0800 – 0900	51.6		
0900 – 1000	45.1		
1000 – 1100	44.4		
1100 – 1200	44.1		
1200 – 1300	54.8		
1300 – 1400	55.2		
1400 – 1500	61.2		
1500 – 1600	48.8		
1600 – 1700	60.2		
1700 – 1800	55.2		
1800 – 1900	59.5		
1900 – 2000	60.0	NA	NA
2000 – 2100	60.7		
2100 – 2200	54.4		
2200 – 2300	48.8	NA	NA
2300 – 0000	47.4		
0000 – 0100	48.1		
0100 – 0200	48.2		
0200 – 0300	49.5		
0300 – 0400	48.9		
0400 – 0500	48.7		
0500 – 0600	47.4		
0600 – 0700	49.2		

Remark: NA denote Not Available

Table 43: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL06_R2 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	55.4	NA	NA
0800 – 0900	50.2		
0900 – 1000	55.9		
1000 – 1100	51.9		
1100 – 1200	51.4		
1200 – 1300	54.7		
1300 – 1400	55.7		
1400 – 1500	55.9		
1500 – 1600	57.4		
1600 – 1700	60.8		
1700 – 1800	57.1		
1800 – 1900	63.6		
1900 – 2000	69.1	NA	NA
2000 – 2100	59.2		
2100 – 2200	57.4		
2200 – 2300	48.9	NA	NA
2300 – 0000	49.7		
0000 – 0100	45.8		
0100 – 0200	46.4		
0200 – 0300	46.2		
0300 – 0400	47.2		
0400 – 0500	49.0		
0500 – 0600	61.9		
0600 – 0700	57.0		

Remark: NA denote Not Available

Table 44: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL06_R2 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	50.1	NA	NA
0800 – 0900	50.5		
0900 – 1000	54.1		
1000 – 1100	59.6		
1100 – 1200	56.4		
1200 – 1300	50.0		
1300 – 1400	59.2		
1400 – 1500	61.3		
1500 – 1600	50.0		
1600 – 1700	50.9		
1700 – 1800	51.6		
1800 – 1900	57.0		
1900 – 2000	59.5	NA	NA
2000 – 2100	60.8		
2100 – 2200	56.3		
2200 – 2300	51.9	NA	NA
2300 – 0000	53.4		
0000 – 0100	48.2		
0100 – 0200	47.8		
0200 – 0300	47.6		
0300 – 0400	47.8		
0400 – 0500	49.2		
0500 – 0600	48.9		
0600 – 0700	50.6		

Remark: NA denote Not Available

Table 45: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL06_R2 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	56.7	NA	NA
0800 – 0900	50.7		
0900 – 1000	51.3		
1000 – 1100	55.2		
1100 – 1200	58.8		
1200 – 1300	57.3		
1300 – 1400	56.7		
1400 – 1500	56.0		
1500 – 1600	56.7		
1600 – 1700	51.9		
1700 – 1800	50.7		
1800 – 1900	48.8		
1900 – 2000	48.7	NA	NA
2000 – 2100	49.9		
2100 – 2200	51.4		
2200 – 2300	50.1	NA	NA
2300 – 0000	47.9		
0000 – 0100	54.5		
0100 – 0200	58.2		
0200 – 0300	47.4		
0300 – 0400	47.0		
0400 – 0500	54.7		
0500 – 0600	53.4		
0600 – 0700	53.0		

Remark: NA denote Not Available

Table 46: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL06_R2 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	50.3	NA	NA
0800 – 0900	49.3		
0900 – 1000	47.7		
1000 – 1100	45.3		
1100 – 1200	41.4		
1200 – 1300	43.3		
1300 – 1400	41.6		
1400 – 1500	46.6		
1500 – 1600	49.3		
1600 – 1700	45.3		
1700 – 1800	49.9		
1800 – 1900	49.8		
1900 – 2000	50.7	NA	NA
2000 – 2100	65.8		
2100 – 2200	65.8		
2200 – 2300	64.4	NA	NA
2300 – 0000	57.7		
0000 – 0100	47.7		
0100 – 0200	45.5		
0200 – 0300	46.0		
0300 – 0400	45.6		
0400 – 0500	46.9		
0500 – 0600	46.5		
0600 – 0700	48.6		

Remark: NA denote Not Available

Table 47: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL06_R2 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	48.7	NA	NA
0800 – 0900	47.0		
0900 – 1000	49.1		
1000 – 1100	42.5		
1100 – 1200	46.9		
1200 – 1300	49.0		
1300 – 1400	42.0		
1400 – 1500	47.0		
1500 – 1600	46.2		
1600 – 1700	45.2		
1700 – 1800	46.6		
1800 – 1900	47.5		
1900 – 2000	58.2	NA	NA
2000 – 2100	54.1		
2100 – 2200	51.2		
2200 – 2300	49.5	NA	NA
2300 – 0000	51.0		
0000 – 0100	56.9		
0100 – 0200	52.4		
0200 – 0300	52.6		
0300 – 0400	46.3		
0400 – 0500	50.9		
0500 – 0600	52.8		
0600 – 0700	48.3		

Remark: NA denote Not Available

Table 48: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL06_R2 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	49.5	NA	NA
0800 – 0900	49.6		
0900 – 1000	48.5		
1000 – 1100	51.2		
1100 – 1200	51.9		
1200 – 1300	58.4		
1300 – 1400	58.8		
1400 – 1500	59.4		
1500 – 1600	63.9		
1600 – 1700	64.5		
1700 – 1800	60.4		
1800 – 1900	51.1		
1900 – 2000	56.0	NA	NA
2000 – 2100	54.6		
2100 – 2200	56.1		
2200 – 2300	48.5	NA	NA
2300 – 0000	46.5		
0000 – 0100	48.8		
0100 – 0200	45.7		
0200 – 0300	45.6		
0300 – 0400	45.7		
0400 – 0500	46.6		
0500 – 0600	47.1		
0600 – 0700	52.7		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 49: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL07_R2 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	53.2	NA	NA
0800 – 0900	52.4		
0900 – 1000	56.0		
1000 – 1100	54.2		
1100 – 1200	54.8		
1200 – 1300	55.6		
1300 – 1400	53.3		
1400 – 1500	71.7		
1500 – 1600	68.1		
1600 – 1700	55.2		
1700 – 1800	56.7		
1800 – 1900	53.8		
1900 – 2000	56.7	NA	NA
2000 – 2100	56.1		
2100 – 2200	57.1		
2200 – 2300	53.8	NA	NA
2300 – 0000	51.8		
0000 – 0100	52.6		
0100 – 0200	52.0		
0200 – 0300	55.0		
0300 – 0400	50.8		
0400 – 0500	50.6		
0500 – 0600	50.8		
0600 – 0700	52.3		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 50: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL07_R2 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	48.5	NA	NA
0800 – 0900	49.4		
0900 – 1000	52.6		
1000 – 1100	53.5		
1100 – 1200	53.4		
1200 – 1300	51.7		
1300 – 1400	63.8		
1400 – 1500	56.6		
1500 – 1600	58.0		
1600 – 1700	58.2		
1700 – 1800	54.4		
1800 – 1900	54.0		
1900 – 2000	56.1	NA	NA
2000 – 2100	56.8		
2100 – 2200	56.3		
2200 – 2300	58.4	NA	NA
2300 – 0000	53.5		
0000 – 0100	51.4		
0100 – 0200	55.5		
0200 – 0300	50.7		
0300 – 0400	50.7		
0400 – 0500	50.3		
0500 – 0600	49.2		
0600 – 0700	46.8		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 51: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL07_R2 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	47.9	NA	NA
0800 – 0900	50.6		
0900 – 1000	53.0		
1000 – 1100	51.3		
1100 – 1200	49.8		
1200 – 1300	53.7		
1300 – 1400	49.0		
1400 – 1500	60.6		
1500 – 1600	58.8		
1600 – 1700	53.3		
1700 – 1800	52.9		
1800 – 1900	55.0		
1900 – 2000	55.9	NA	NA
2000 – 2100	56.0		
2100 – 2200	57.6		
2200 – 2300	56.2	NA	NA
2300 – 0000	59.4		
0000 – 0100	51.6		
0100 – 0200	54.5		
0200 – 0300	51.5		
0300 – 0400	49.2		
0400 – 0500	46.0		
0500 – 0600	46.4		
0600 – 0700	46.1		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 52: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL07_R2 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	51.7	NA	NA
0800 – 0900	52.3		
0900 – 1000	53.2		
1000 – 1100	53.7		
1100 – 1200	53.6		
1200 – 1300	52.1		
1300 – 1400	51.8		
1400 – 1500	66.6		
1500 – 1600	58.7		
1600 – 1700	52.4		
1700 – 1800	52.0		
1800 – 1900	55.2		
1900 – 2000	57.4	NA	NA
2000 – 2100	58.1		
2100 – 2200	56.8		
2200 – 2300	57.2	NA	NA
2300 – 0000	55.0		
0000 – 0100	53.8		
0100 – 0200	50.9		
0200 – 0300	53.6		
0300 – 0400	51.6		
0400 – 0500	55.6		
0500 – 0600	51.4		
0600 – 0700	52.3		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 53: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL07_R2 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	52.0	NA	NA
0800 – 0900	53.1		
0900 – 1000	53.5		
1000 – 1100	55.8		
1100 – 1200	54.2		
1200 – 1300	52.4		
1300 – 1400	67.3		
1400 – 1500	57.3		
1500 – 1600	59.5		
1600 – 1700	54.8		
1700 – 1800	55.7		
1800 – 1900	55.8		
1900 – 2000	60.8	NA	NA
2000 – 2100	58.8		
2100 – 2200	60.4		
2200 – 2300	56.6	NA	NA
2300 – 0000	51.5		
0000 – 0100	53.7		
0100 – 0200	50.7		
0200 – 0300	50.4		
0300 – 0400	50.5		
0400 – 0500	51.0		
0500 – 0600	50.7		
0600 – 0700	50.8		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 54: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL07_R2 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	51.7	NA	NA
0800 – 0900	54.4		
0900 – 1000	54.3		
1000 – 1100	59.8		
1100 – 1200	56.4		
1200 – 1300	53.7		
1300 – 1400	55.2		
1400 – 1500	67.9		
1500 – 1600	57.6		
1600 – 1700	59.7		
1700 – 1800	54.8		
1800 – 1900	57.5		
1900 – 2000	60.0	NA	NA
2000 – 2100	59.5		
2100 – 2200	59.1		
2200 – 2300	53.6	NA	NA
2300 – 0000	51.0		
0000 – 0100	53.4		
0100 – 0200	52.4		
0200 – 0300	52.9		
0300 – 0400	52.2		
0400 – 0500	50.8		
0500 – 0600	50.5		
0600 – 0700	50.7		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 55: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL07_R2 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	52.3	NA	NA
0800 – 0900	56.0		
0900 – 1000	60.1		
1000 – 1100	55.8		
1100 – 1200	56.2		
1200 – 1300	54.7		
1300 – 1400	55.7		
1400 – 1500	69.3		
1500 – 1600	61.2		
1600 – 1700	58.8		
1700 – 1800	57.7		
1800 – 1900	56.8		
1900 – 2000	57.1	NA	NA
2000 – 2100	57.1		
2100 – 2200	58.6		
2200 – 2300	60.0	NA	NA
2300 – 0000	50.9		
0000 – 0100	50.8		
0100 – 0200	51.2		
0200 – 0300	50.2		
0300 – 0400	50.0		
0400 – 0500	49.9		
0500 – 0600	50.3		
0600 – 0700	52.6		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 56: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL08_R2 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	65.6	NA	NA
0800 – 0900	64.9		
0900 – 1000	54.9		
1000 – 1100	60.7		
1100 – 1200	52.5		
1200 – 1300	54.5		
1300 – 1400	64.6		
1400 – 1500	55.9		
1500 – 1600	53.2		
1600 – 1700	52.6		
1700 – 1800	55.8		
1800 – 1900	46.3		
1900 – 2000	47.2	NA	NA
2000 – 2100	46.7		
2100 – 2200	45.6		
2200 – 2300	46.0	NA	NA
2300 – 0000	47.0		
0000 – 0100	46.1		
0100 – 0200	46.0		
0200 – 0300	46.2		
0300 – 0400	47.3		
0400 – 0500	46.3		
0500 – 0600	46.8		
0600 – 0700	50.1		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 57: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL08_R2 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	50.7	NA	NA
0800 – 0900	50.8		
0900 – 1000	55.0		
1000 – 1100	64.9		
1100 – 1200	52.1		
1200 – 1300	65.6		
1300 – 1400	49.9		
1400 – 1500	49.2		
1500 – 1600	47.3		
1600 – 1700	48.9		
1700 – 1800	47.8		
1800 – 1900	46.6		
1900 – 2000	44.9	NA	NA
2000 – 2100	46.5		
2100 – 2200	46.5		
2200 – 2300	46.2	NA	NA
2300 – 0000	46.4		
0000 – 0100	45.6		
0100 – 0200	45.6		
0200 – 0300	45.2		
0300 – 0400	45.5		
0400 – 0500	46.3		
0500 – 0600	46.2		
0600 – 0700	51.4		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 58: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL08_R2 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	53.1	NA	NA
0800 – 0900	51.0		
0900 – 1000	55.5		
1000 – 1100	60.4		
1100 – 1200	49.5		
1200 – 1300	60.4		
1300 – 1400	47.7		
1400 – 1500	48.1		
1500 – 1600	47.2		
1600 – 1700	47.4		
1700 – 1800	47.4		
1800 – 1900	45.0		
1900 – 2000	44.3	NA	NA
2000 – 2100	45.6		
2100 – 2200	45.5		
2200 – 2300	46.7	NA	NA
2300 – 0000	46.7		
0000 – 0100	46.3		
0100 – 0200	45.4		
0200 – 0300	47.1		
0300 – 0400	44.7		
0400 – 0500	45.6		
0500 – 0600	47.2		
0600 – 0700	50.7		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 59: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL08_R2 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	50.2	NA	NA
0800 – 0900	48.1		
0900 – 1000	48.9		
1000 – 1100	67.2		
1100 – 1200	47.7		
1200 – 1300	48.5		
1300 – 1400	49.8		
1400 – 1500	46.8		
1500 – 1600	45.9		
1600 – 1700	45.6		
1700 – 1800	45.4		
1800 – 1900	44.7		
1900 – 2000	43.7	NA	NA
2000 – 2100	45.1		
2100 – 2200	45.3		
2200 – 2300	45.4	NA	NA
2300 – 0000	45.7		
0000 – 0100	46.3		
0100 – 0200	45.6		
0200 – 0300	46.0		
0300 – 0400	46.7		
0400 – 0500	45.4		
0500 – 0600	46.0		
0600 – 0700	49.6		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 60: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL08_R2 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	51.4	NA	NA
0800 – 0900	50.6		
0900 – 1000	64.0		
1000 – 1100	67.0		
1100 – 1200	64.1		
1200 – 1300	51.8		
1300 – 1400	56.4		
1400 – 1500	51.5		
1500 – 1600	53.8		
1600 – 1700	51.8		
1700 – 1800	50.0		
1800 – 1900	52.1		
1900 – 2000	53.1	NA	NA
2000 – 2100	50.1		
2100 – 2200	51.9		
2200 – 2300	46.8	NA	NA
2300 – 0000	45.6		
0000 – 0100	45.3		
0100 – 0200	44.5		
0200 – 0300	43.7		
0300 – 0400	44.7		
0400 – 0500	47.6		
0500 – 0600	46.2		
0600 – 0700	47.7		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 61: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL08_R2 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	50.6	NA	NA
0800 – 0900	61.1		
0900 – 1000	61.3		
1000 – 1100	48.6		
1100 – 1200	64.5		
1200 – 1300	53.4		
1300 – 1400	51.0		
1400 – 1500	51.1		
1500 – 1600	51.5		
1600 – 1700	52.8		
1700 – 1800	53.3		
1800 – 1900	51.9		
1900 – 2000	53.5	NA	NA
2000 – 2100	54.5		
2100 – 2200	52.1		
2200 – 2300	46.2	NA	NA
2300 – 0000	45.6		
0000 – 0100	45.8		
0100 – 0200	45.5		
0200 – 0300	46.4		
0300 – 0400	45.6		
0400 – 0500	46.9		
0500 – 0600	47.3		
0600 – 0700	49.6		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 62: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL08_R2 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	55.2	NA	NA
0800 – 0900	52.2		
0900 – 1000	58.6		
1000 – 1100	66.4		
1100 – 1200	64.1		
1200 – 1300	64.9		
1300 – 1400	50.2		
1400 – 1500	48.1		
1500 – 1600	50.0		
1600 – 1700	52.6		
1700 – 1800	59.6		
1800 – 1900	53.6		
1900 – 2000	52.8	NA	NA
2000 – 2100	49.3		
2100 – 2200	47.5		
2200 – 2300	46.9	NA	NA
2300 – 0000	45.9		
0000 – 0100	46.0		
0100 – 0200	45.6		
0200 – 0300	46.4		
0300 – 0400	45.0		
0400 – 0500	45.5		
0500 – 0600	46.0		
0600 – 0700	49.2		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 63: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL09_R2 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	50.7	NA	NA
0800 – 0900	69.5		
0900 – 1000	56.9		
1000 – 1100	54.5		
1100 – 1200	52.7		
1200 – 1300	54.2		
1300 – 1400	54.6		
1400 – 1500	55.4		
1500 – 1600	53.8		
1600 – 1700	51.1		
1700 – 1800	53.3		
1800 – 1900	50.2		
1900 – 2000	50.3	NA	NA
2000 – 2100	49.4		
2100 – 2200	49.0		
2200 – 2300	48.9	NA	NA
2300 – 0000	48.9		
0000 – 0100	49.2		
0100 – 0200	50.2		
0200 – 0300	48.2		
0300 – 0400	48.2		
0400 – 0500	48.0		
0500 – 0600	48.3		
0600 – 0700	50.5		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 64: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL09_R2 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	50.8	NA	NA
0800 – 0900	62.5		
0900 – 1000	55.0		
1000 – 1100	56.0		
1100 – 1200	53.2		
1200 – 1300	51.6		
1300 – 1400	50.7		
1400 – 1500	50.0		
1500 – 1600	47.9		
1600 – 1700	47.9		
1700 – 1800	49.1		
1800 – 1900	48.2		
1900 – 2000	48.1	NA	NA
2000 – 2100	48.4		
2100 – 2200	48.5		
2200 – 2300	49.1	NA	NA
2300 – 0000	48.7		
0000 – 0100	49.5		
0100 – 0200	50.8		
0200 – 0300	48.9		
0300 – 0400	48.3		
0400 – 0500	48.3		
0500 – 0600	48.2		
0600 – 0700	50.1		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 65: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL09_R2 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	49.7	NA	NA
0800 – 0900	48.8		
0900 – 1000	56.2		
1000 – 1100	50.5		
1100 – 1200	50.4		
1200 – 1300	50.9		
1300 – 1400	49.8		
1400 – 1500	49.2		
1500 – 1600	48.0		
1600 – 1700	49.0		
1700 – 1800	48.8		
1800 – 1900	48.1		
1900 – 2000	48.3	NA	NA
2000 – 2100	48.8		
2100 – 2200	48.7		
2200 – 2300	48.4	NA	NA
2300 – 0000	48.1		
0000 – 0100	50.3		
0100 – 0200	50.7		
0200 – 0300	49.0		
0300 – 0400	48.9		
0400 – 0500	48.8		
0500 – 0600	48.4		
0600 – 0700	49.0		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 66: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL09_R2 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	48.4	NA	NA
0800 – 0900	49.1		
0900 – 1000	48.1		
1000 – 1100	50.8		
1100 – 1200	48.9		
1200 – 1300	48.4		
1300 – 1400	48.3		
1400 – 1500	48.4		
1500 – 1600	48.6		
1600 – 1700	50.9		
1700 – 1800	47.9		
1800 – 1900	49.3		
1900 – 2000	47.4	NA	NA
2000 – 2100	47.4		
2100 – 2200	47.9		
2200 – 2300	48.0	NA	NA
2300 – 0000	49.6		
0000 – 0100	48.9		
0100 – 0200	49.7		
0200 – 0300	49.5		
0300 – 0400	48.6		
0400 – 0500	48.3		
0500 – 0600	48.1		
0600 – 0700	48.0		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 67: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL09_R2 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	51.1	NA	NA
0800 – 0900	49.8		
0900 – 1000	50.1		
1000 – 1100	52.2		
1100 – 1200	52.3		
1200 – 1300	52.3		
1300 – 1400	56.0		
1400 – 1500	53.8		
1500 – 1600	52.7		
1600 – 1700	51.3		
1700 – 1800	49.7		
1800 – 1900	52.1		
1900 – 2000	53.3	NA	NA
2000 – 2100	51.2		
2100 – 2200	51.7		
2200 – 2300	48.6	NA	NA
2300 – 0000	48.4		
0000 – 0100	50.7		
0100 – 0200	50.6		
0200 – 0300	47.9		
0300 – 0400	48.1		
0400 – 0500	47.7		
0500 – 0600	47.1		
0600 – 0700	48.8		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 68: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL09_R2 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	51.8	NA	NA
0800 – 0900	49.0		
0900 – 1000	51.8		
1000 – 1100	48.8		
1100 – 1200	52.5		
1200 – 1300	53.8		
1300 – 1400	51.6		
1400 – 1500	50.2		
1500 – 1600	51.6		
1600 – 1700	52.6		
1700 – 1800	52.8		
1800 – 1900	52.4		
1900 – 2000	52.7	NA	NA
2000 – 2100	54.1		
2100 – 2200	51.8		
2200 – 2300	48.1	NA	NA
2300 – 0000	48.7		
0000 – 0100	48.0		
0100 – 0200	48.5		
0200 – 0300	50.1		
0300 – 0400	48.2		
0400 – 0500	48.1		
0500 – 0600	48.3		
0600 – 0700	49.4		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 69: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL09_R2 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	51.6	NA	NA
0800 – 0900	50.9		
0900 – 1000	51.0		
1000 – 1100	51.6		
1100 – 1200	54.1		
1200 – 1300	51.5		
1300 – 1400	52.7		
1400 – 1500	48.6		
1500 – 1600	51.3		
1600 – 1700	61.6		
1700 – 1800	54.4		
1800 – 1900	53.7		
1900 – 2000	52.7	NA	NA
2000 – 2100	50.7		
2100 – 2200	50.1		
2200 – 2300	50.4	NA	NA
2300 – 0000	49.9		
0000 – 0100	49.7		
0100 – 0200	48.5		
0200 – 0300	48.2		
0300 – 0400	47.0		
0400 – 0500	46.7		
0500 – 0600	47.8		
0600 – 0700	49.3		

Remark: * Limit of Affected Buildings (other than above)
NA denote Not Available

Table 70: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL10_R2 Day 1

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	48.6	NA	NA
0800 – 0900	48.8		
0900 – 1000	53.8		
1000 – 1100	53.4		
1100 – 1200	50.8		
1200 – 1300	54.7		
1300 – 1400	56.9		
1400 – 1500	53.2		
1500 – 1600	54.1		
1600 – 1700	51.3		
1700 – 1800	54.2		
1800 – 1900	48.0		
1900 – 2000	50.9	NA	NA
2000 – 2100	50.1		
2100 – 2200	50.7		
2200 – 2300	47.7	NA	NA
2300 – 0000	46.0		
0000 – 0100	46.1		
0100 – 0200	44.8		
0200 – 0300	43.8		
0300 – 0400	43.6		
0400 – 0500	45.1		
0500 – 0600	46.9		
0600 – 0700	50.3		

Remark: NA denote Not Available

Table 71: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL10_R2 Day 2

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	46.1	NA	NA
0800 – 0900	46.4		
0900 – 1000	50.8		
1000 – 1100	51.0		
1100 – 1200	58.9		
1200 – 1300	50.5		
1300 – 1400	47.7		
1400 – 1500	49.0		
1500 – 1600	51.0		
1600 – 1700	42.7		
1700 – 1800	42.9		
1800 – 1900	54.8		
1900 – 2000	50.1	NA	NA
2000 – 2100	48.2		
2100 – 2200	49.5		
2200 – 2300	48.1	NA	NA
2300 – 0000	46.4		
0000 – 0100	44.6		
0100 – 0200	45.6		
0200 – 0300	47.2		
0300 – 0400	47.3		
0400 – 0500	46.8		
0500 – 0600	48.0		
0600 – 0700	48.4		

Remark: NA denote Not Available

Table 72: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL10_R2 Day 3

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	47.6	NA	NA
0800 – 0900	48.8		
0900 – 1000	49.3		
1000 – 1100	49.9		
1100 – 1200	49.6		
1200 – 1300	48.2		
1300 – 1400	43.8		
1400 – 1500	56.3		
1500 – 1600	46.1		
1600 – 1700	44.3		
1700 – 1800	47.9		
1800 – 1900	47.0		
1900 – 2000	50.0	NA	NA
2000 – 2100	50.2		
2100 – 2200	49.6		
2200 – 2300	49.8	NA	NA
2300 – 0000	48.5		
0000 – 0100	45.3		
0100 – 0200	44.7		
0200 – 0300	45.6		
0300 – 0400	45.2		
0400 – 0500	44.6		
0500 – 0600	45.1		
0600 – 0700	47.3		

Remark: NA denote Not Available

Table 73: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL10_R2 Day 4

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4 (weekend)	**Sunday/ Public Holiday**	**Monday to Saturday**
0700 – 0800	46.8	NA	NA
0800 – 0900	46.4		
0900 – 1000	48.2		
1000 – 1100	46.2		
1100 – 1200	45.9		
1200 – 1300	44.8		
1300 – 1400	44.1		
1400 – 1500	50.2		
1500 – 1600	58.8		
1600 – 1700	45.8		
1700 – 1800	50.5		
1800 – 1900	46.9		
1900 – 2000	51.9	NA	NA
2000 – 2100	49.9		
2100 – 2200	48.8		
2200 – 2300	46.9	NA	NA
2300 – 0000	46.7		
0000 – 0100	48.4		
0100 – 0200	47.8		
0200 – 0300	46.8		
0300 – 0400	47.0		
0400 – 0500	47.1		
0500 – 0600	47.0		
0600 – 0700	46.5		

Remark: NA denote Not Available

Table 74: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL10_R2 Day 5

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	45.3	NA	NA
0800 – 0900	48.7		
0900 – 1000	46.7		
1000 – 1100	47.4		
1100 – 1200	50.2		
1200 – 1300	48.9		
1300 – 1400	52.5		
1400 – 1500	54.1		
1500 – 1600	54.9		
1600 – 1700	53.1		
1700 – 1800	52.9		
1800 – 1900	54.0		
1900 – 2000	53.1	NA	NA
2000 – 2100	50.5		
2100 – 2200	49.6		
2200 – 2300	46.8	NA	NA
2300 – 0000	45.2		
0000 – 0100	47.6		
0100 – 0200	45.8		
0200 – 0300	44.9		
0300 – 0400	43.9		
0400 – 0500	44.1		
0500 – 0600	46.0		
0600 – 0700	47.7		

Remark: NA denote Not Available

Table 75: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL10_R2 Day 6

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	45.7	NA	NA
0800 – 0900	47.8		
0900 – 1000	51.2		
1000 – 1100	47.5		
1100 – 1200	46.6		
1200 – 1300	50.8		
1300 – 1400	53.9		
1400 – 1500	52.5		
1500 – 1600	54.1		
1600 – 1700	53.0		
1700 – 1800	58.6		
1800 – 1900	52.7		
1900 – 2000	49.9	NA	NA
2000 – 2100	55.3		
2100 – 2200	53.3		
2200 – 2300	48.6	NA	NA
2300 – 0000	47.0		
0000 – 0100	44.9		
0100 – 0200	45.6		
0200 – 0300	45.8		
0300 – 0400	45.5		
0400 – 0500	44.1		
0500 – 0600	48.0		
0600 – 0700	48.6		

Remark: NA denote Not Available

Table 76: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL10_R2 Day 7

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	46.5	NA	NA
0800 – 0900	47.4		
0900 – 1000	49.6		
1000 – 1100	50.2		
1100 – 1200	49.1		
1200 – 1300	50.6		
1300 – 1400	50.7		
1400 – 1500	50.7		
1500 – 1600	46.7		
1600 – 1700	56.0		
1700 – 1800	56.2		
1800 – 1900	55.0		
1900 – 2000	51.9	NA	NA
2000 – 2100	49.3		
2100 – 2200	47.0		
2200 – 2300	45.2	NA	NA
2300 – 0000	43.9		
0000 – 0100	45.6		
0100 – 0200	45.2		
0200 – 0300	45.0		
0300 – 0400	45.2		
0400 – 0500	45.4		
0500 – 0600	46.4		
0600 – 0700	51.9		

Remark: NA denote Not Available

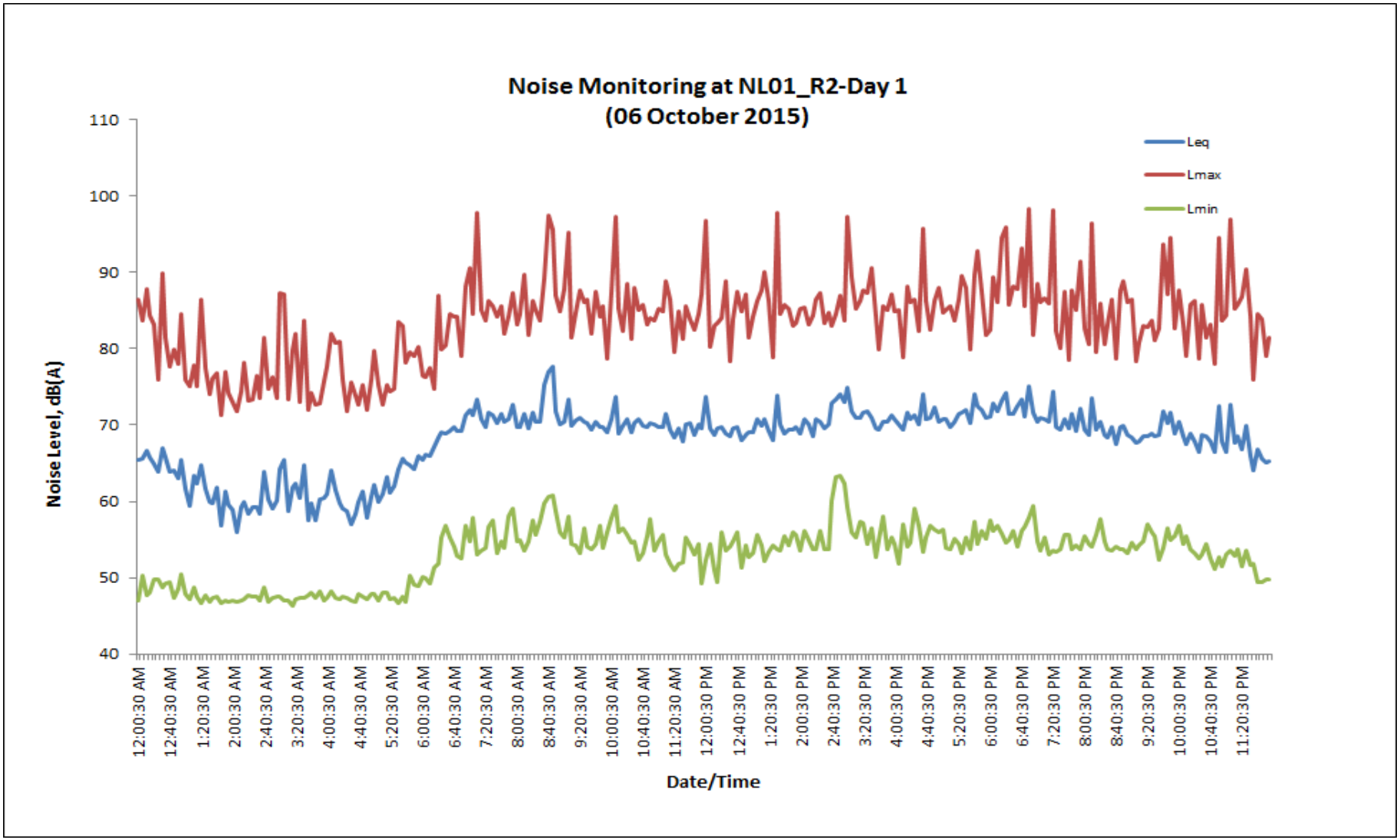

Figure 3: Daily noise level measured at Point NL01_R2 (Day 1)

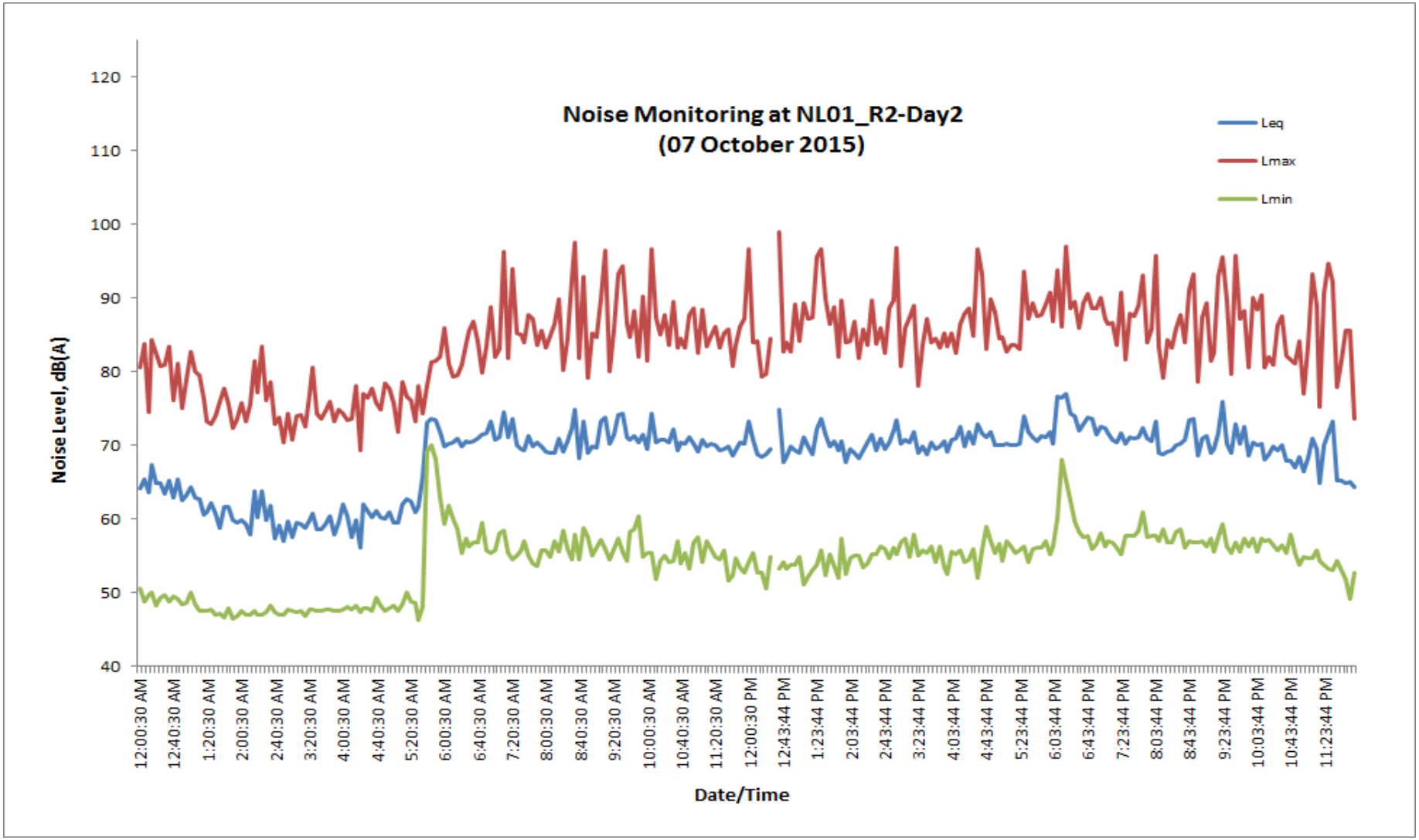

Figure 4: Daily noise level measured at Point NL01_R2 (Day 2)

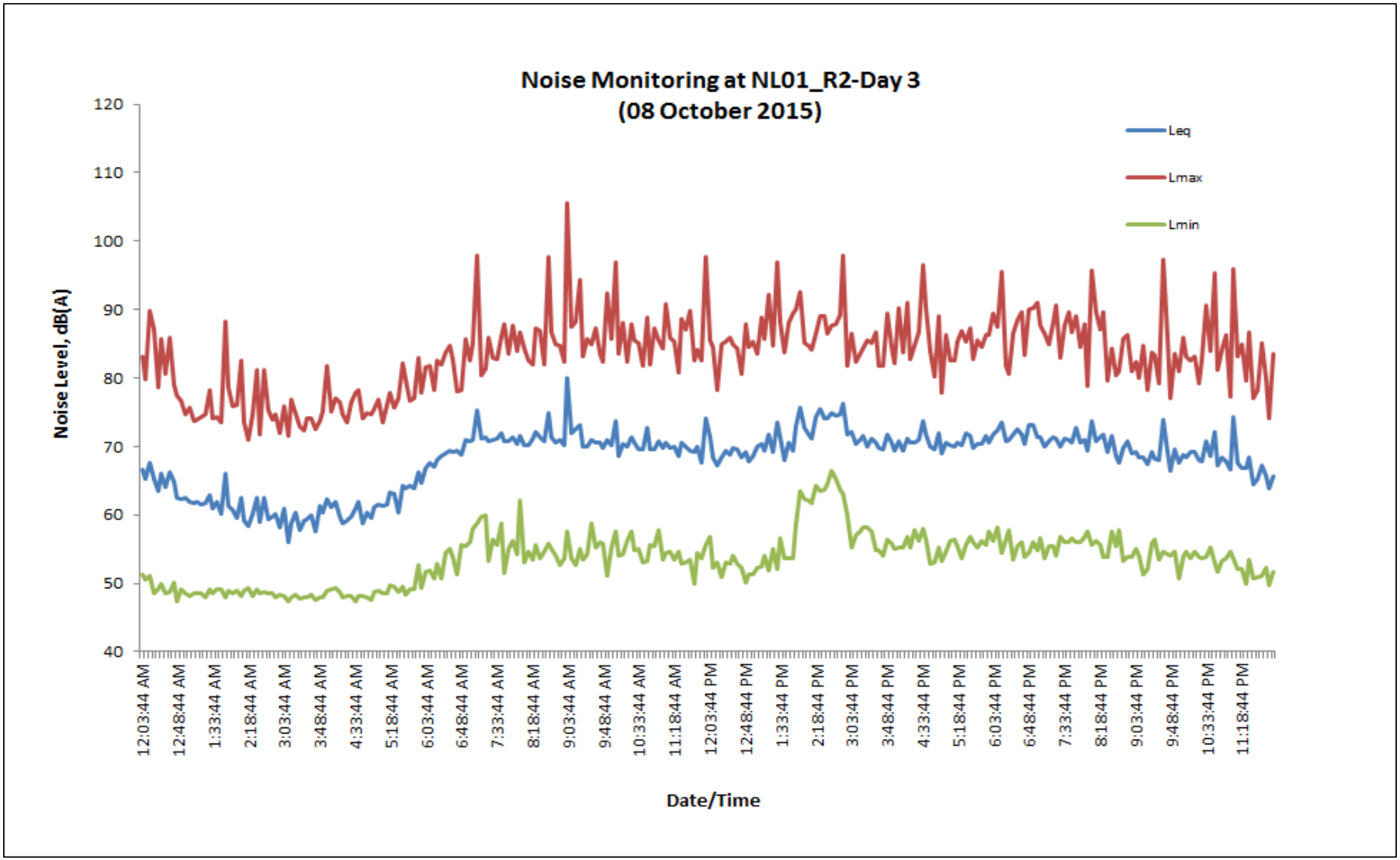

Figure 5: Daily noise level measured at Point NL01_R2 (Day 3)

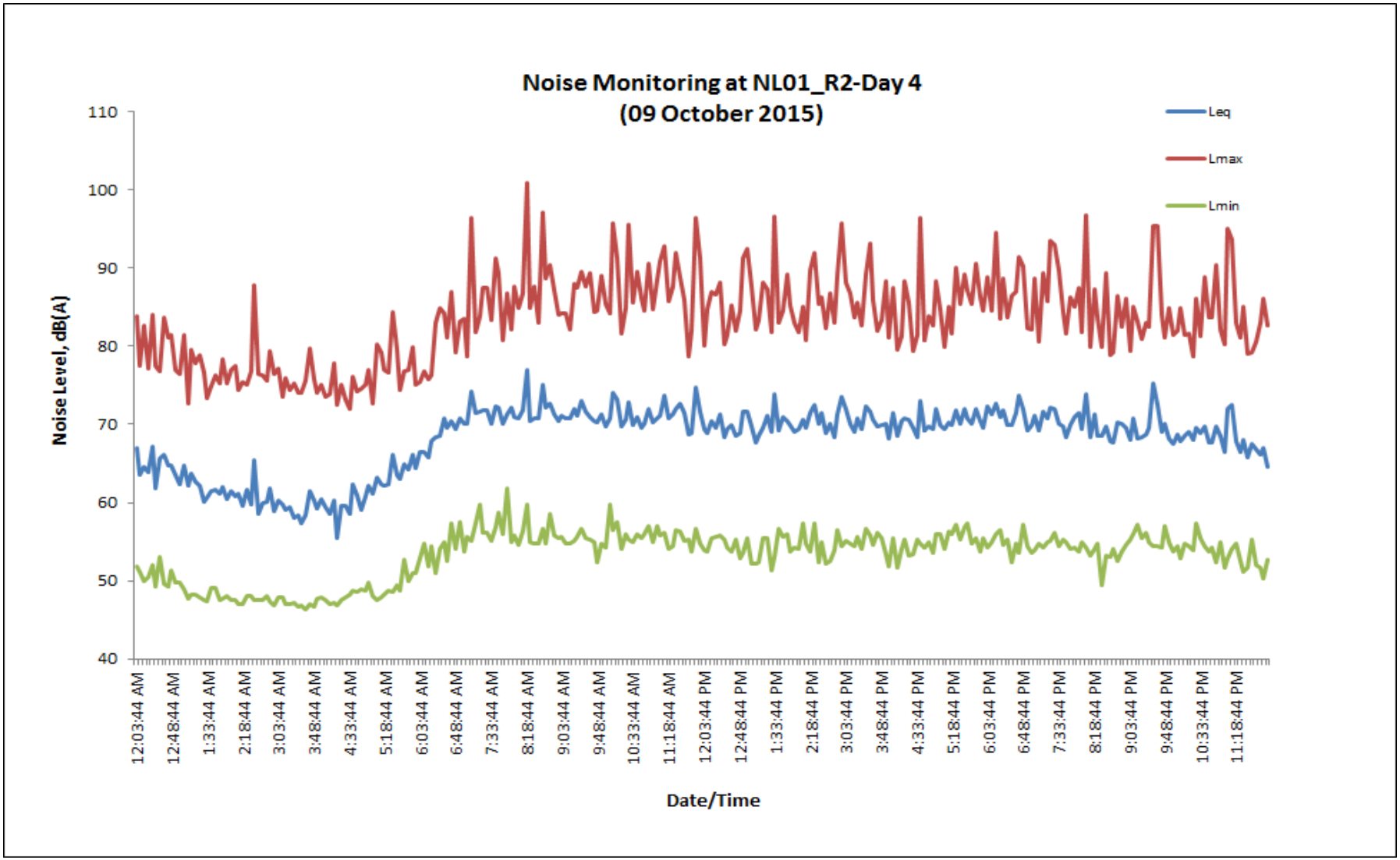

Figure 6: Daily noise level measured at Point NL01_R2 (Day 4)

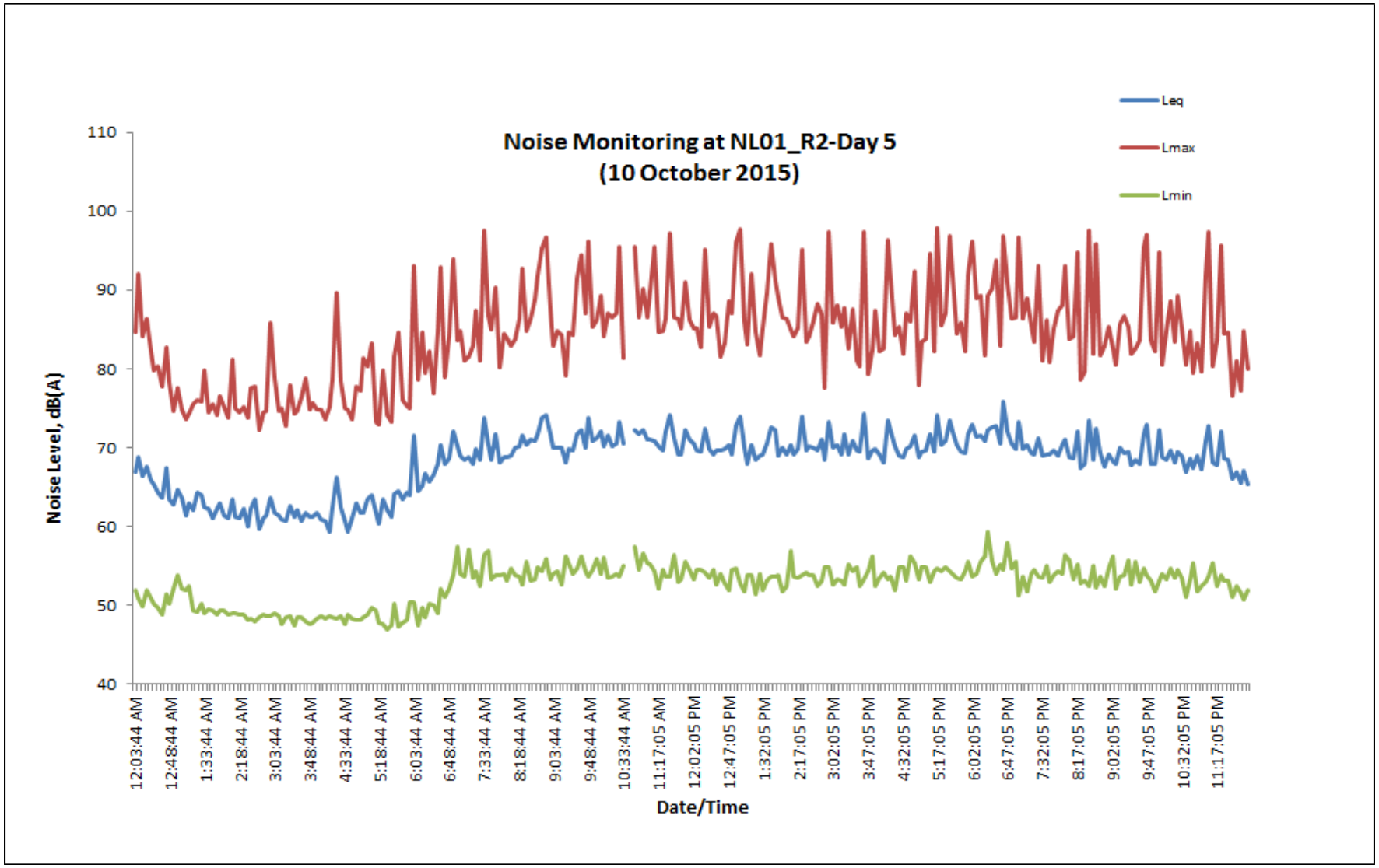

Figure 7: Daily noise level measured at Point NL01_R2 (Day 5)

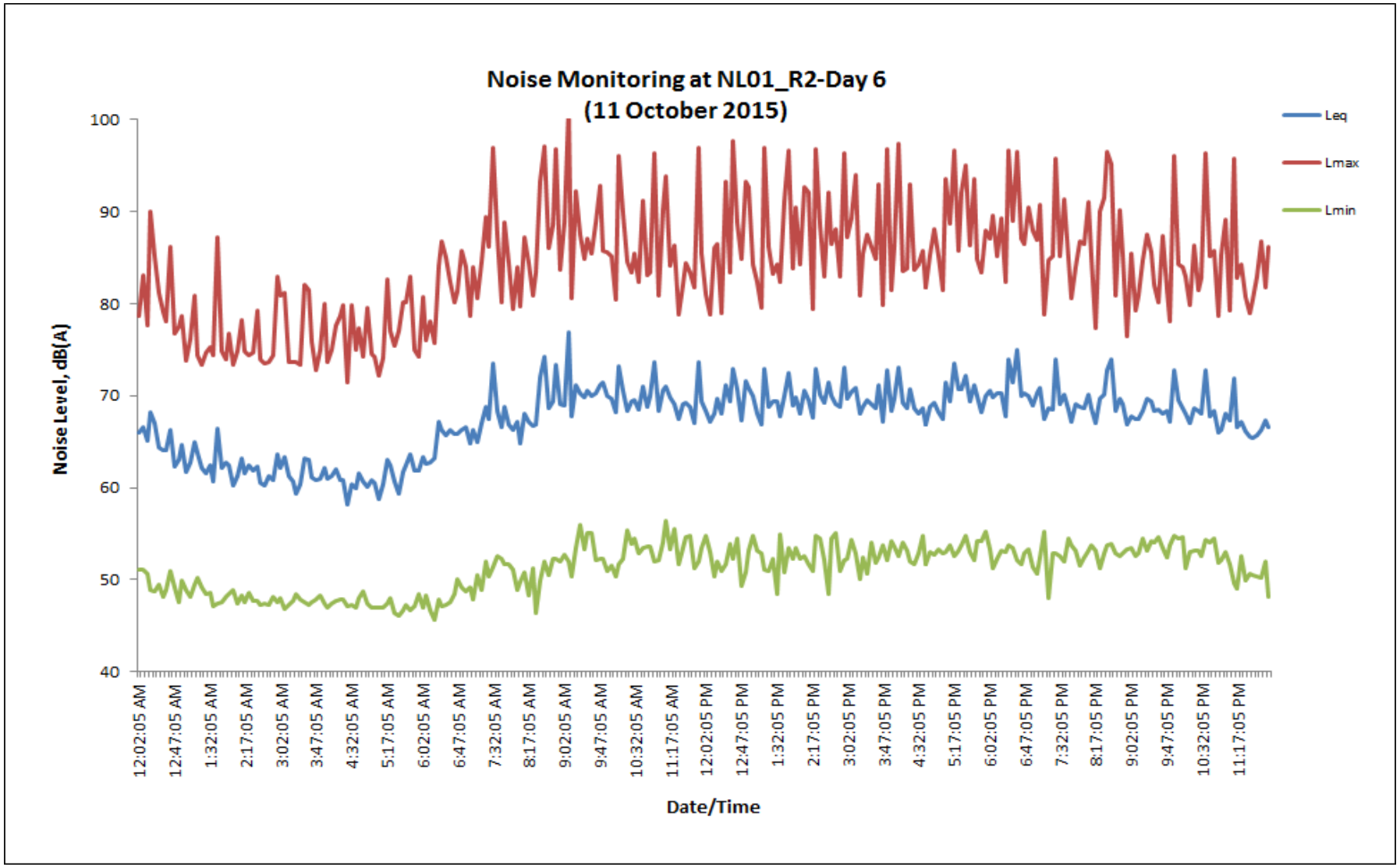

Figure 8: Daily noise level measured at Point NL01_R2 (Day 6)

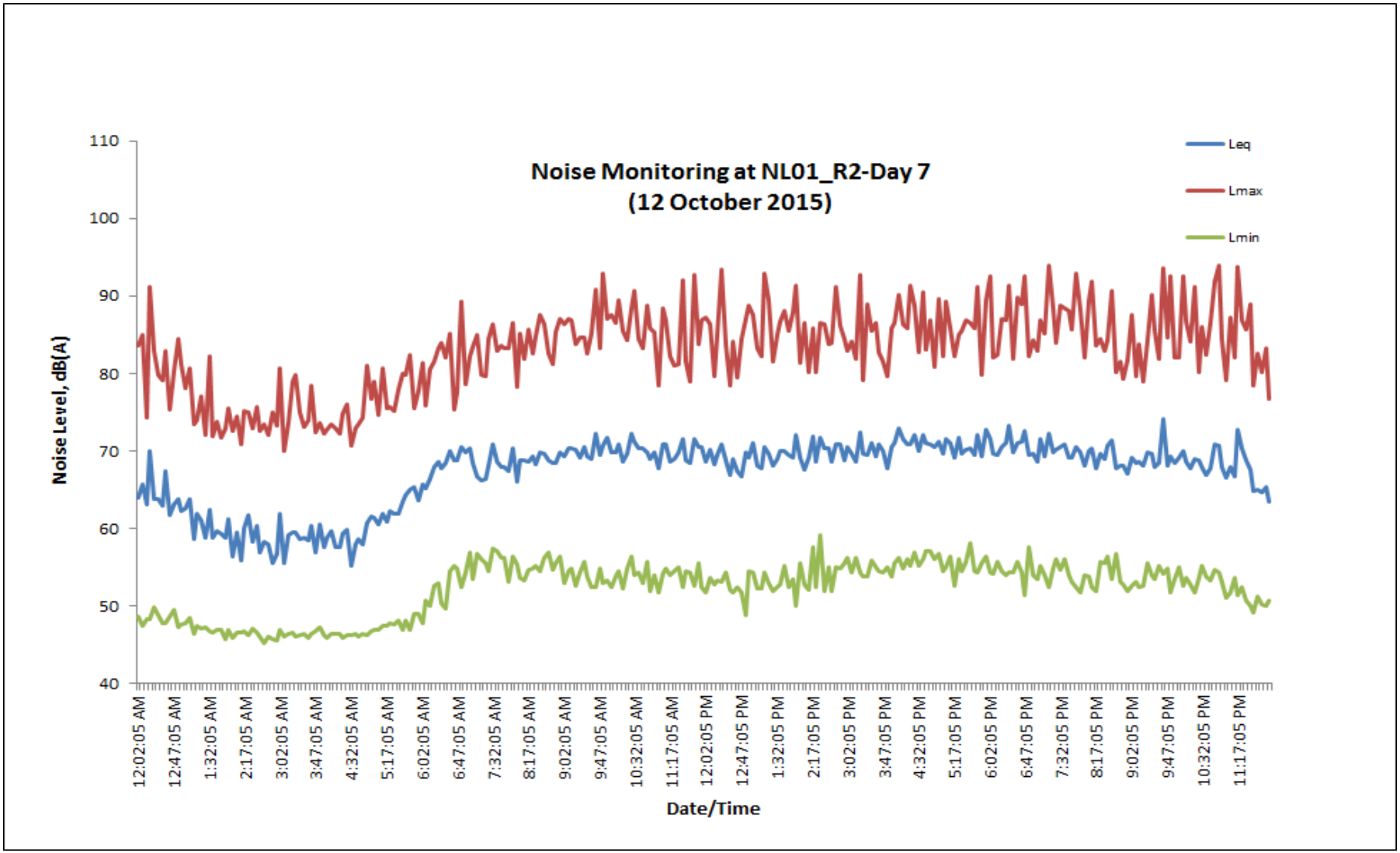

Figure 9: Daily noise level measured at Point NL01_R2 (Day 7)

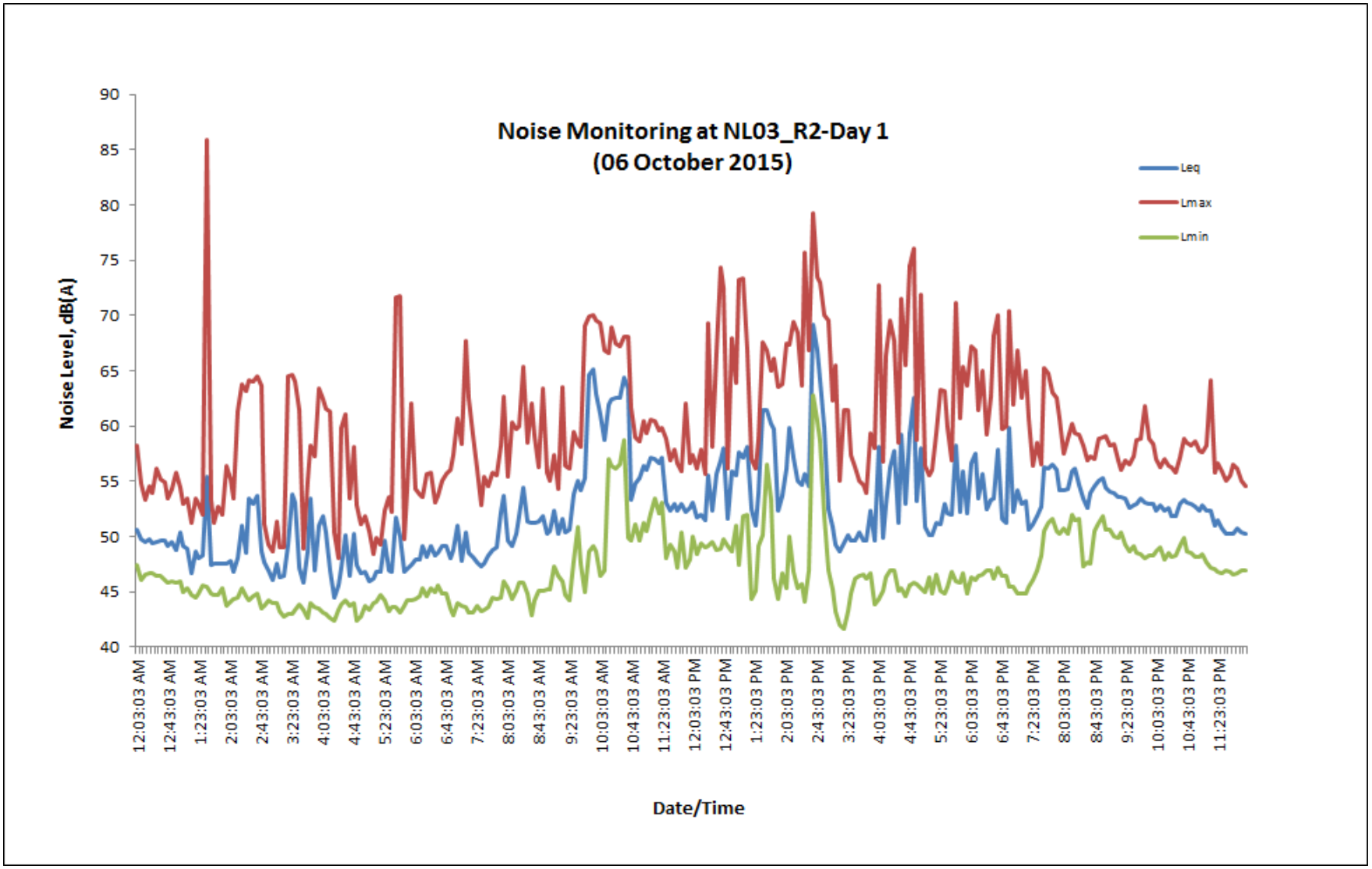

Figure 10: Daily noise level measured at Point NL03_R2 (Day 1)

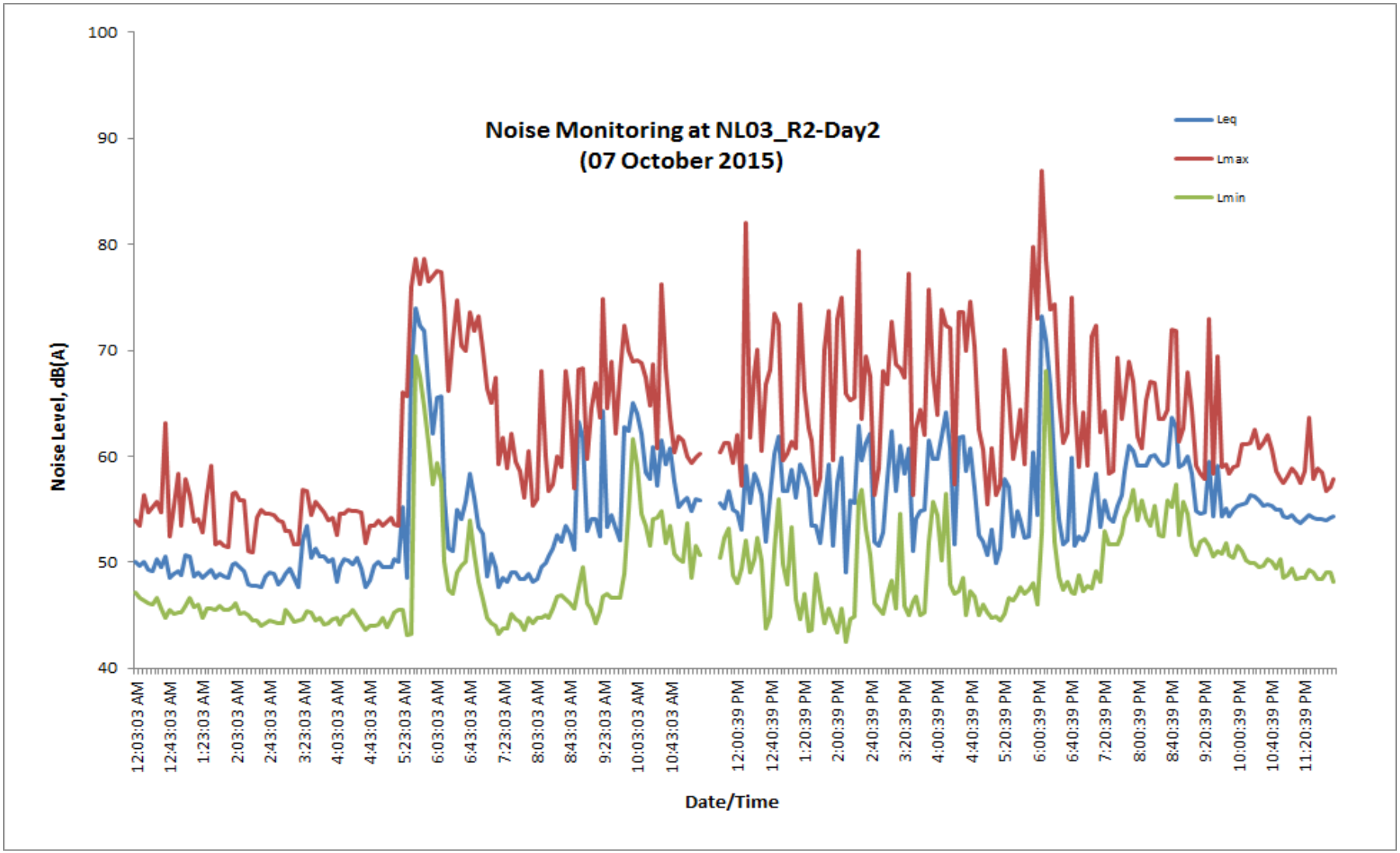

Figure 11: Daily noise level measured at Point NL03_R2 (Day 2)

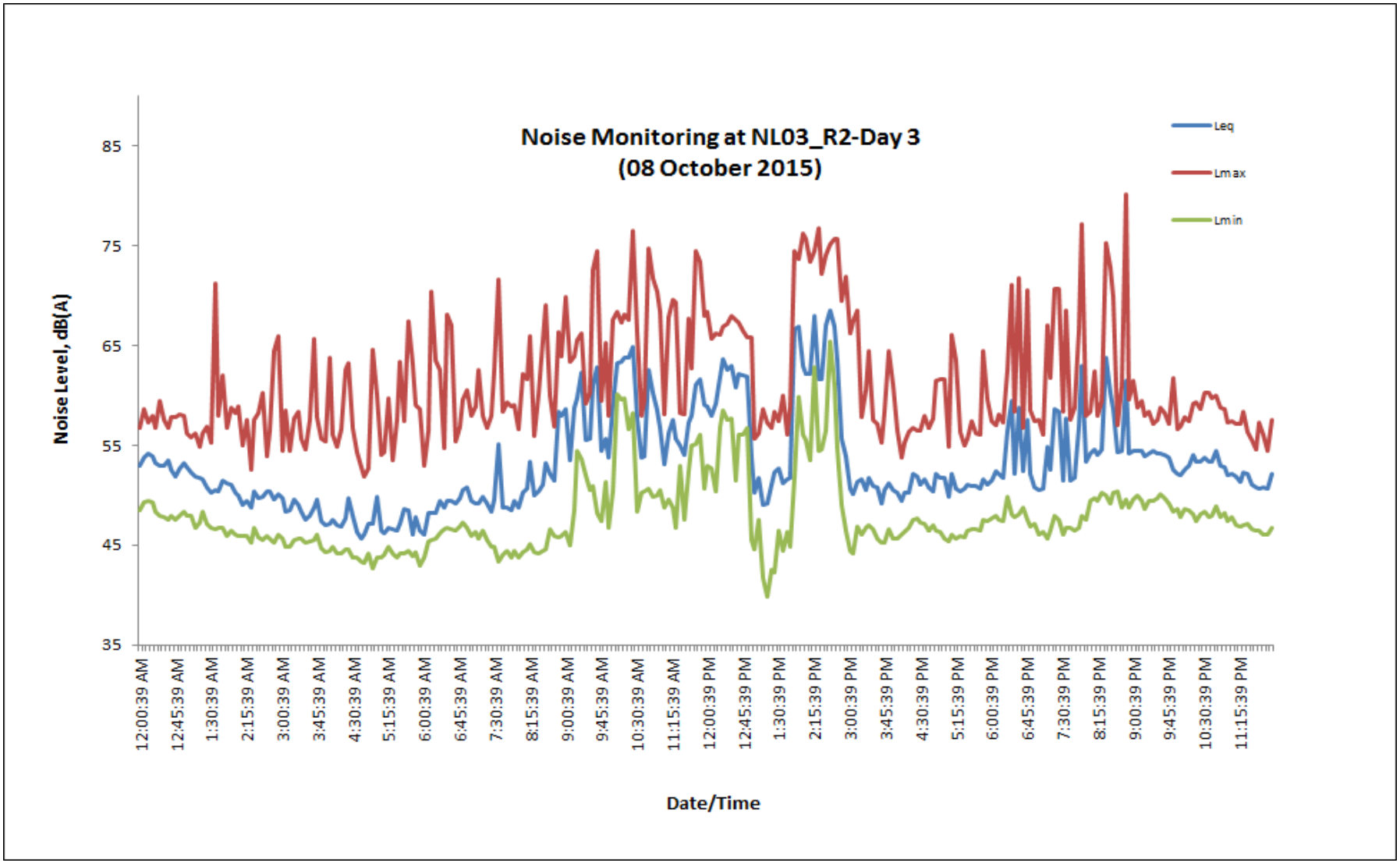

Figure 12: Daily noise level measured at Point NL03_R2 (Day 3)

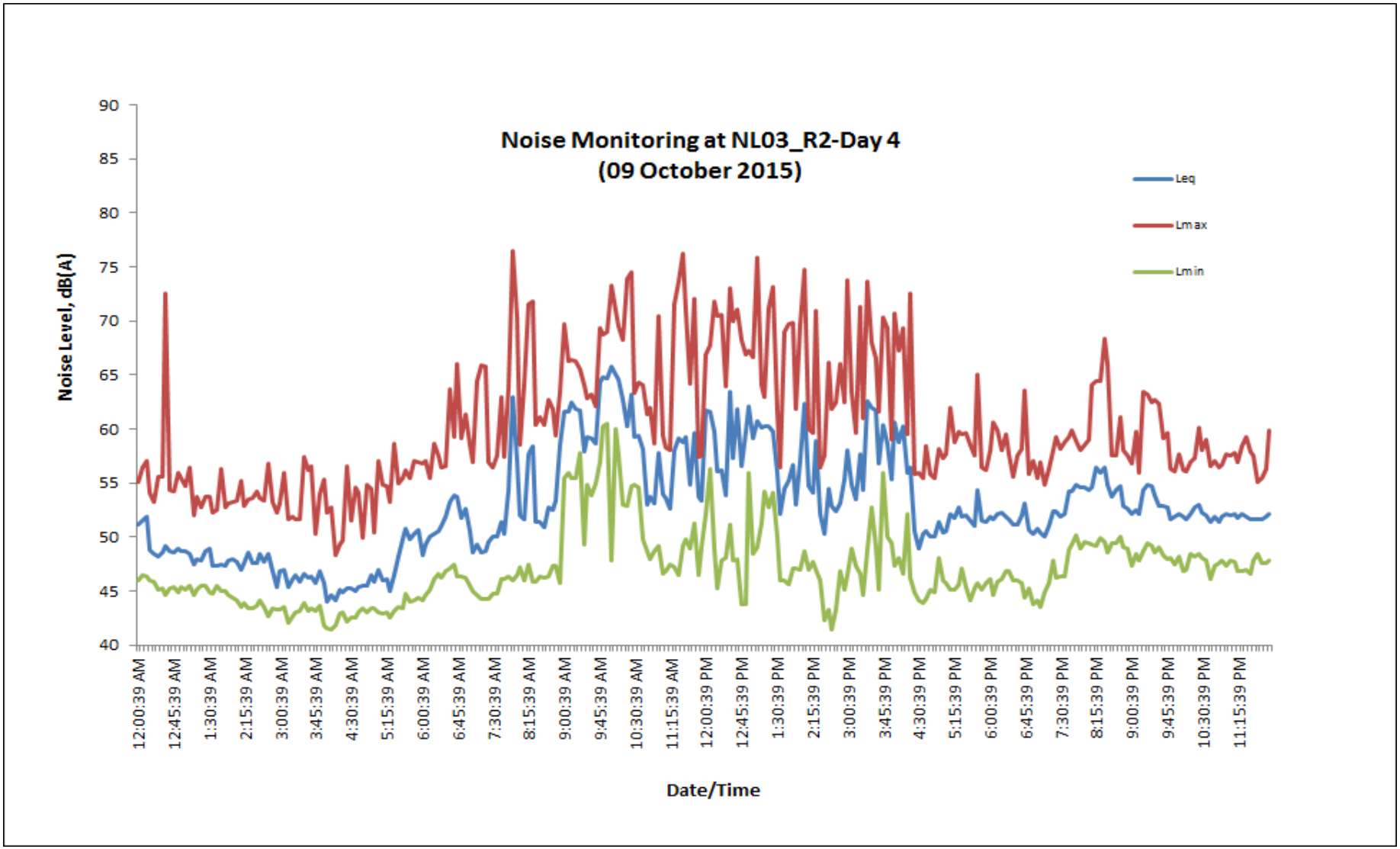

Figure 13: Daily noise level measured at Point NL03_R2 (Day 4)

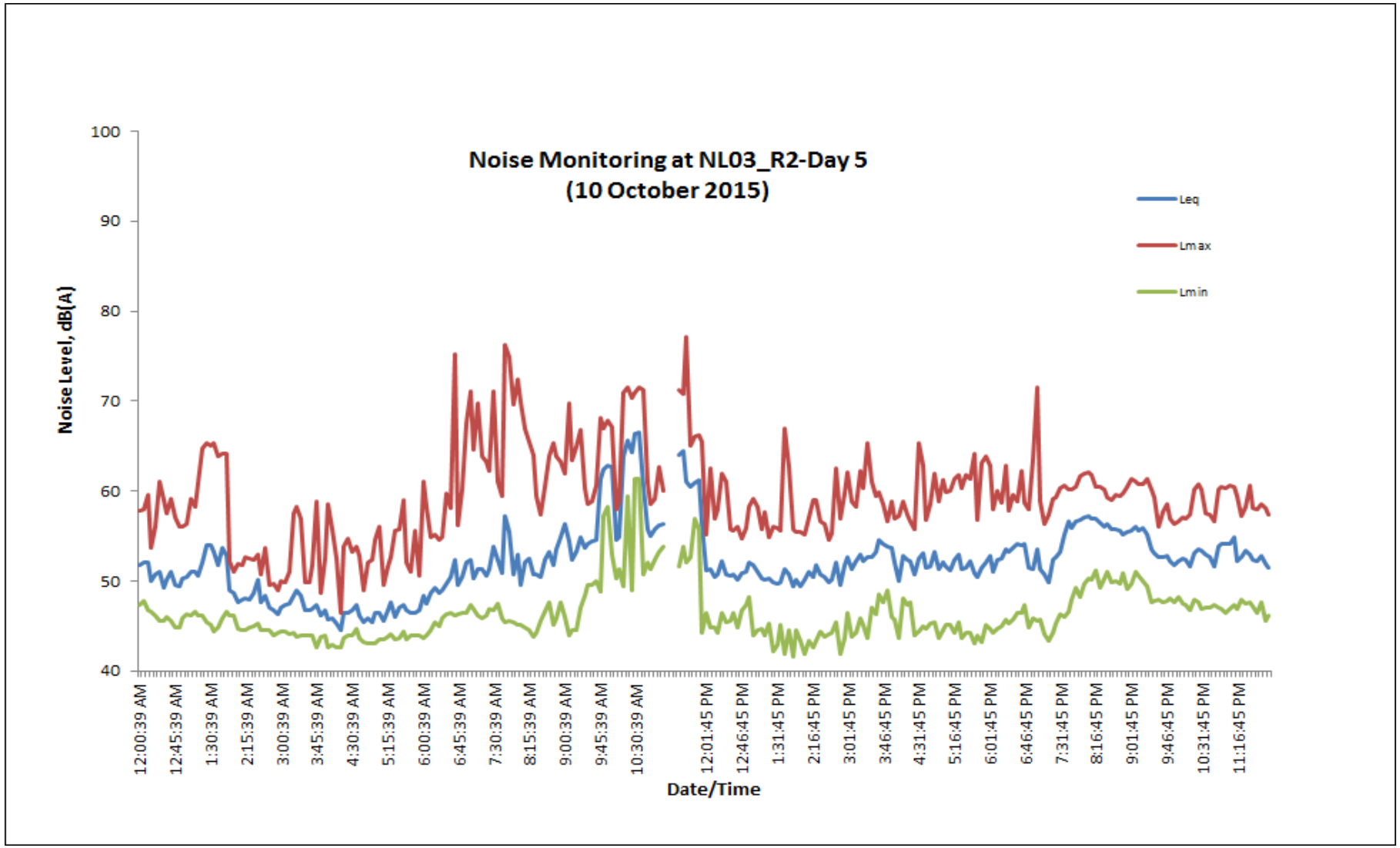

Figure 14: Daily noise level measured at Point NL03_R2 (Day 5)

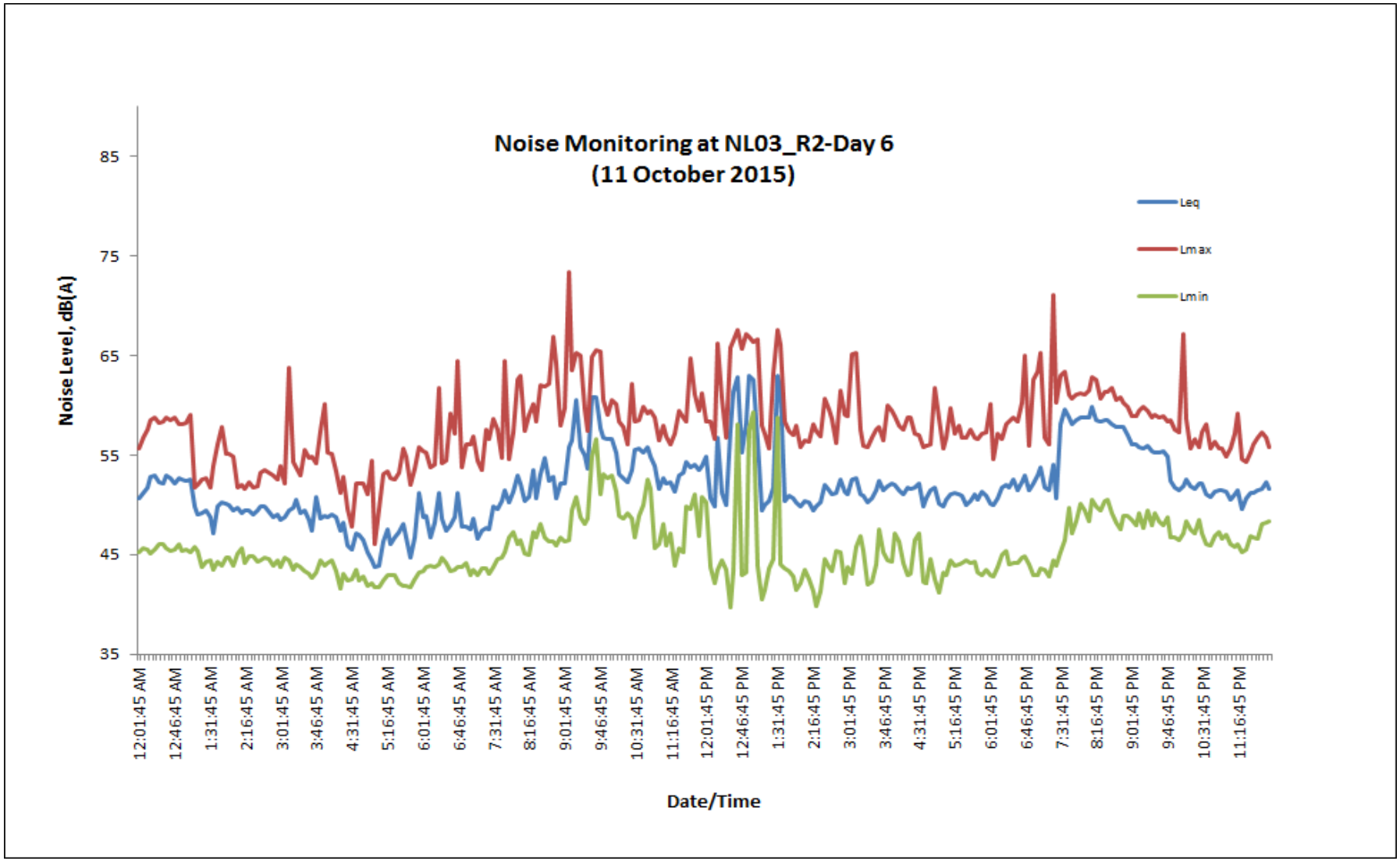

Figure 15: Daily noise level measured at Point NL03_R2 (Day 6)

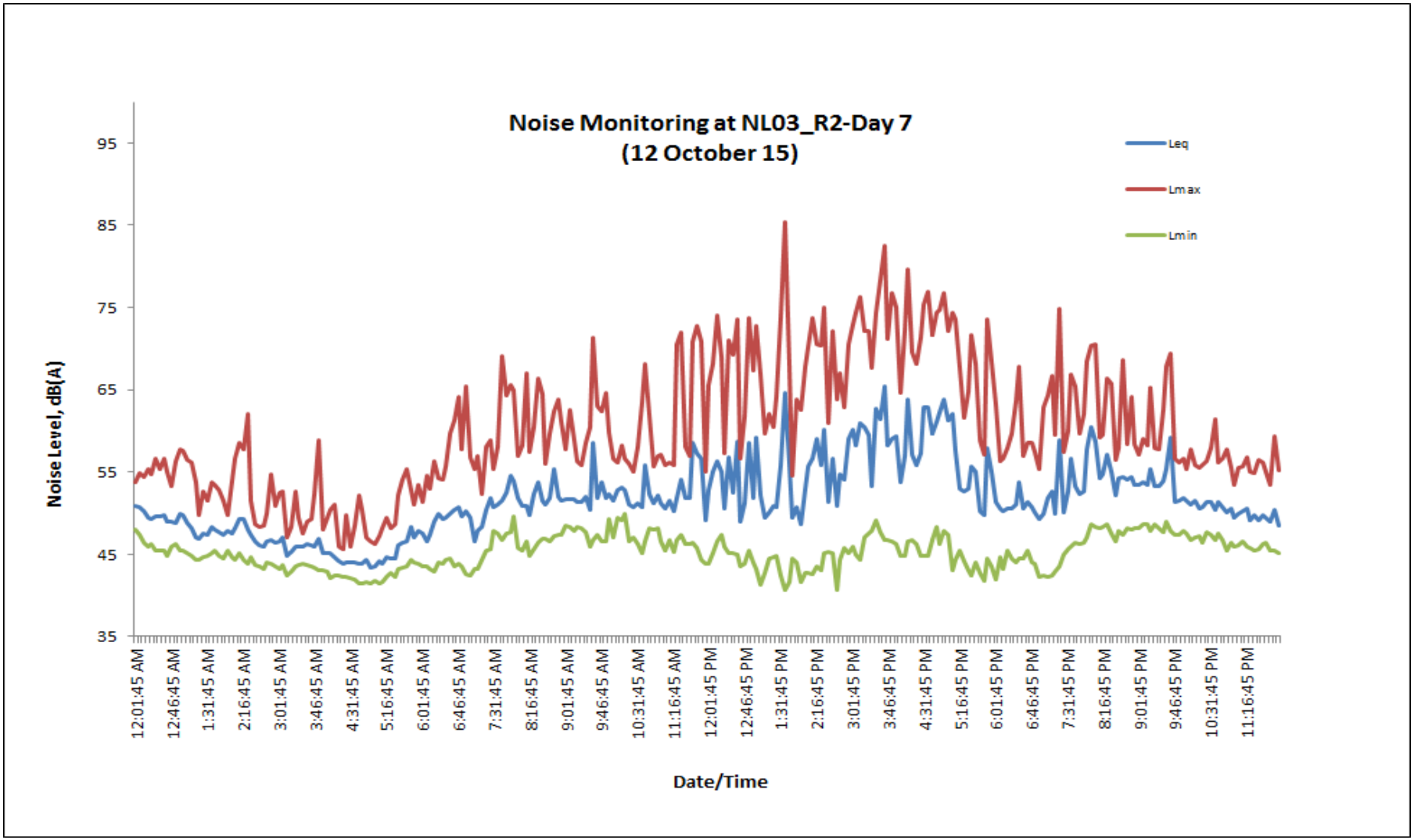

Figure 16: Daily noise level measured at Point NL03_R2 (Day 7)

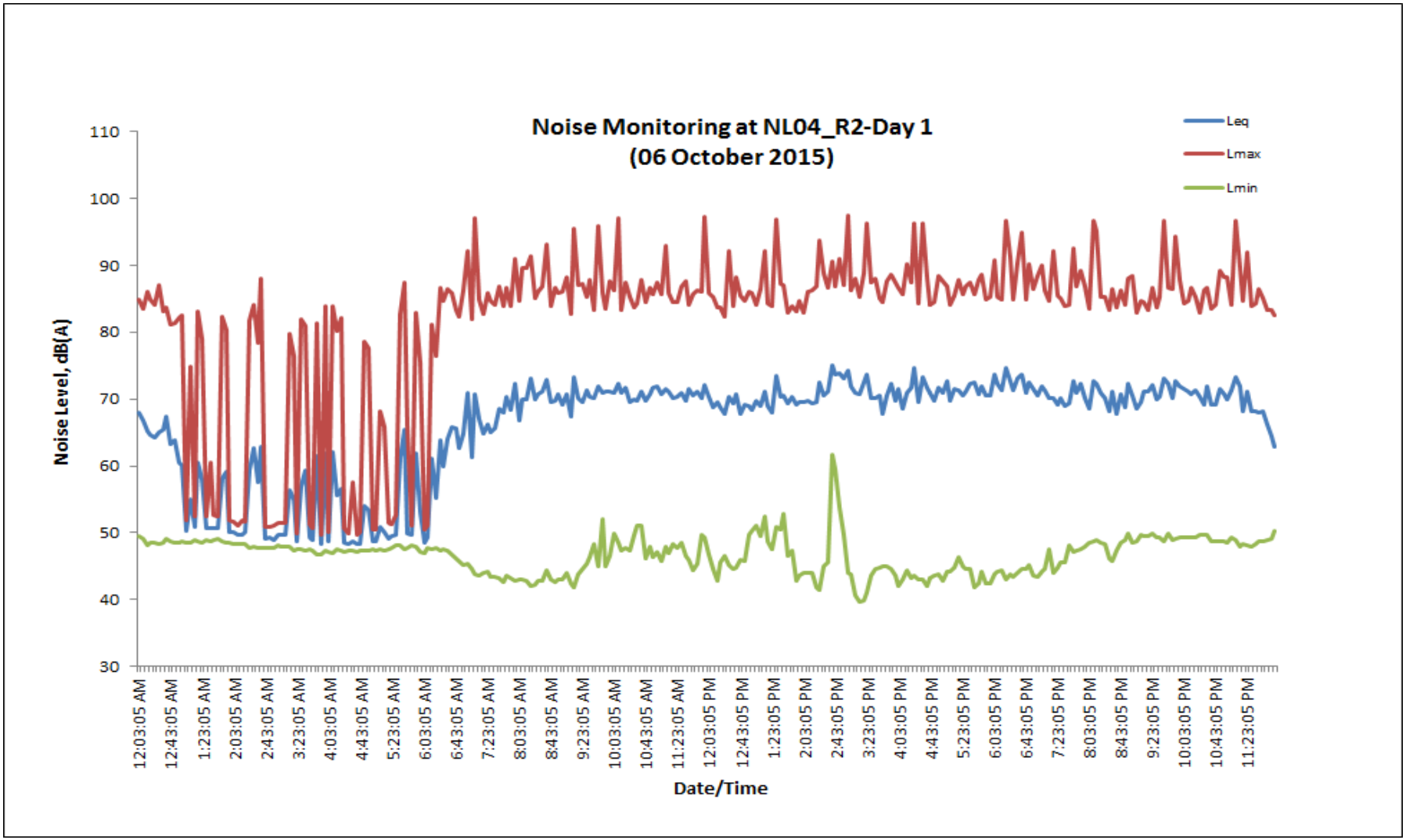

Figure 17: Daily noise level measured at Point NL04_R2 (Day 1)

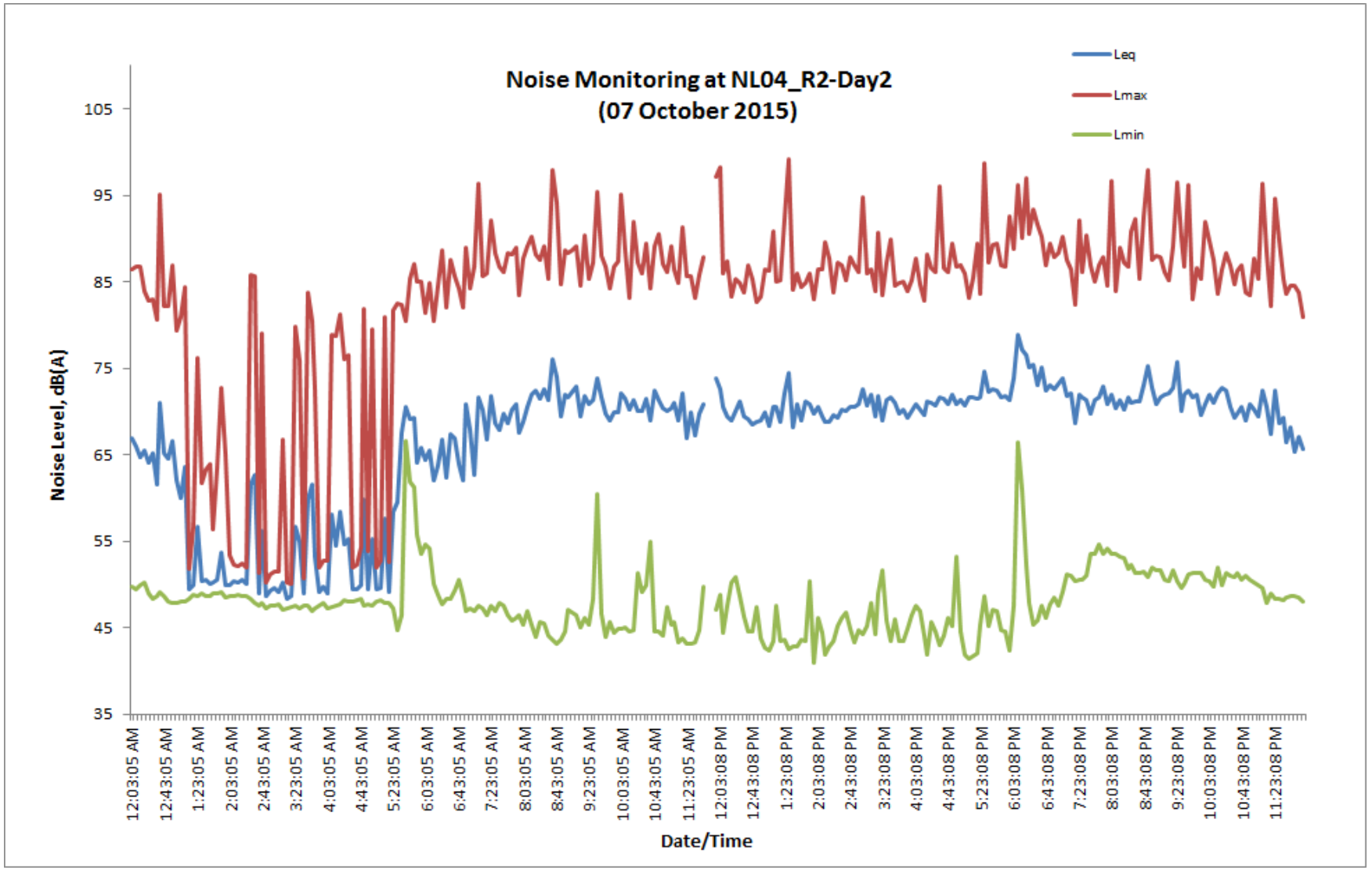

Figure 18: Daily noise level measured at Point NL04_R2 (Day 2)

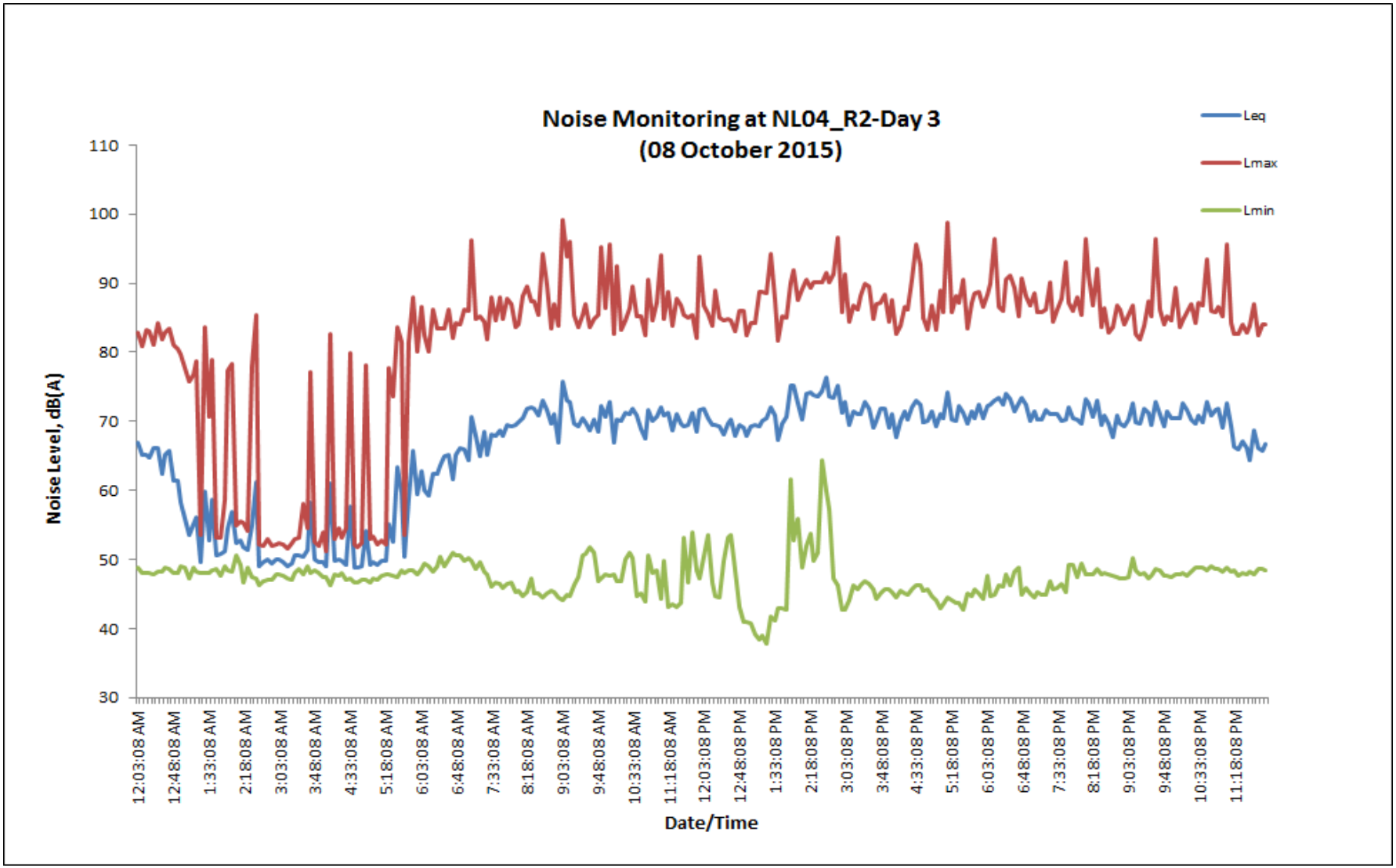

Figure 19: Daily noise level measured at Point NL04_R2 (Day 3)

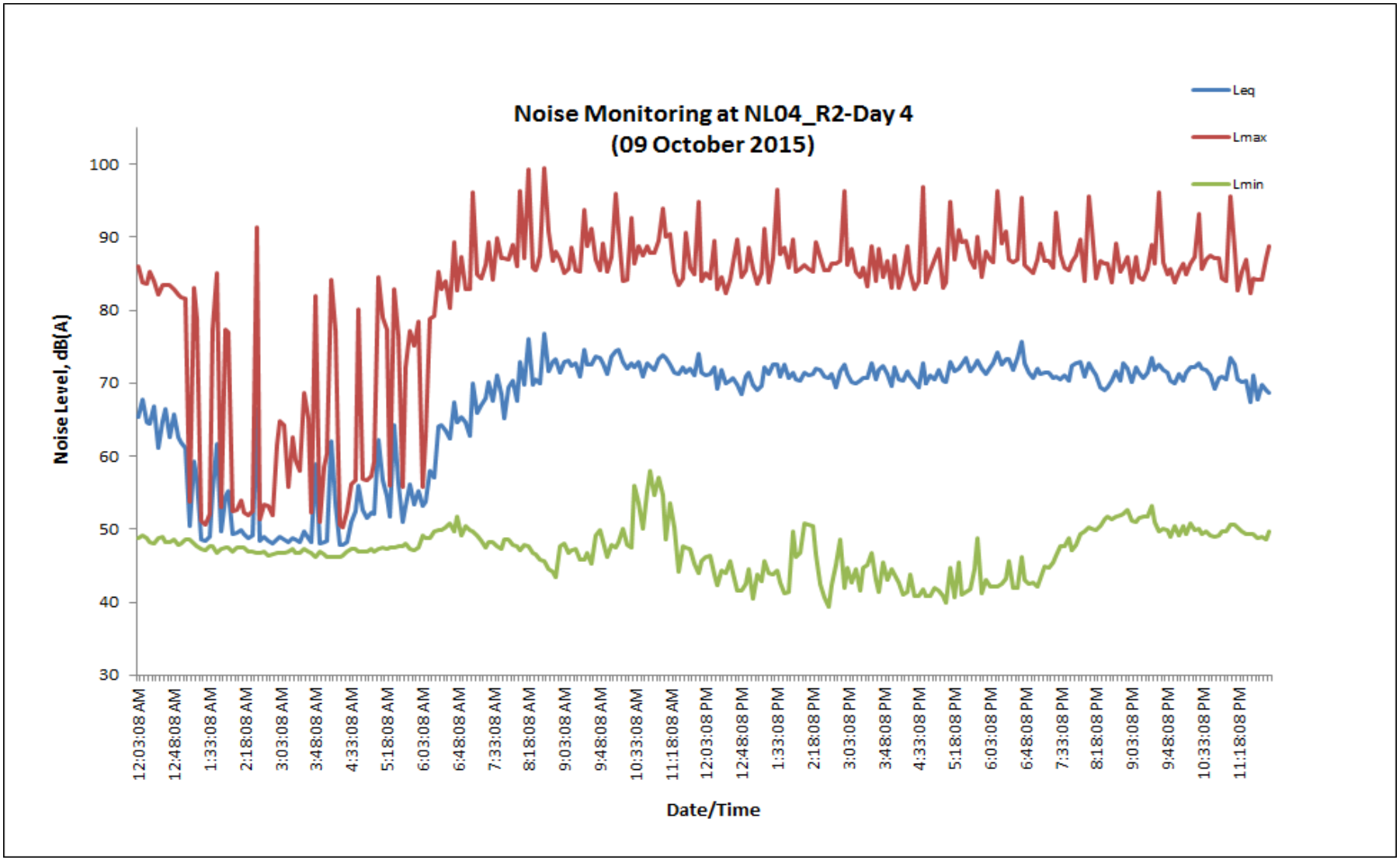

Figure 20: Daily noise level measured at Point NL04_R2 (Day 4)

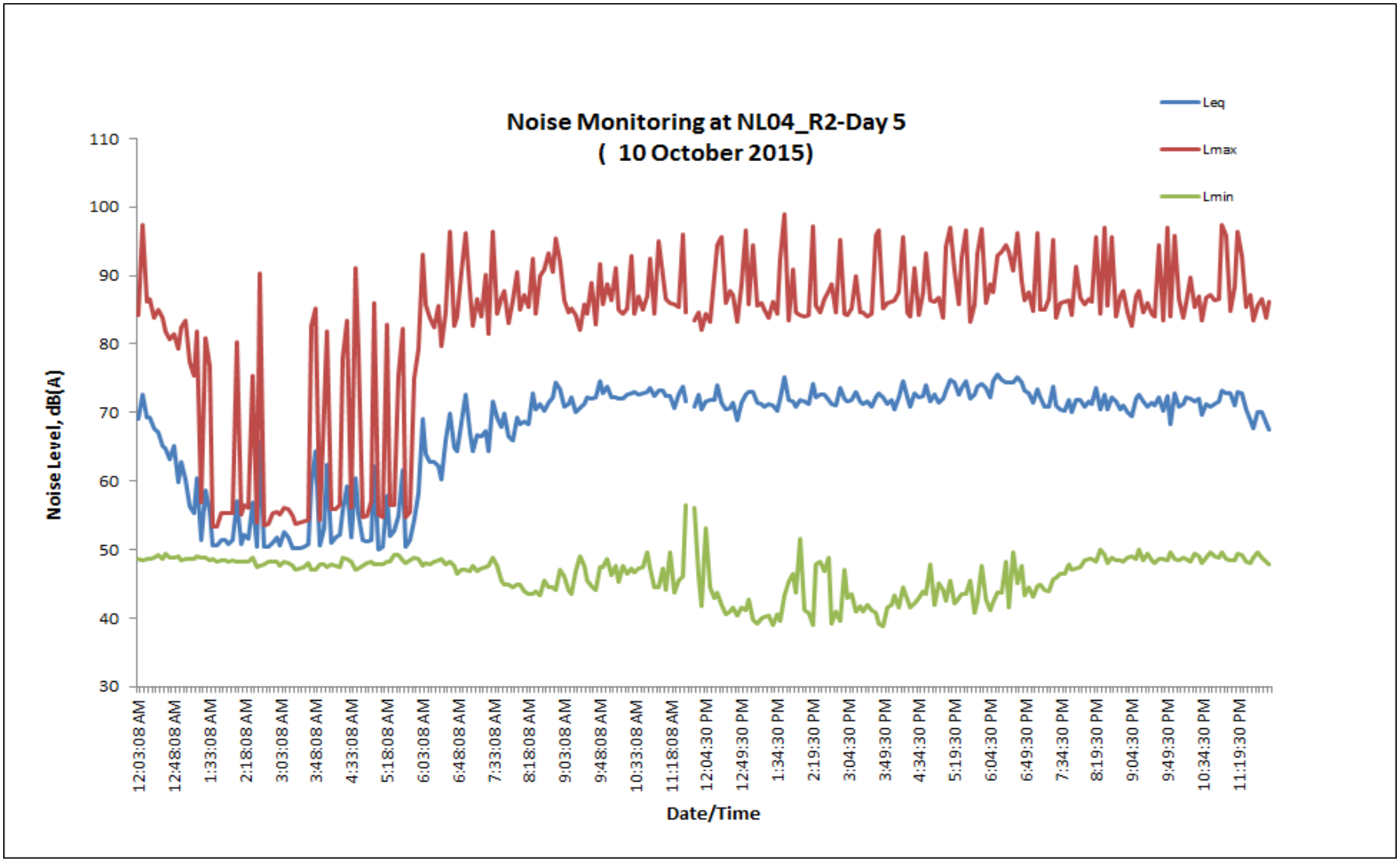

Figure 21: Daily noise level measured at Point NL04_R2 (Day 5)

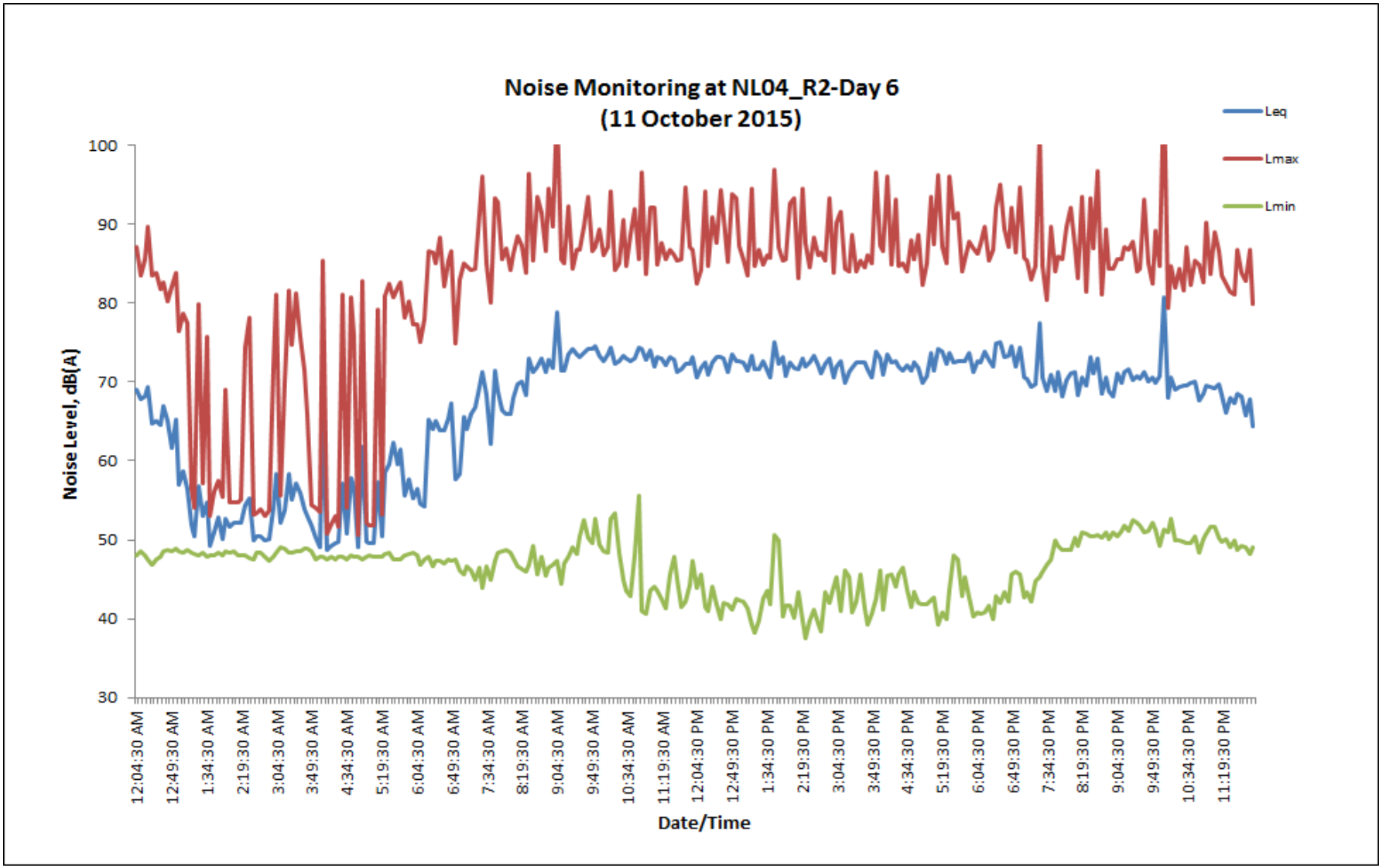

Figure 22: Daily noise level measured at Point NL04_R2 (Day 6)

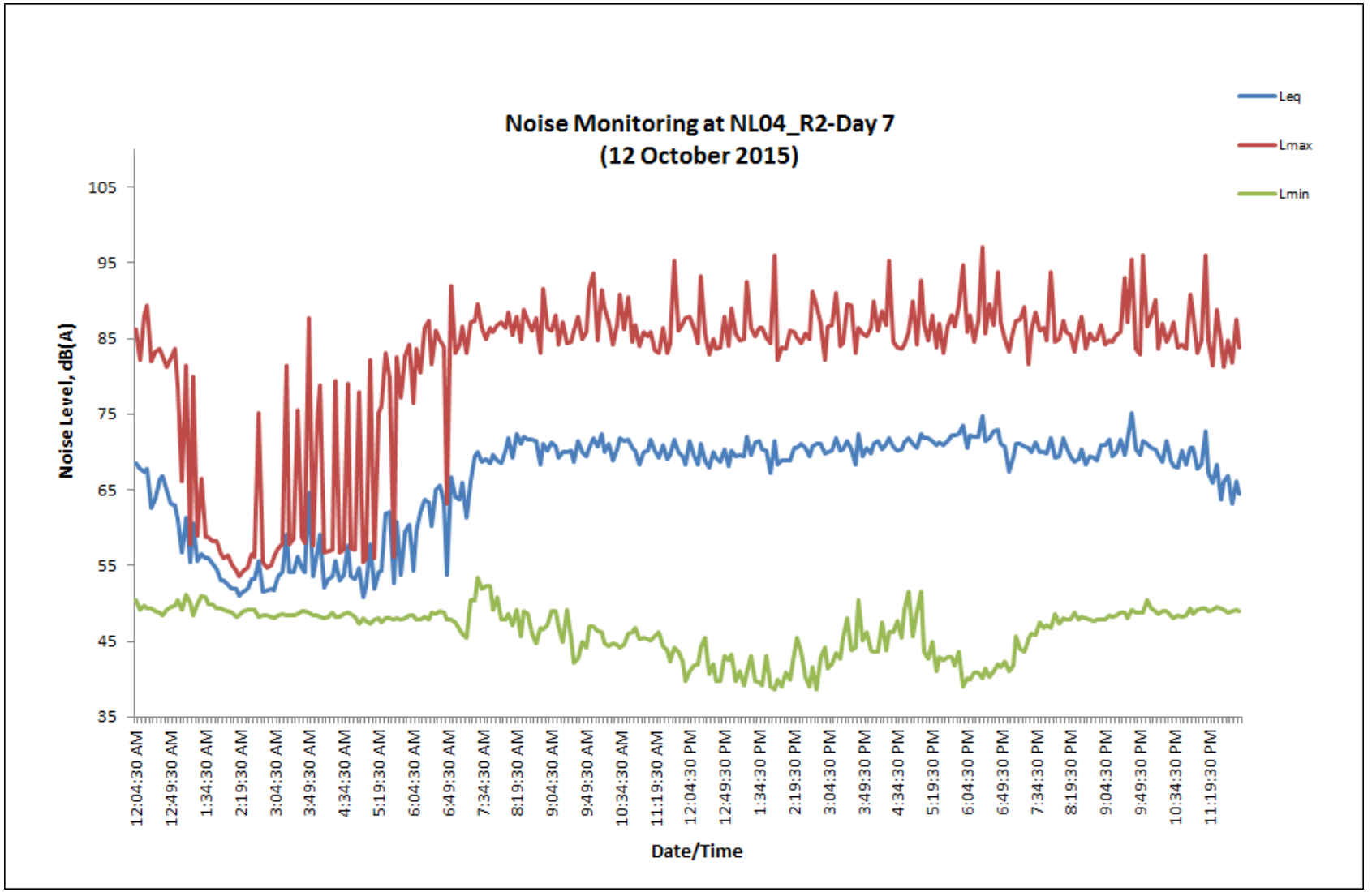

Figure 23: Daily noise level measured at Point NL04_R2 (Day 7)

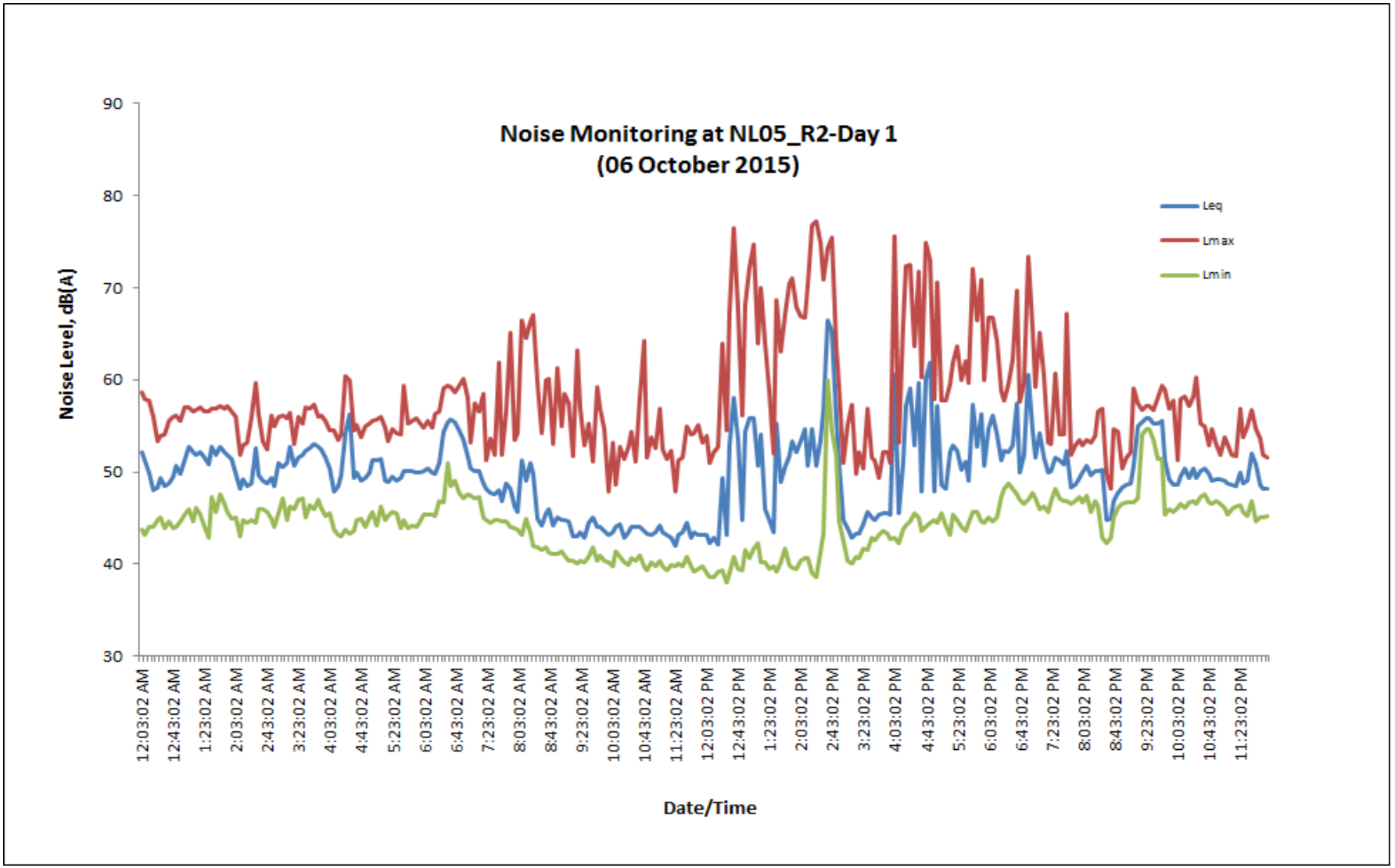

Figure 24: Daily noise level measured at Point NL05_R2 (Day 1)

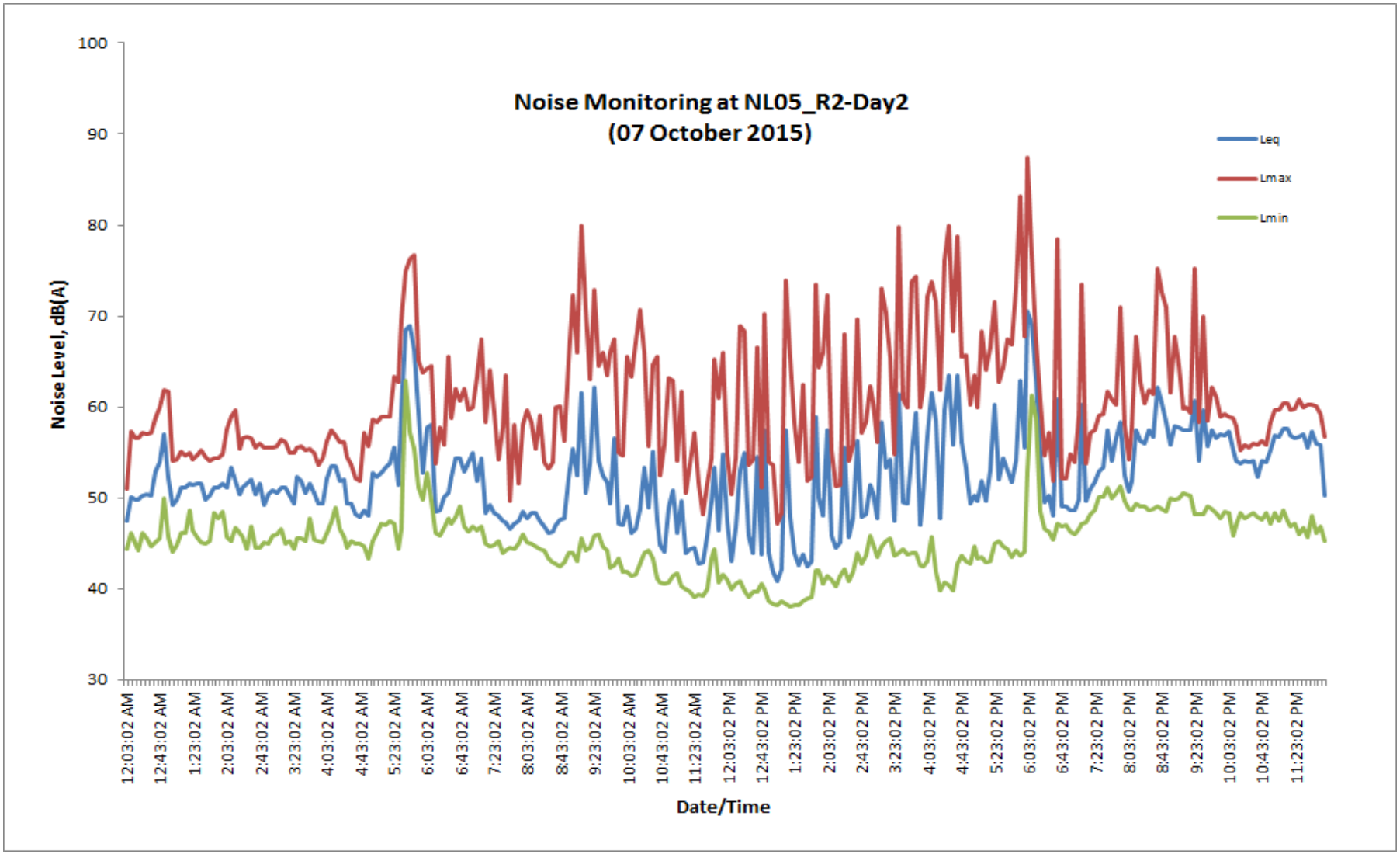

Figure 25: Daily noise level measured at Point NL05_R2 (Day 2)

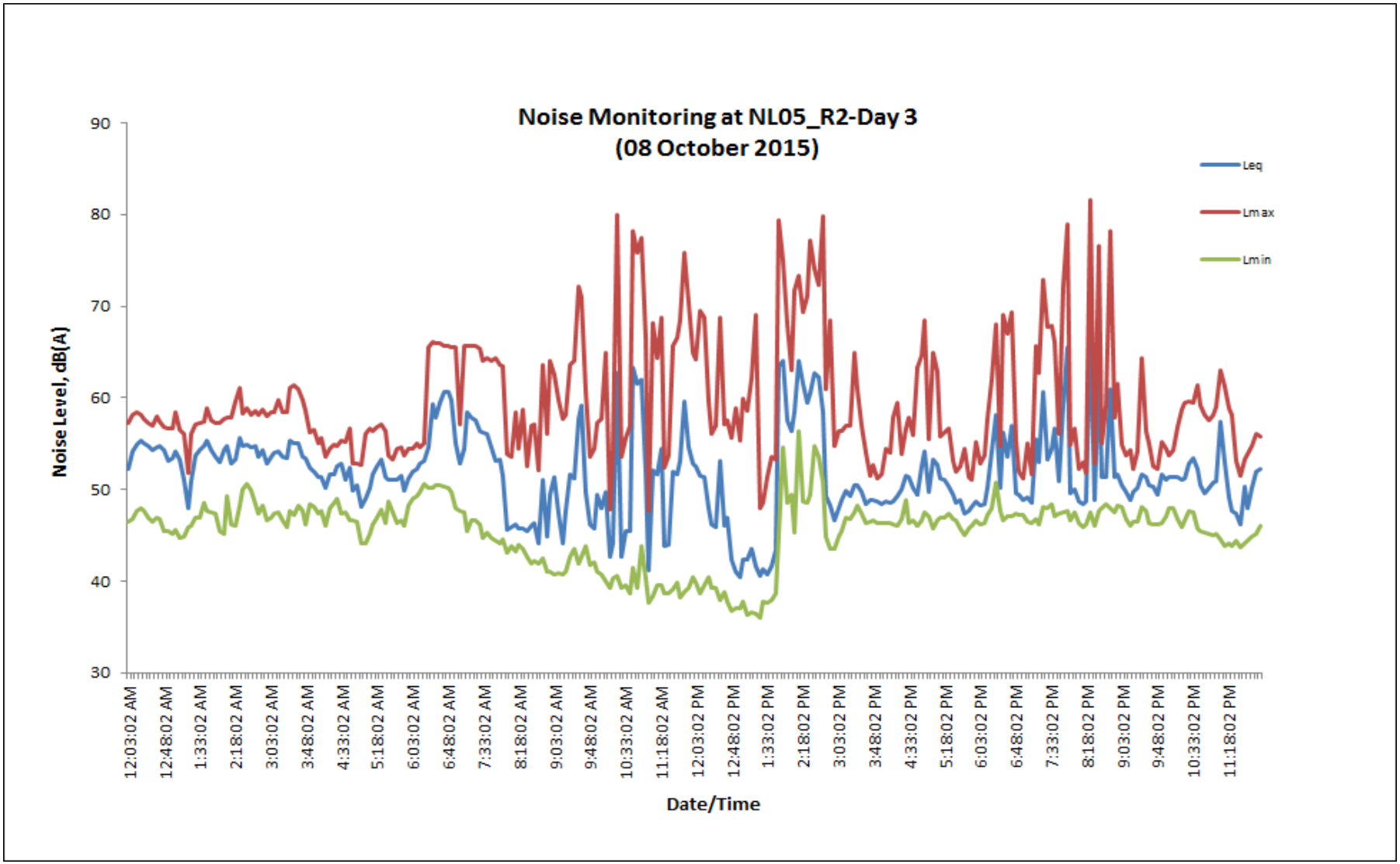

Figure 26: Daily noise level measured at Point NL05_R2 (Day 3)

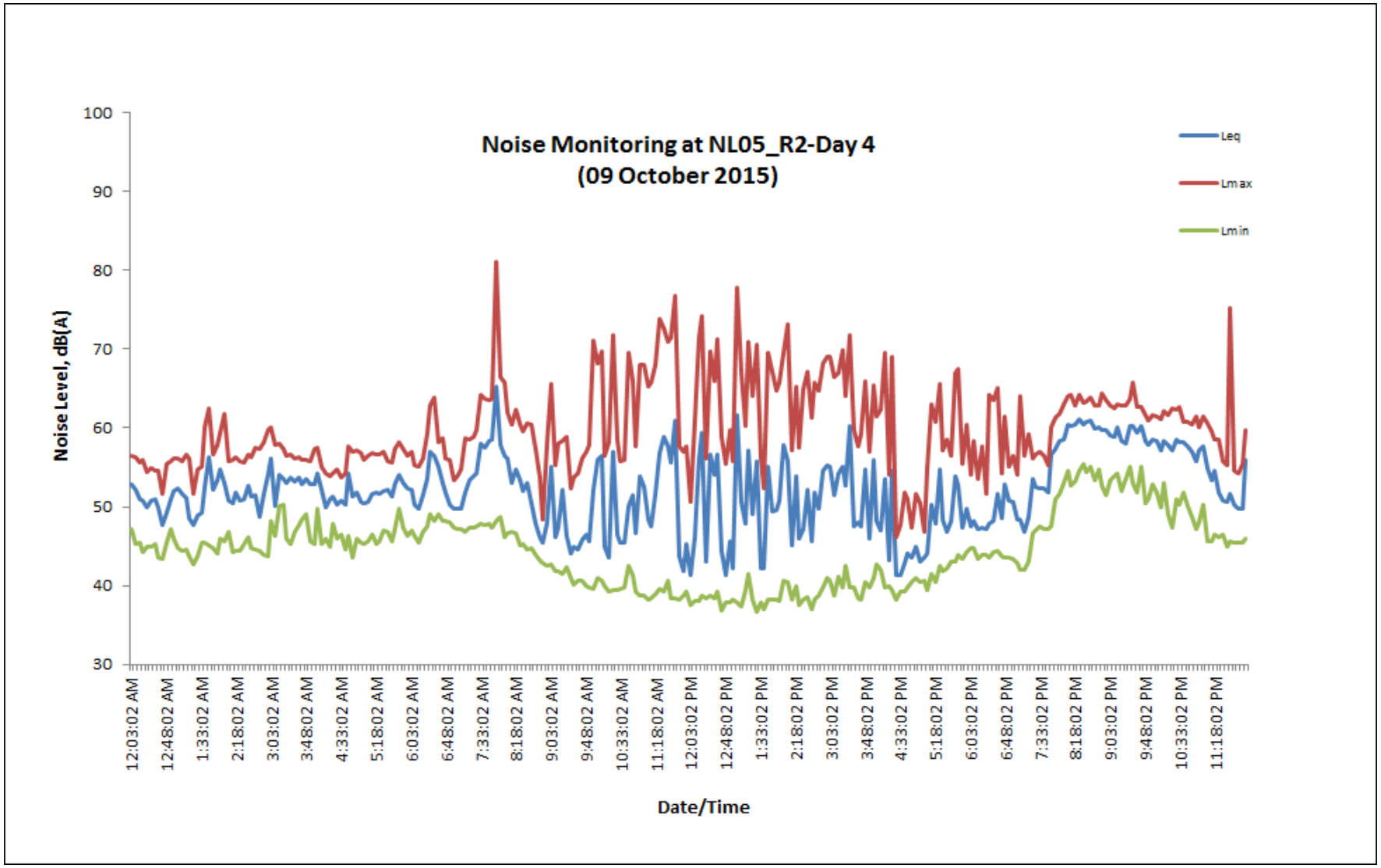

Figure 27: Daily noise level measured at Point NL05_R2 (Day 4)

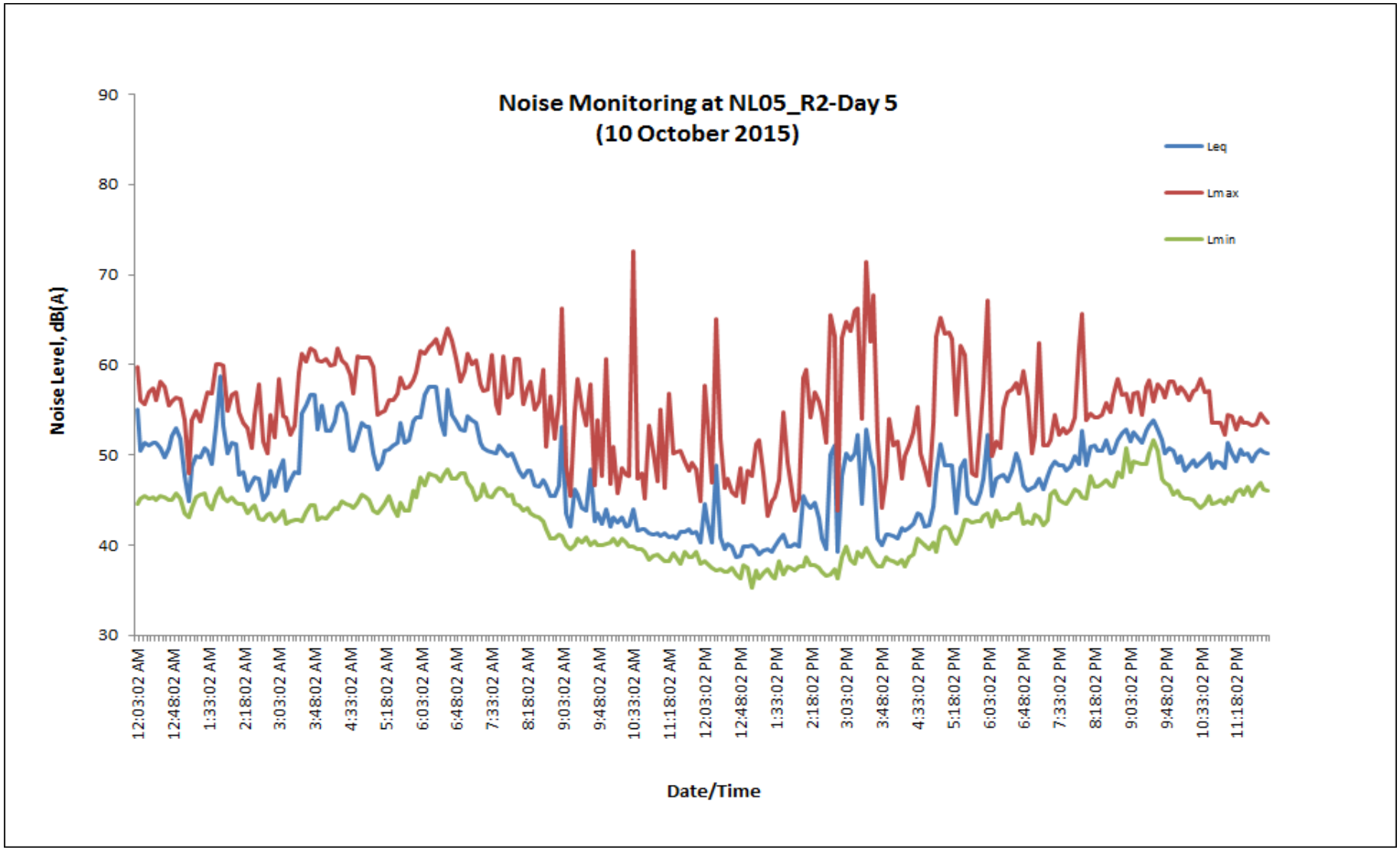

Figure 28: Daily noise level measured at Point NL05_R2 (Day 5)

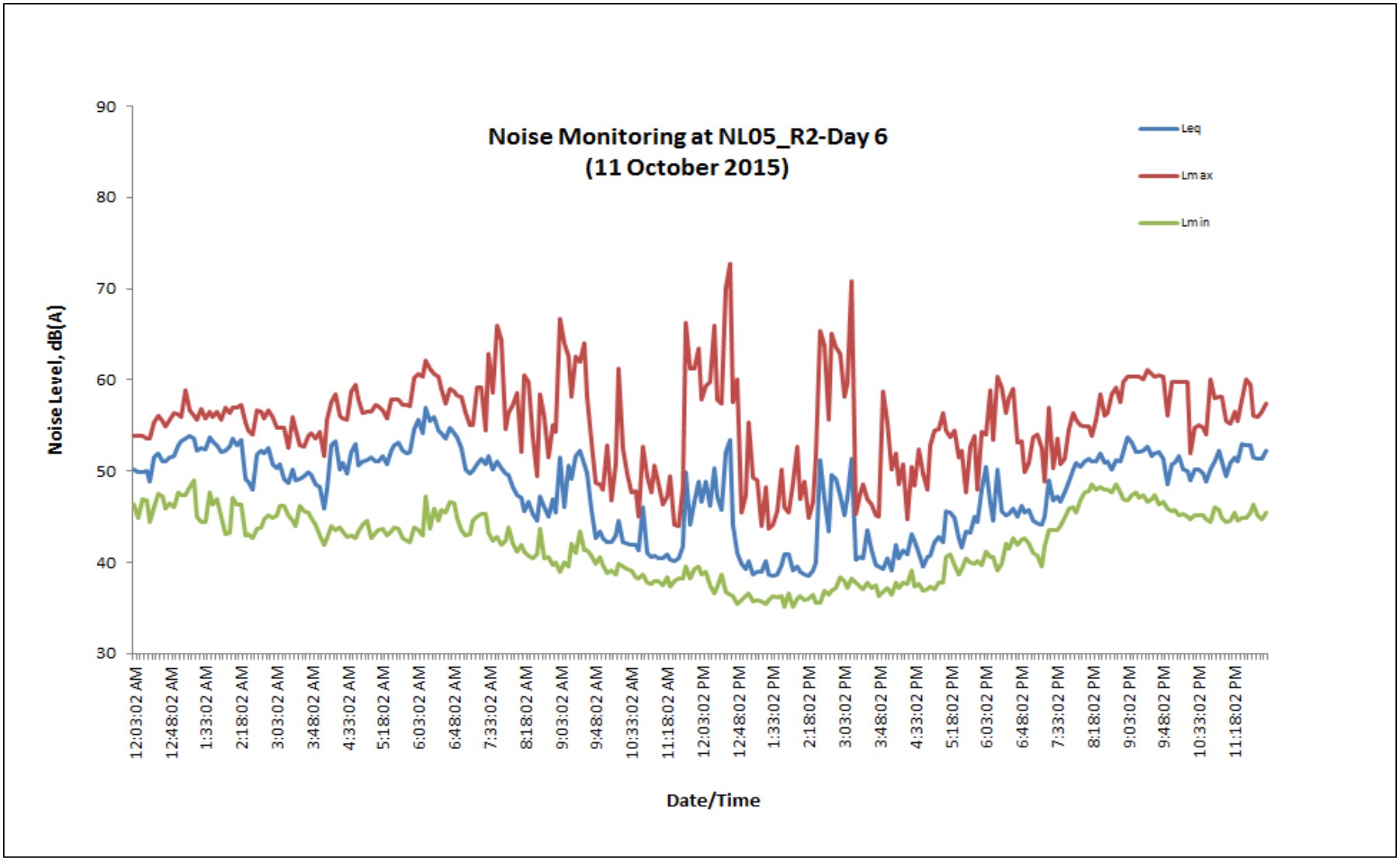

Figure 29: Daily noise level measured at Point NL05_R2 (Day 6)

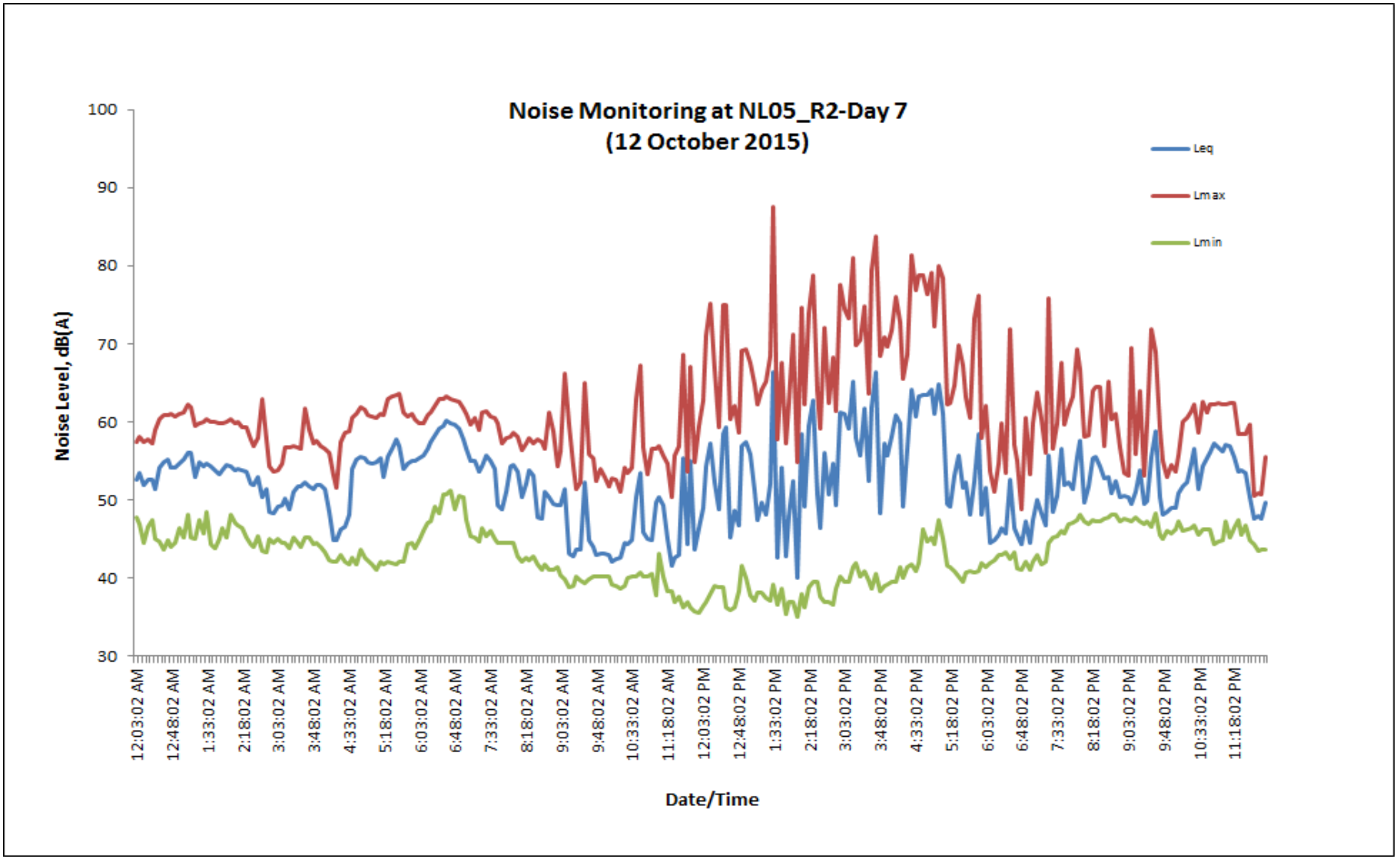

Figure 30: Daily noise level measured at Point NL05_R2 (Day 7)

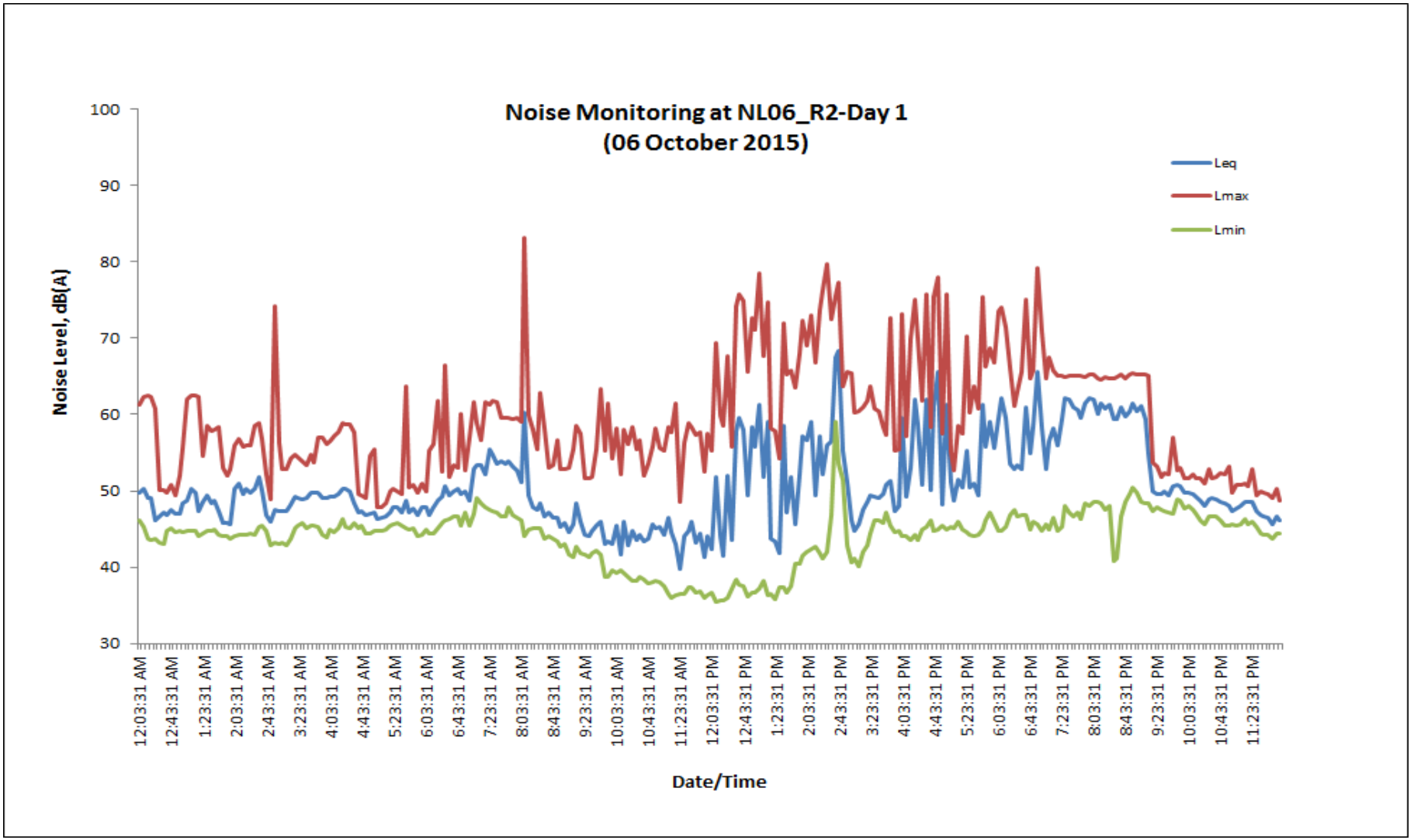

Figure 31: Daily noise level measured at Point NL06_R2 (Day 1)

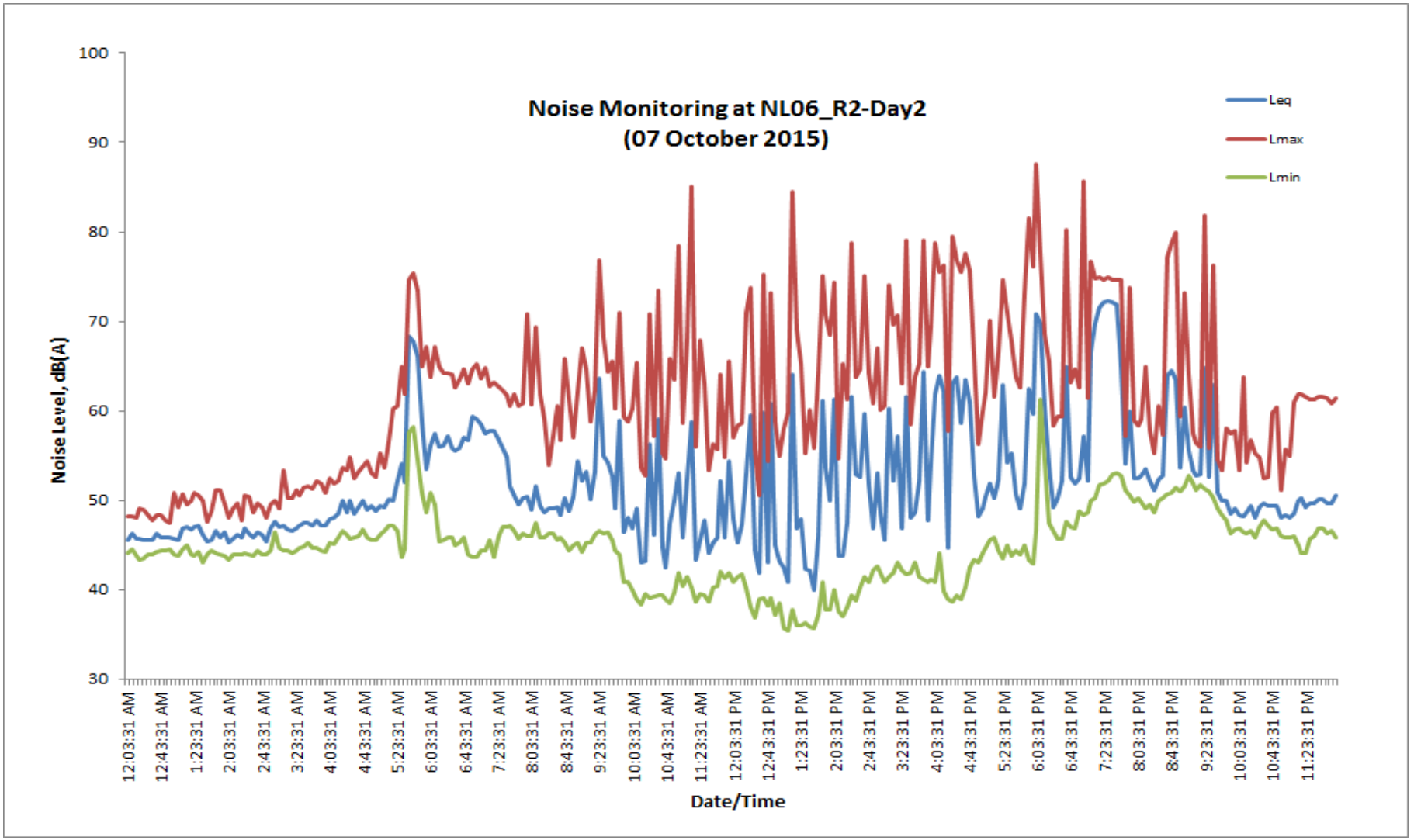

Figure 32: Daily noise level measured at Point NL06_R2 (Day 2)

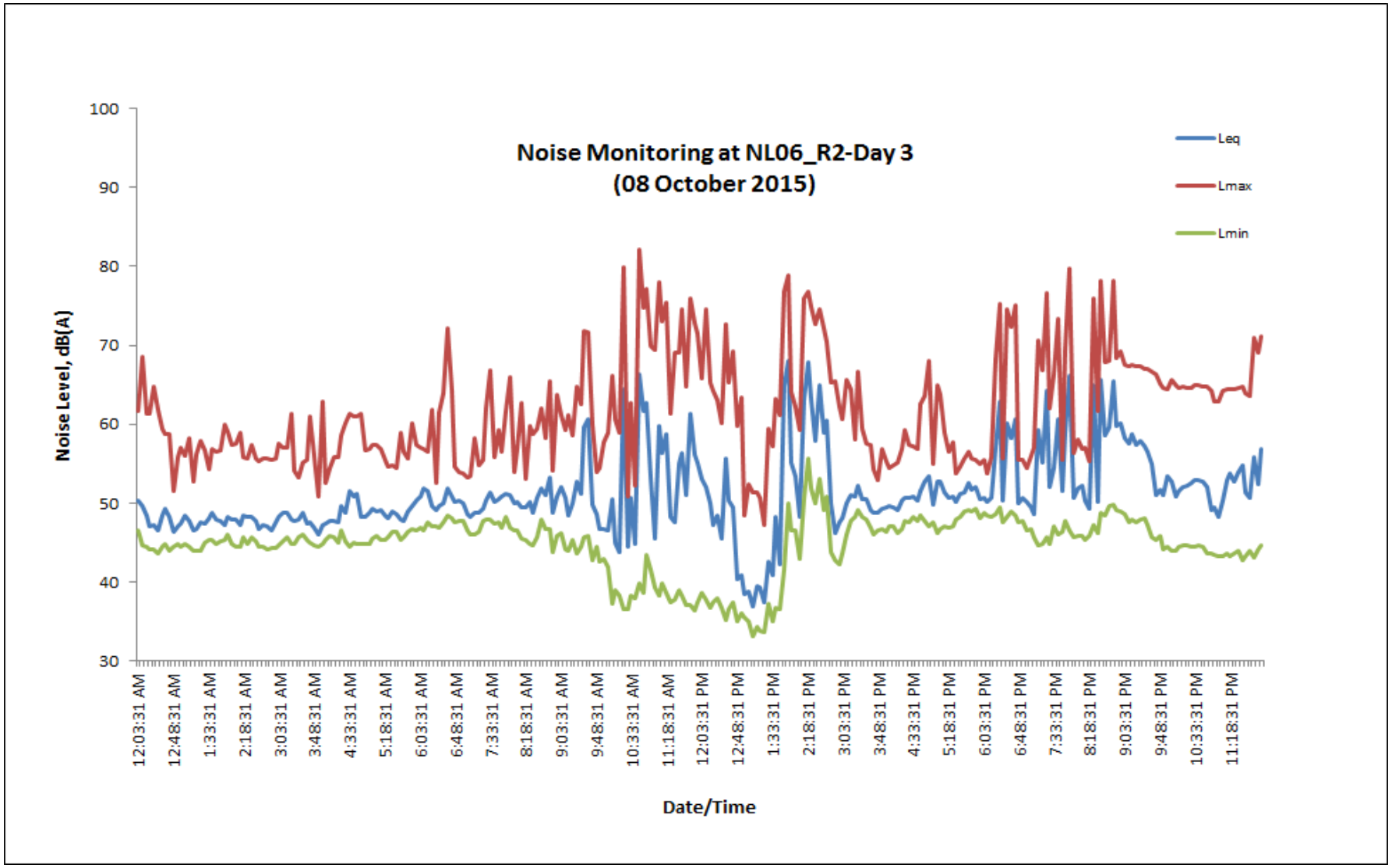

Figure 33: Daily noise level measured at Point NL06_R2 (Day 3)

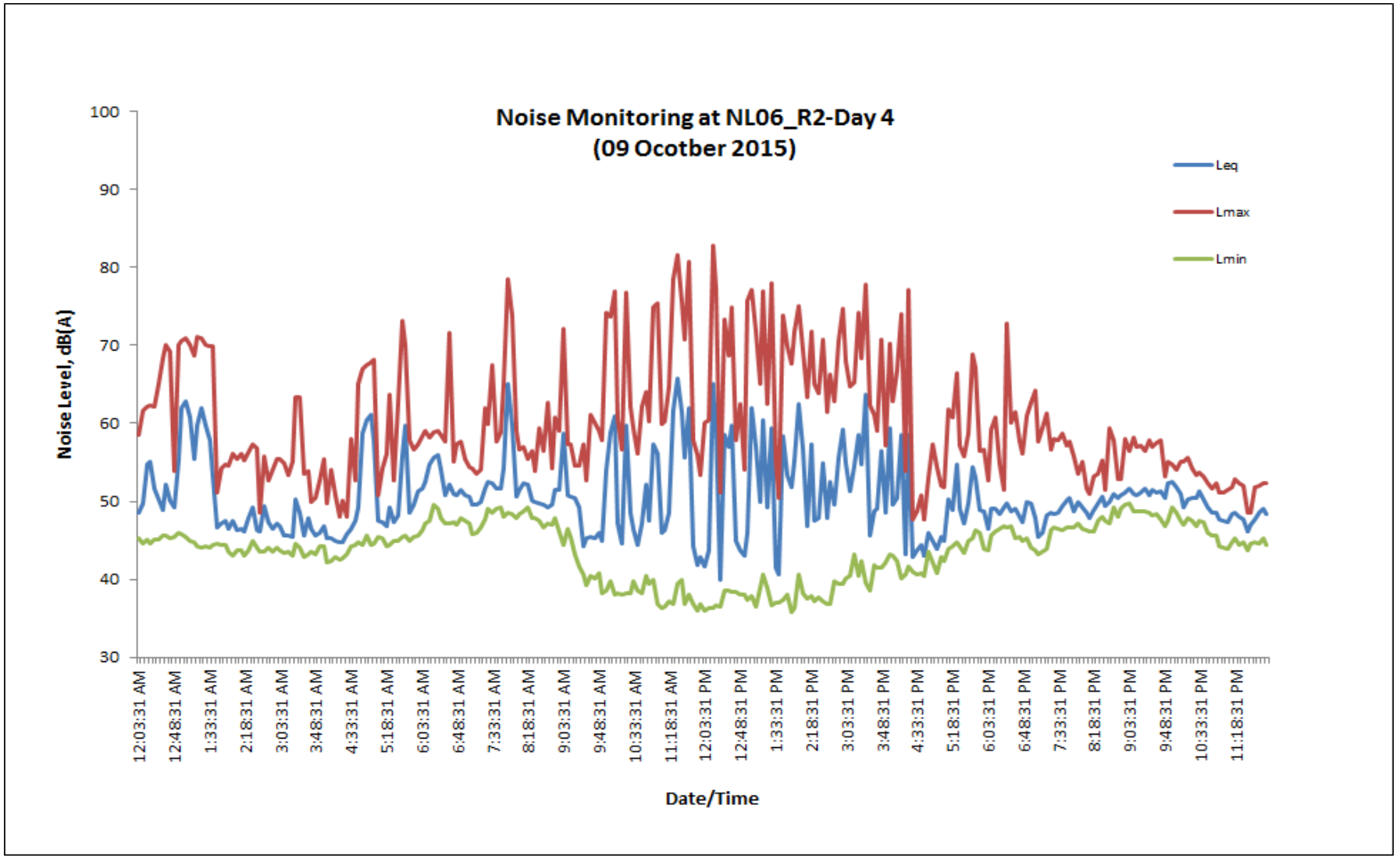

Figure 34: Daily noise level measured at Point NL06_R2 (Day 4)

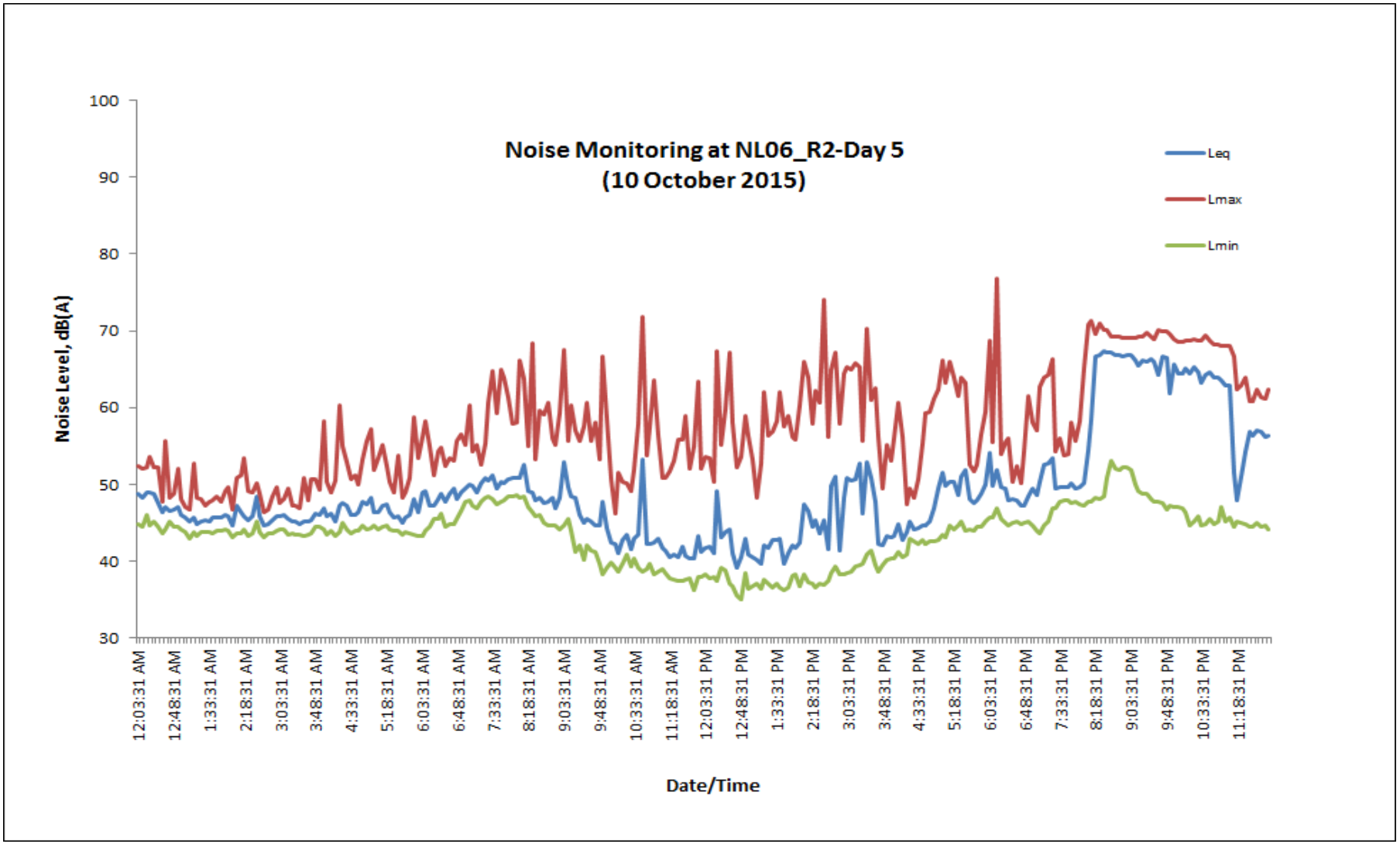

Figure 35: Daily noise level measured at Point NL06_R2 (Day 5)

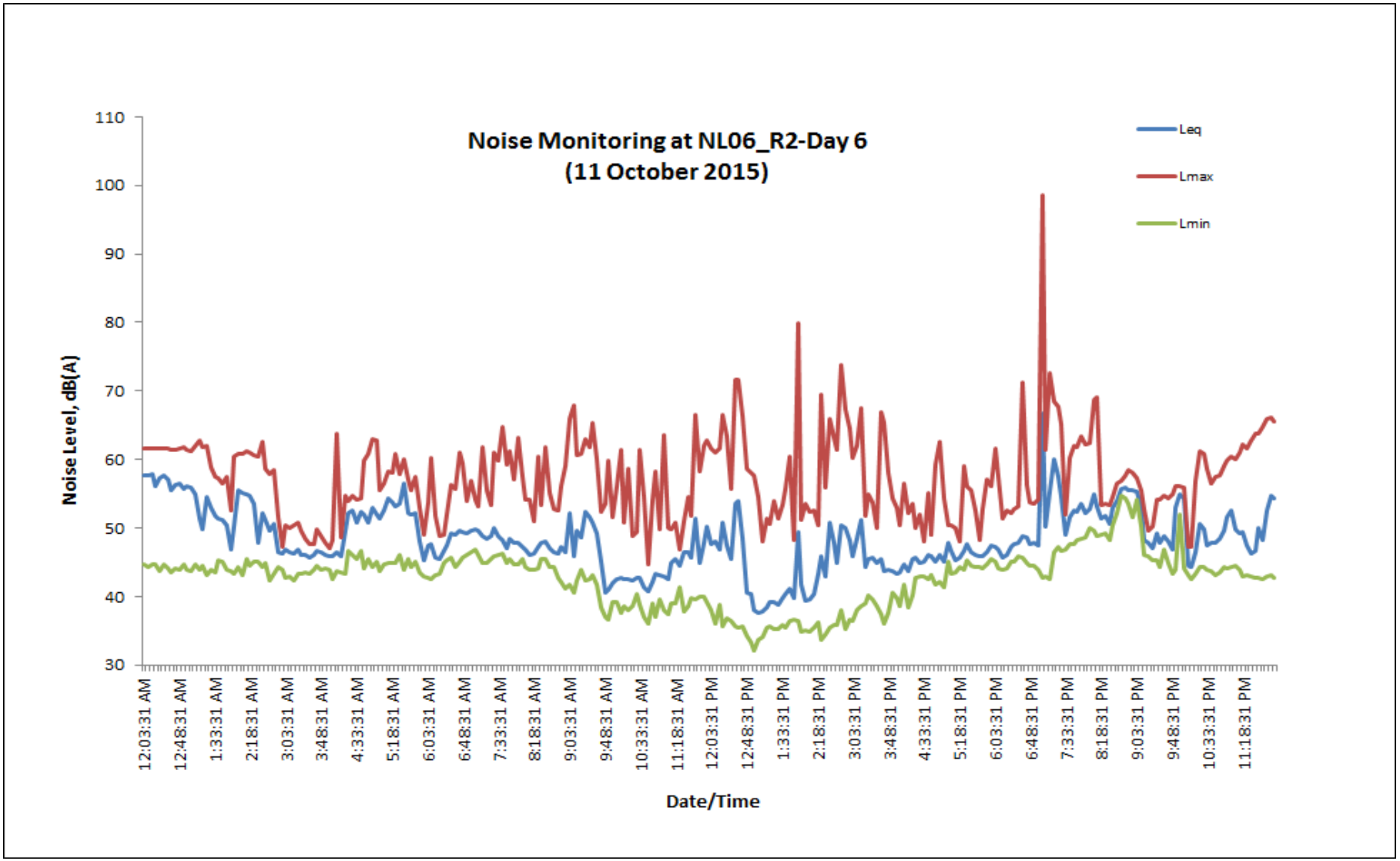

Figure 36: Daily noise level measured at Point NL06_R2 (Day 6)

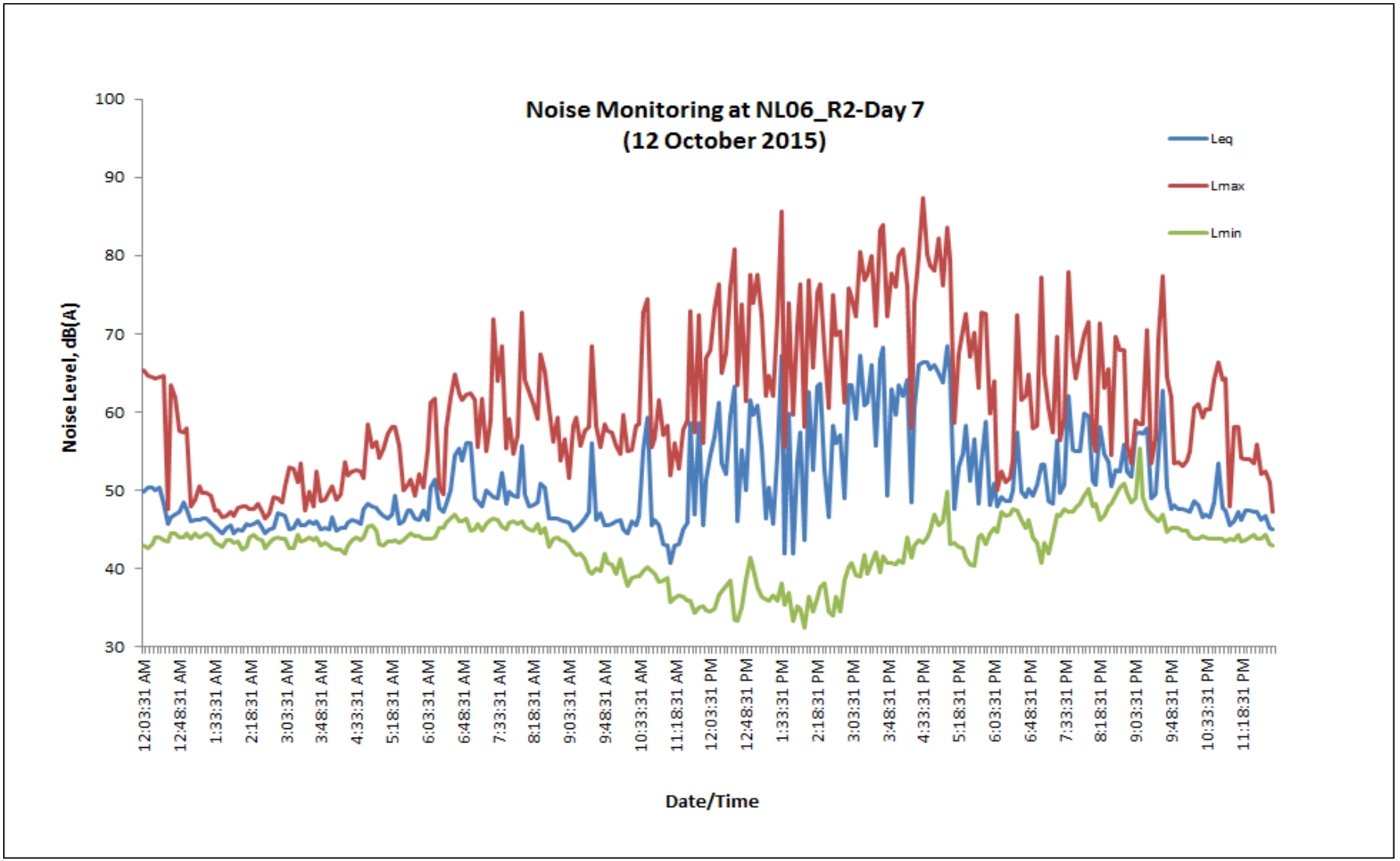

Figure 37: Daily noise level measured at Point NL06_R2 (Day 7)

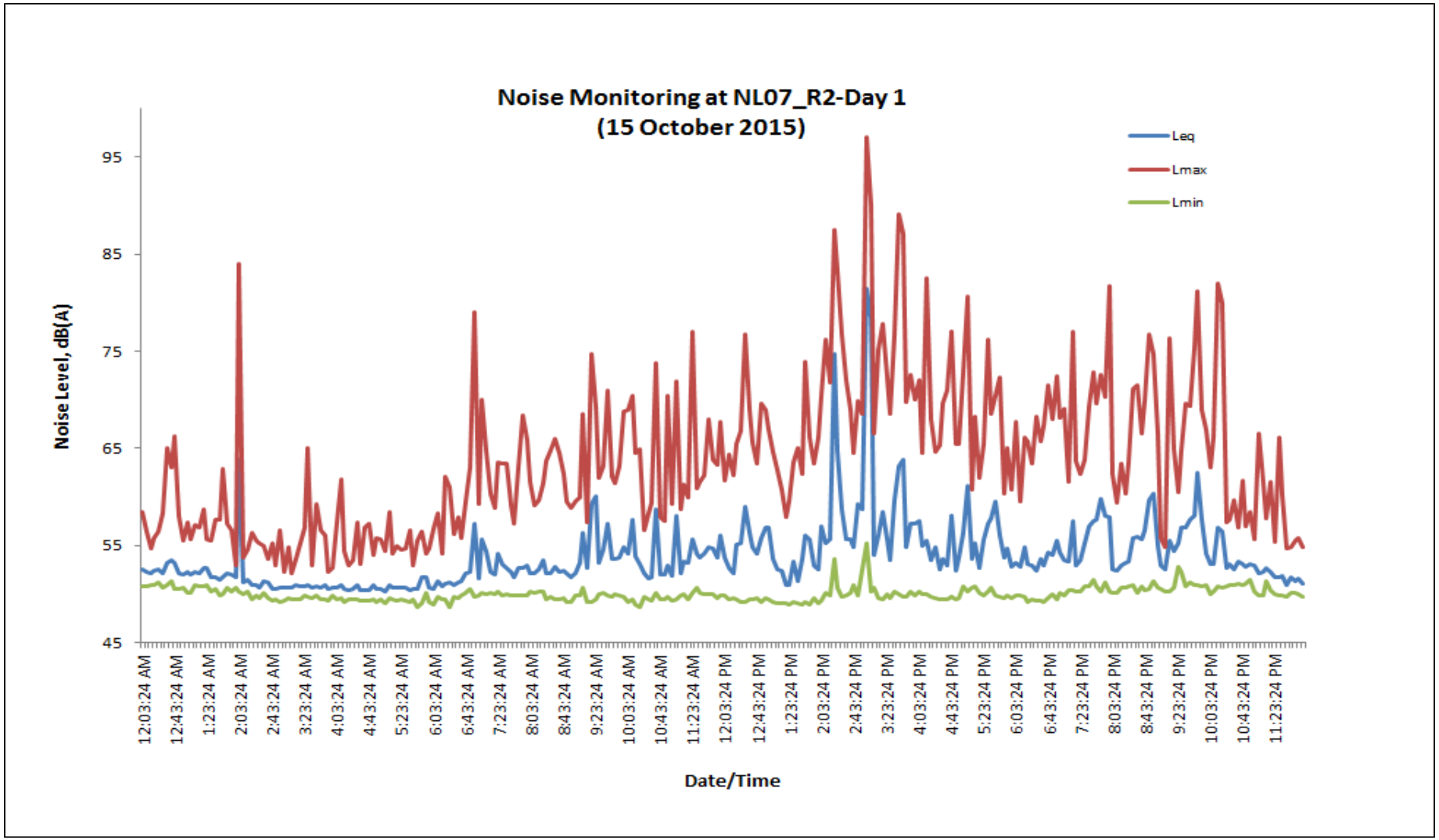

Figure 38: Daily noise level measured at Point NL07_R2 (Day 1)

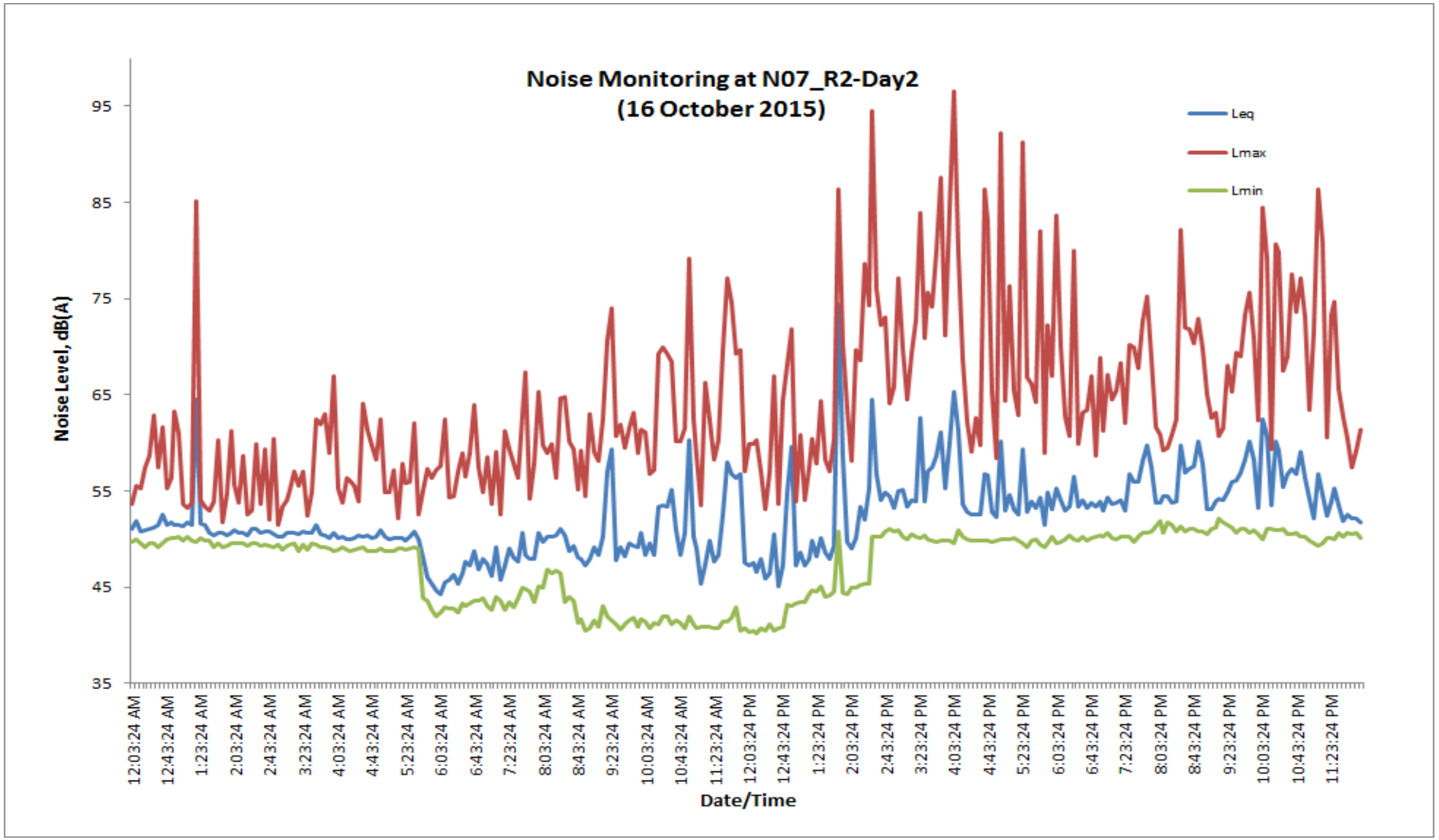

Figure 39: Daily noise level measured at Point NL07_R2 (Day 2)

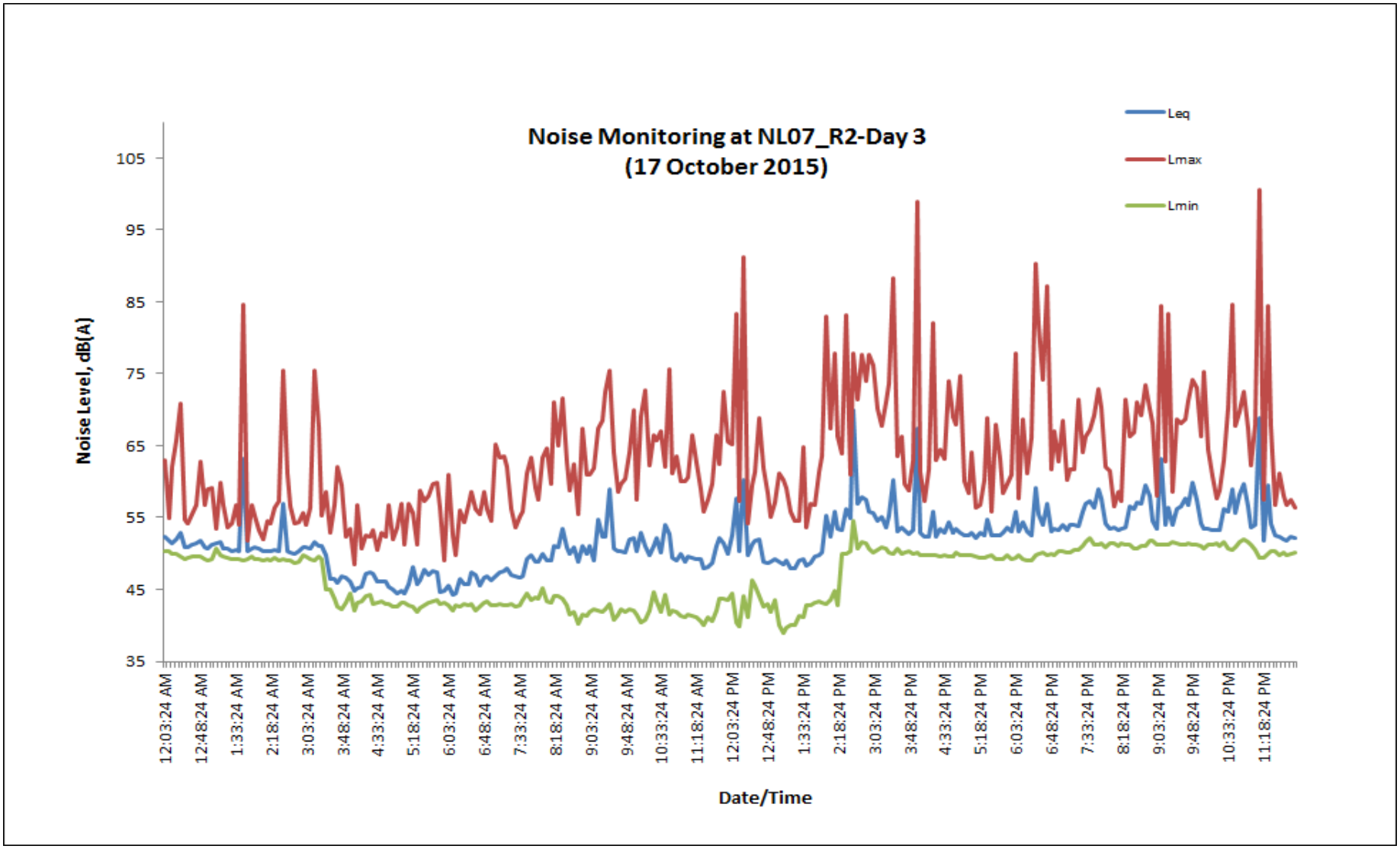

Figure 40: Daily noise level measured at Point NL07_R2 (Day 3)

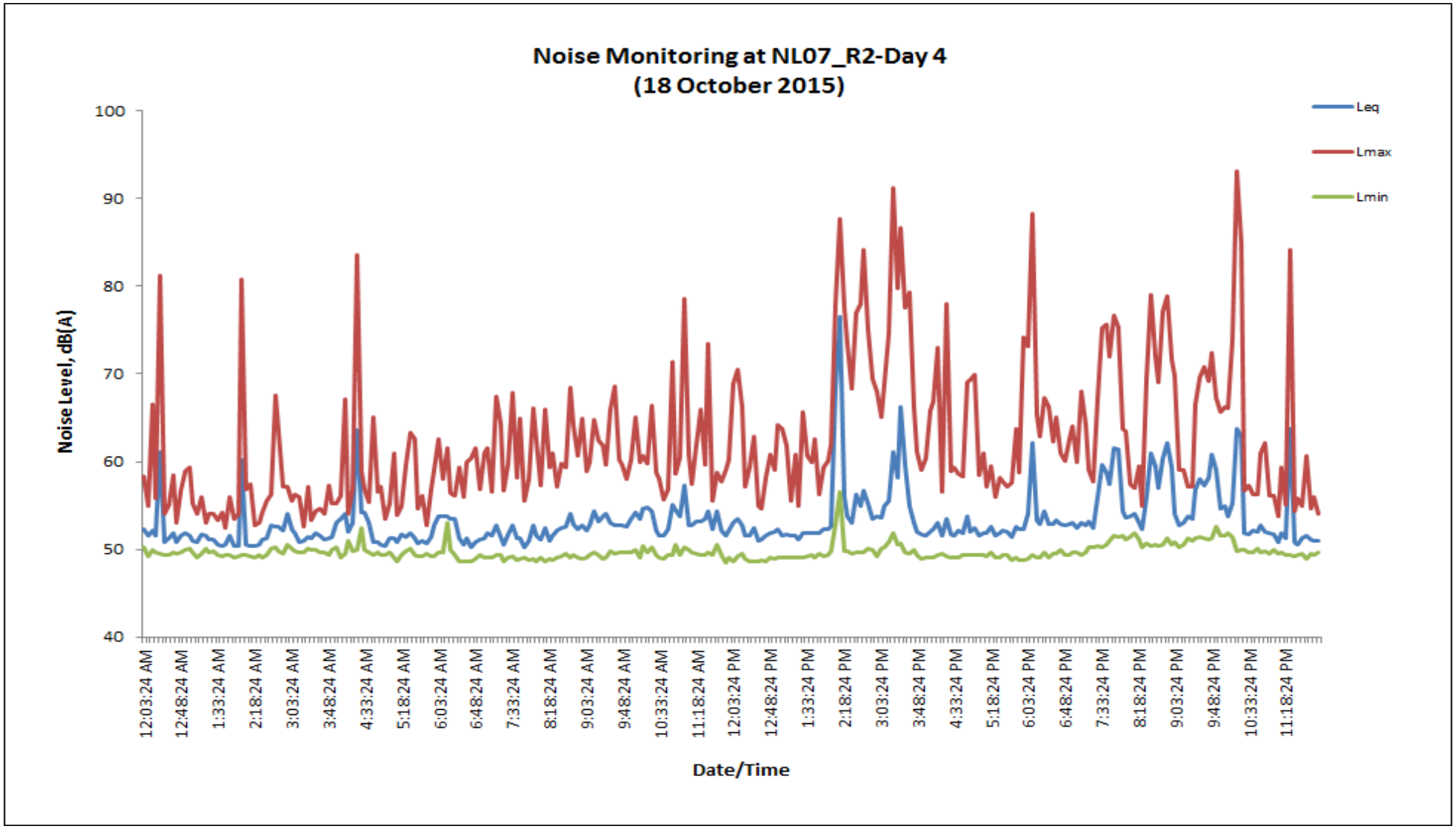

Figure 41: Daily noise level measured at Point NL07_R2 (Day 4)

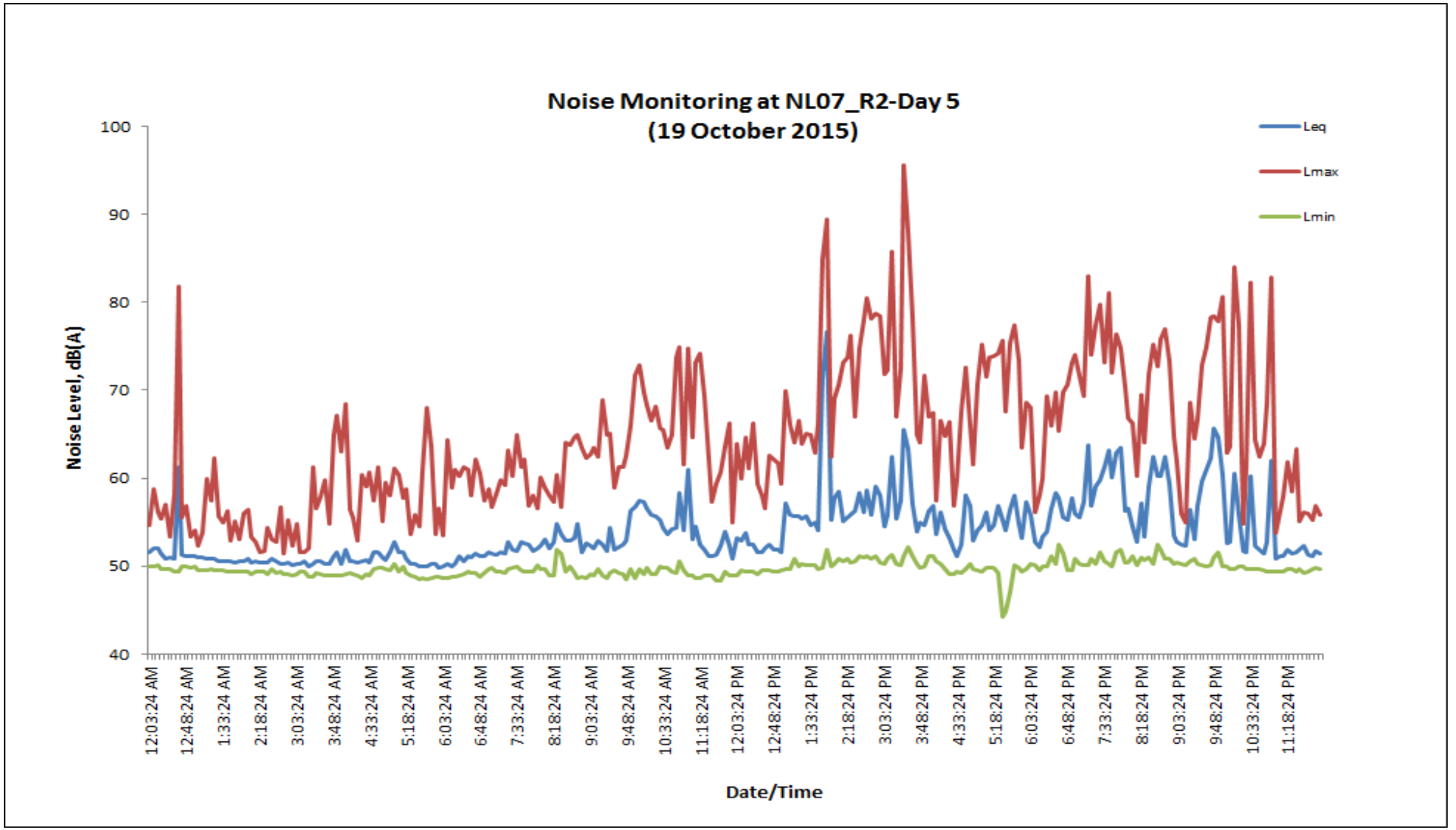

Figure 42: Daily noise level measured at Point NL07_R2 (Day 5)

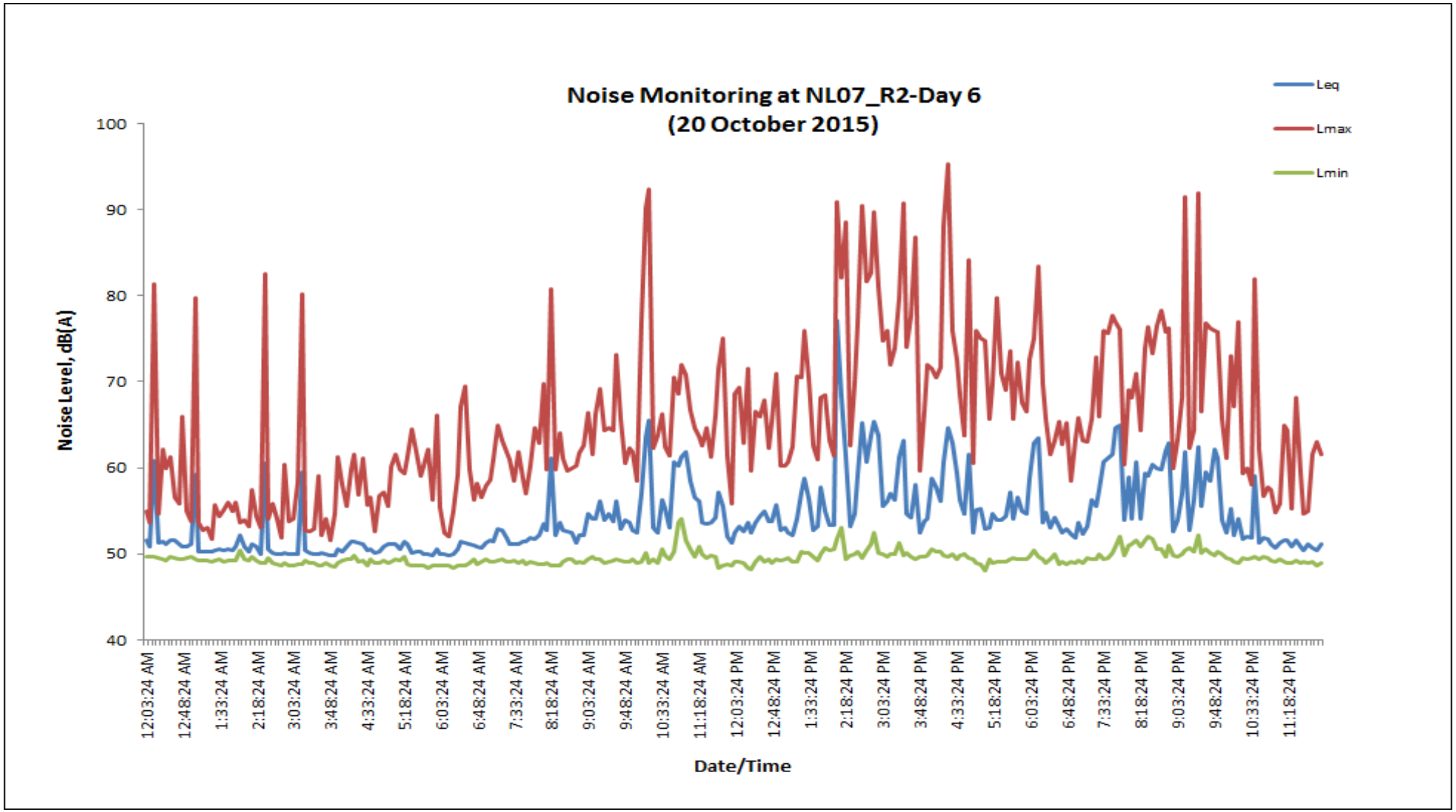

Figure 43: Daily noise level measured at Point NL07_R2 (Day 6)

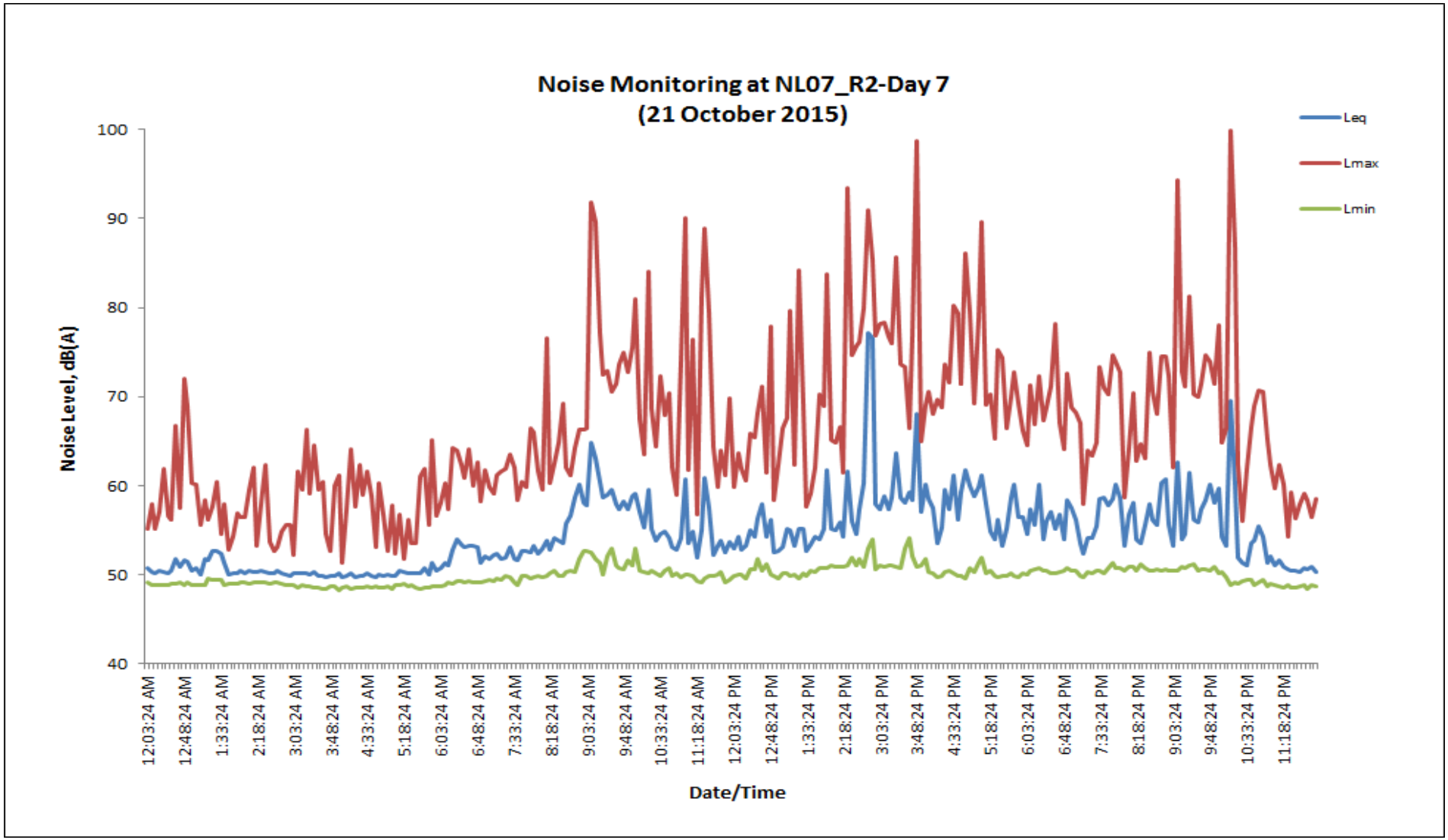

Figure 44: Daily noise level measured at Point NL07_R2 (Day 7)

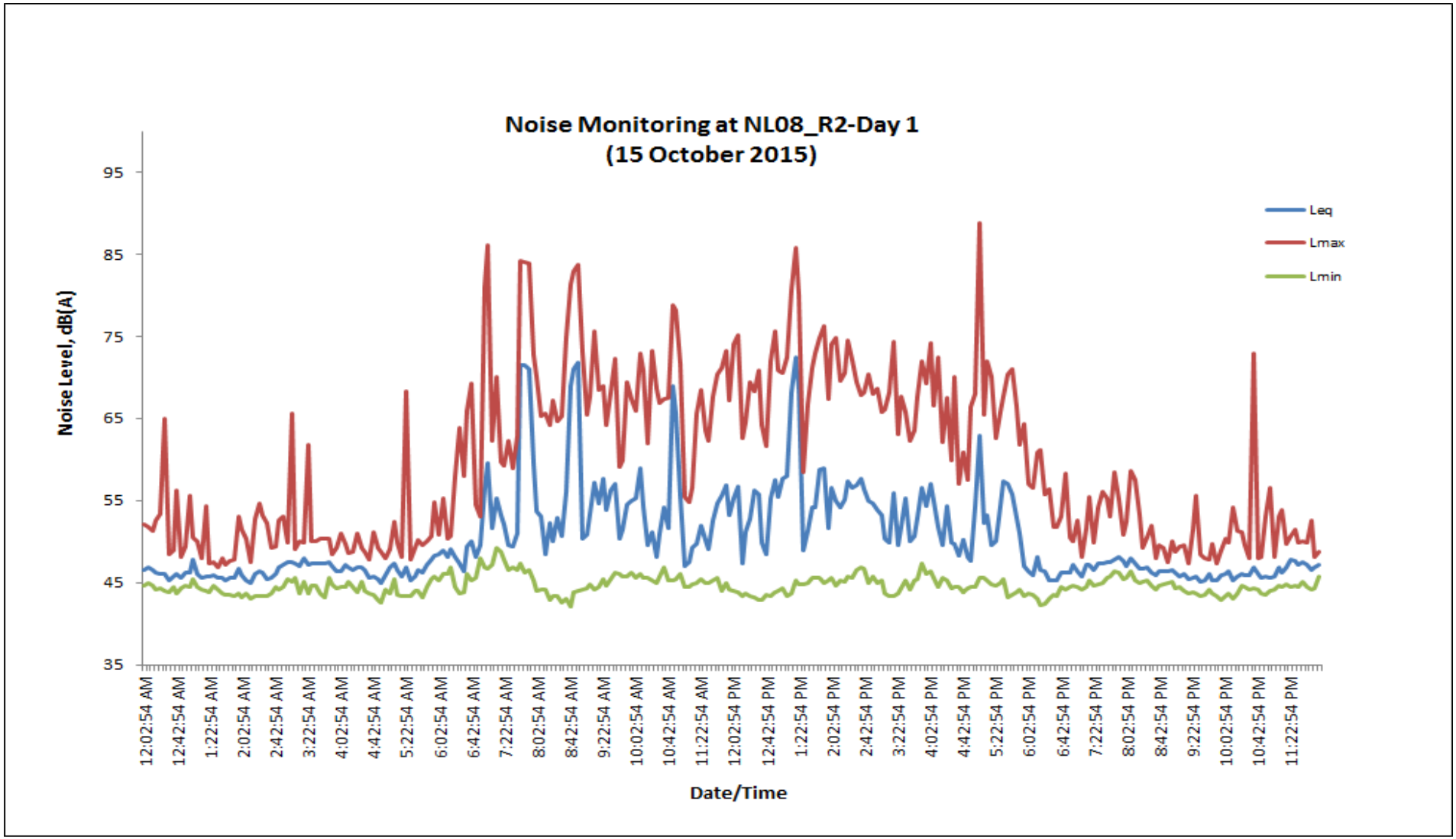

Figure 45: Daily noise level measured at Point NL08_R2 (Day 1)

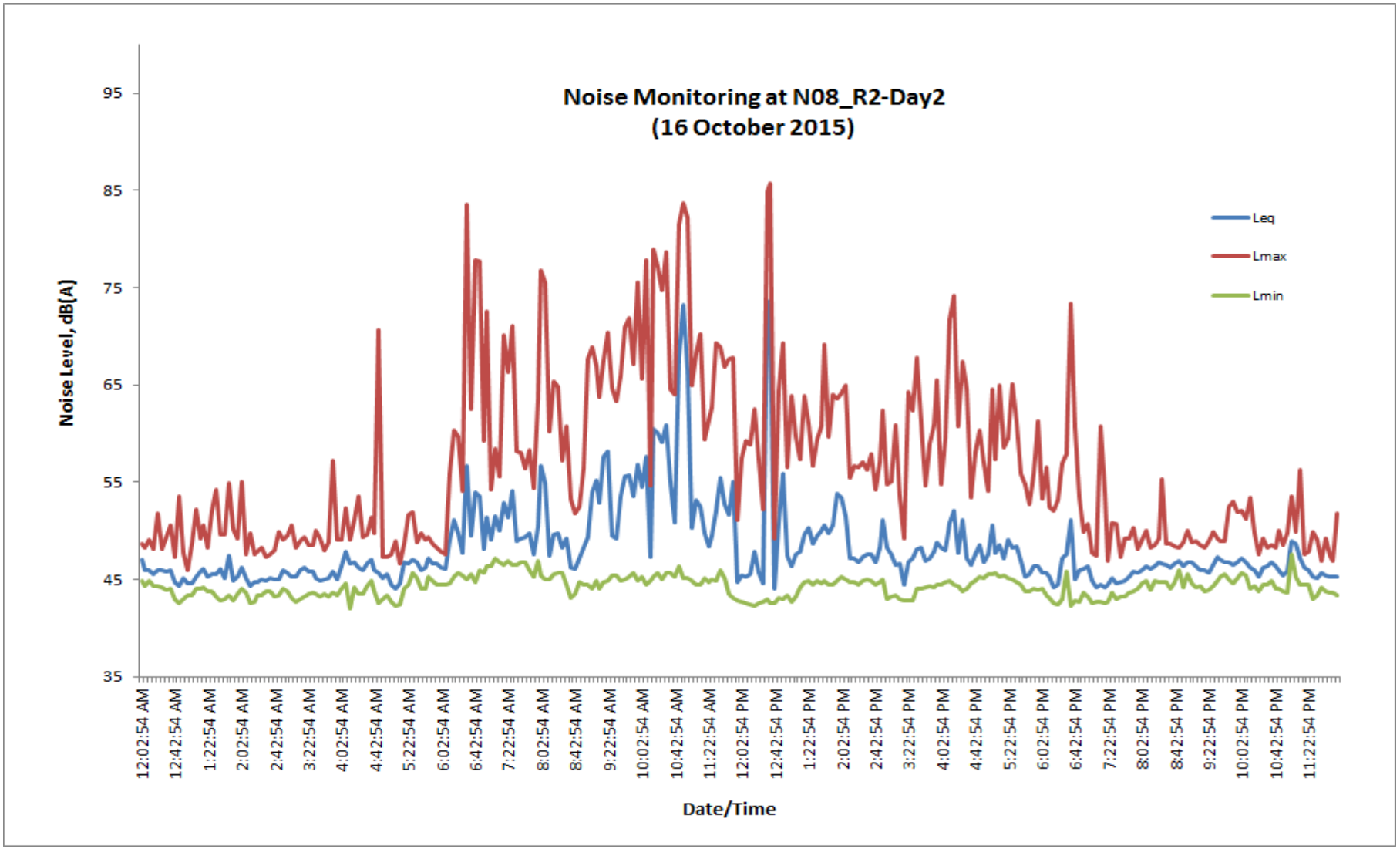

Figure 46: Daily noise level measured at Point NL08_R2 (Day 2)

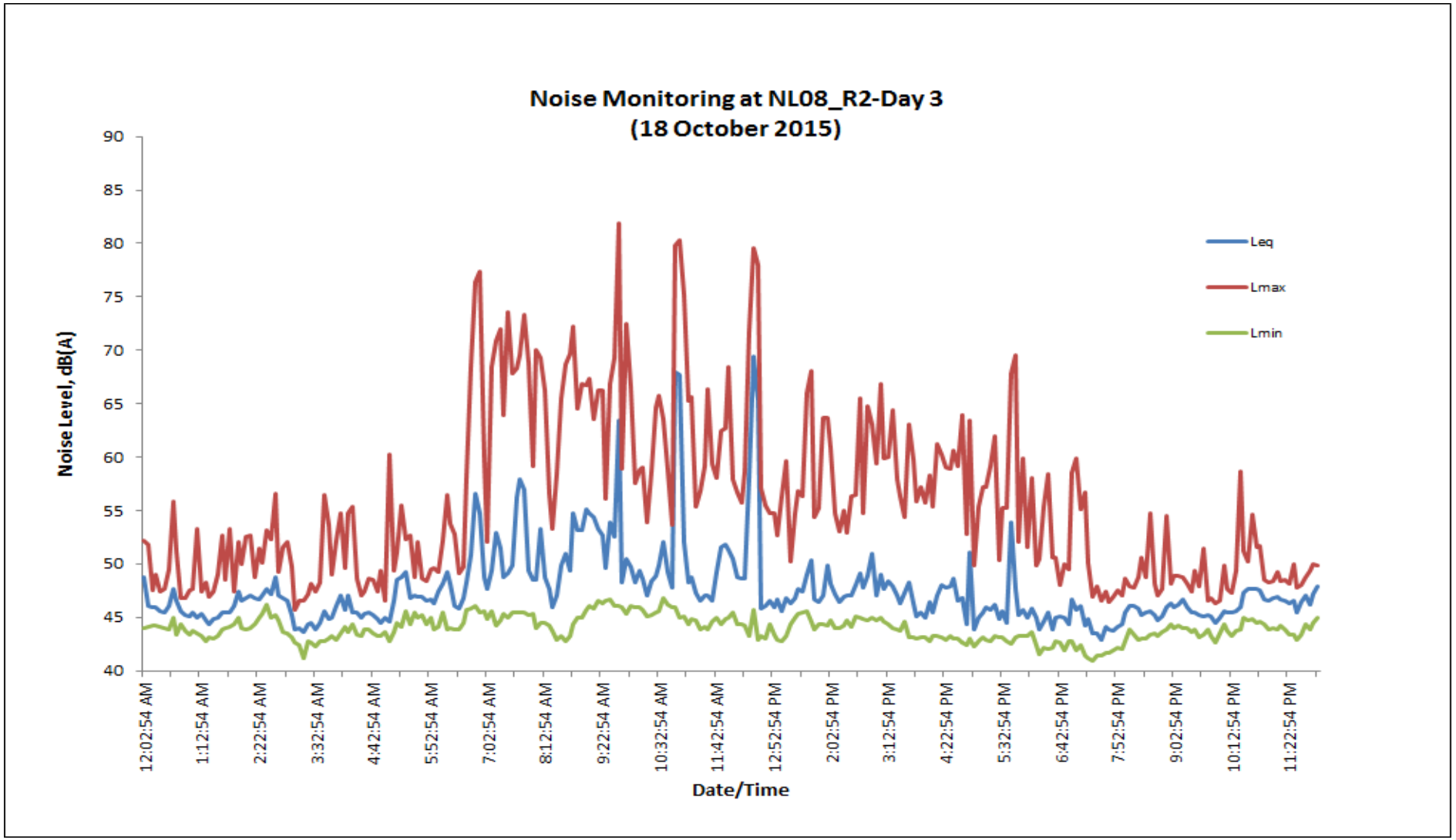

Figure 47: Daily noise level measured at Point NL08_R2 (Day 3)

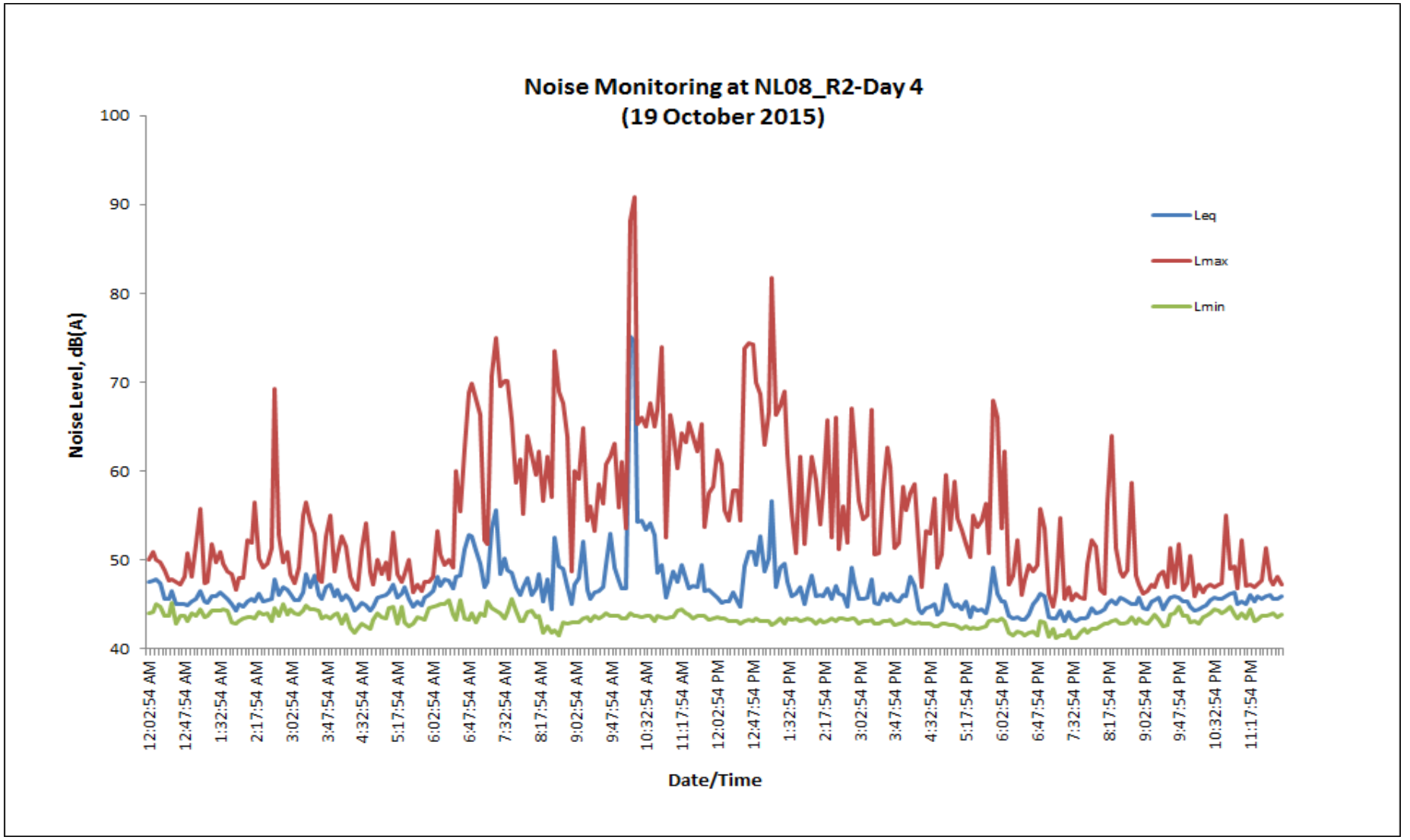

Figure 48: Daily noise level measured at Point NL08_R2 (Day 4)

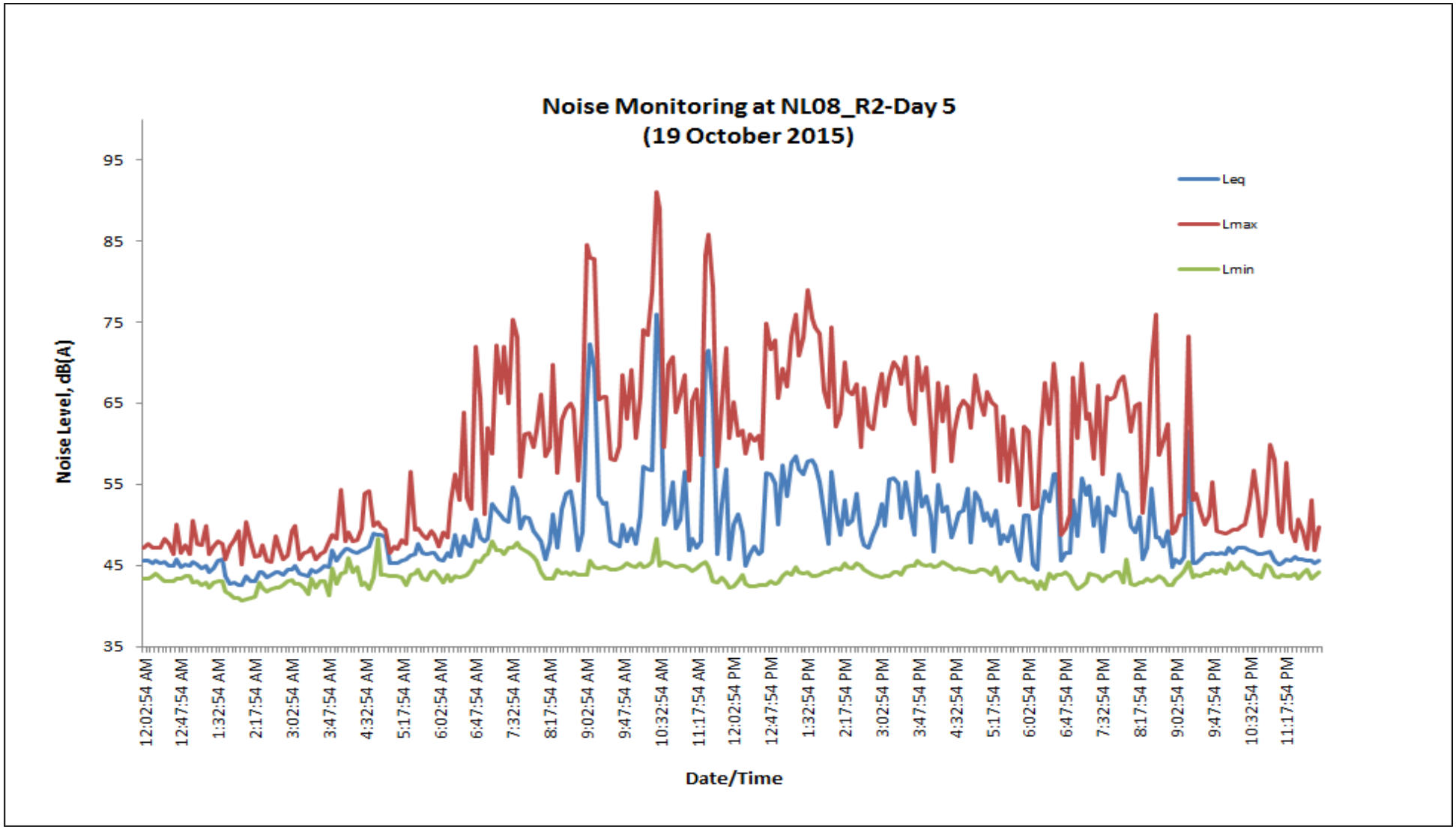

Figure 49: Daily noise level measured at Point NL08_R2 (Day 5)

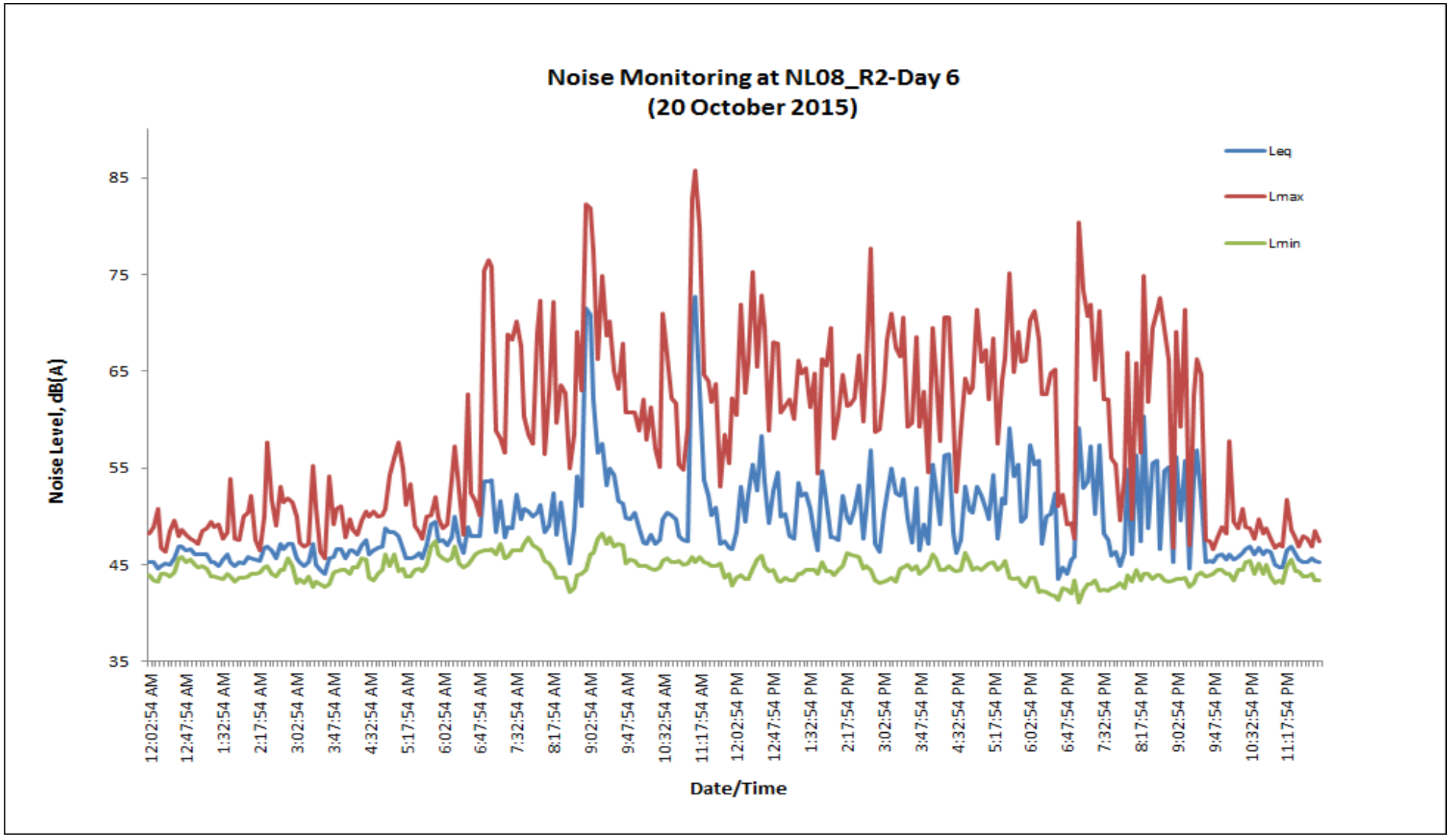

Figure 50: Daily noise level measured at Point NL08_R2 (Day 6)

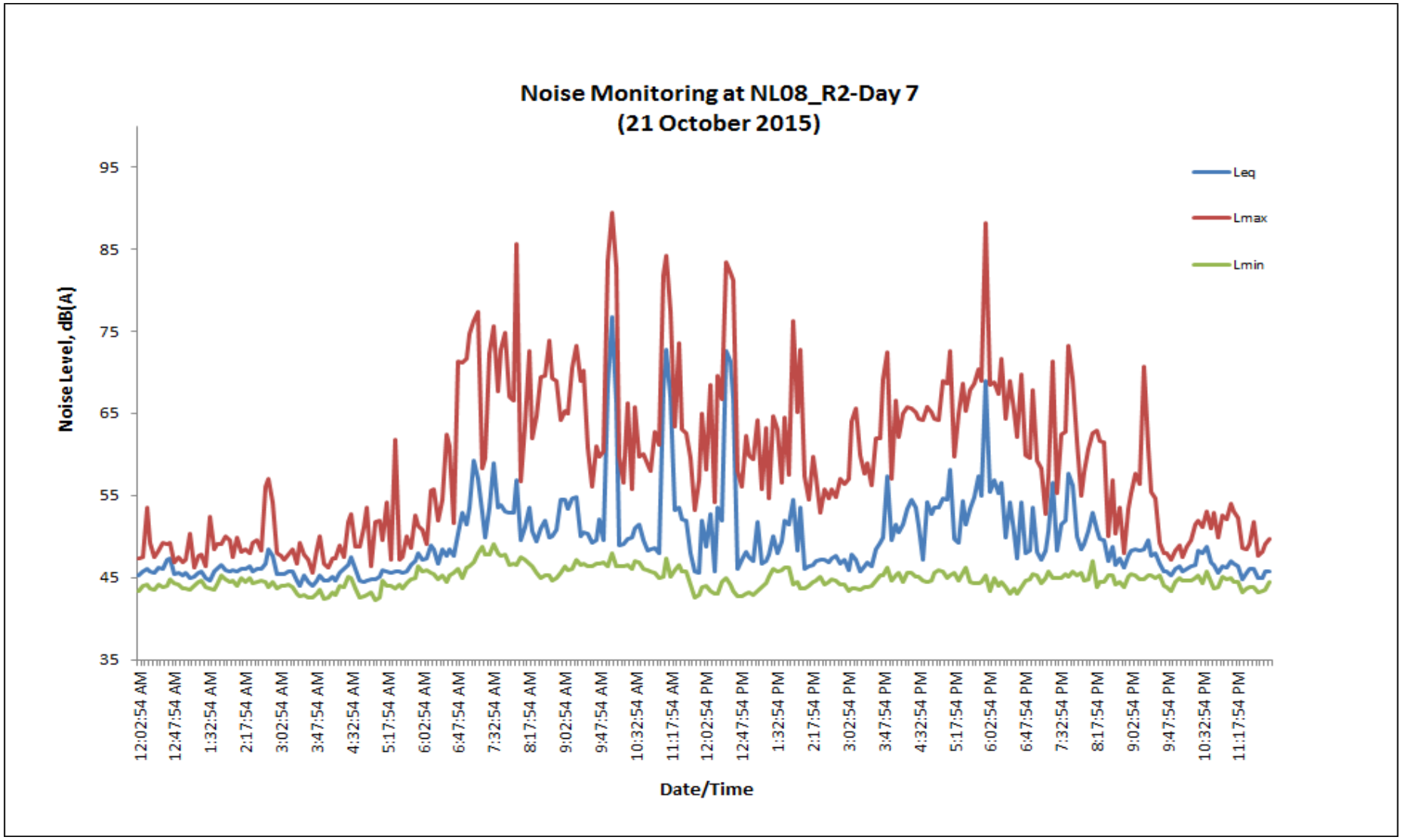

Figure 51: Daily noise level measured at Point NL08_R2 (Day 7)

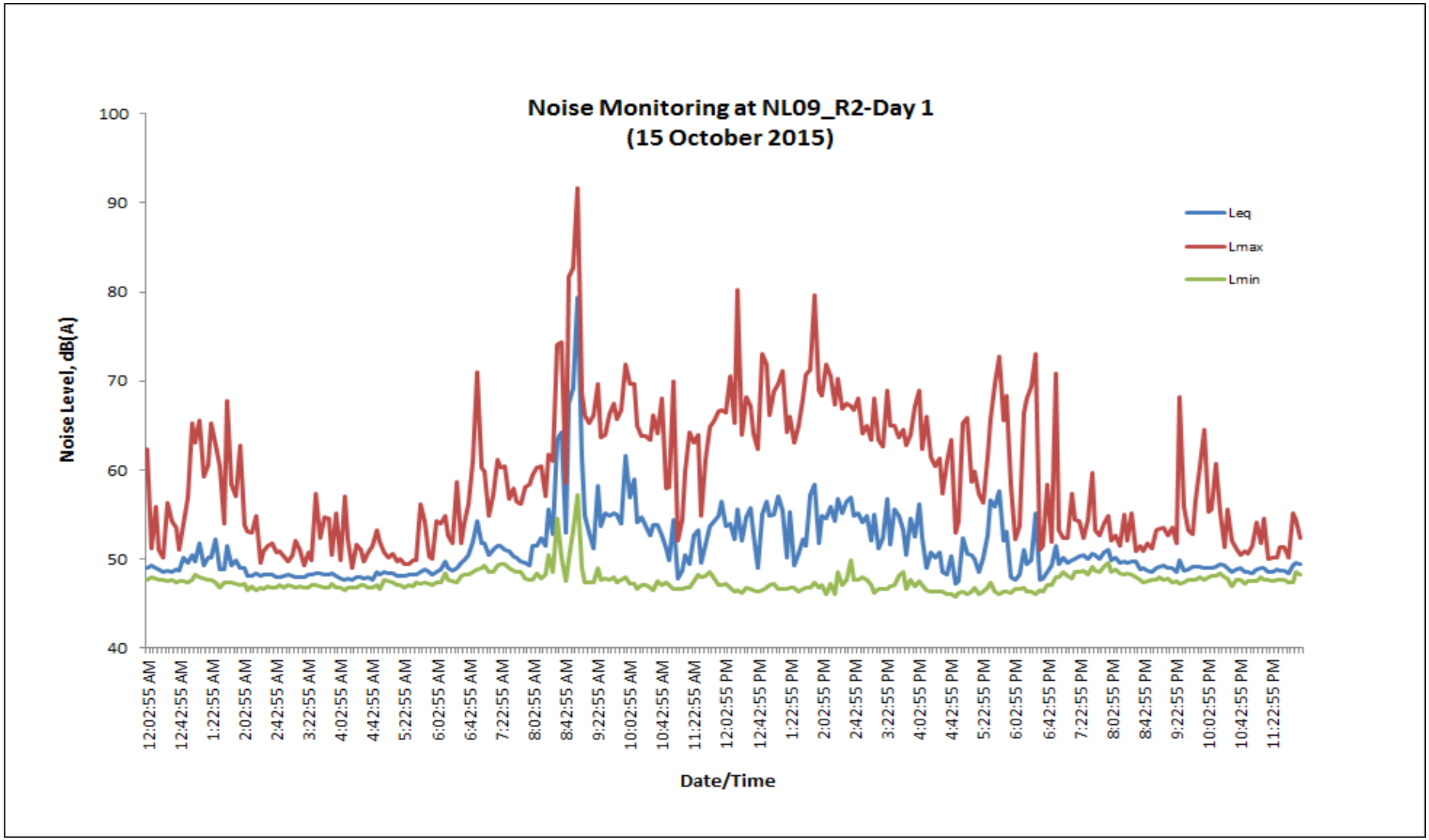

Figure 52: Daily noise level measured at Point NL09_R2 (Day 1)

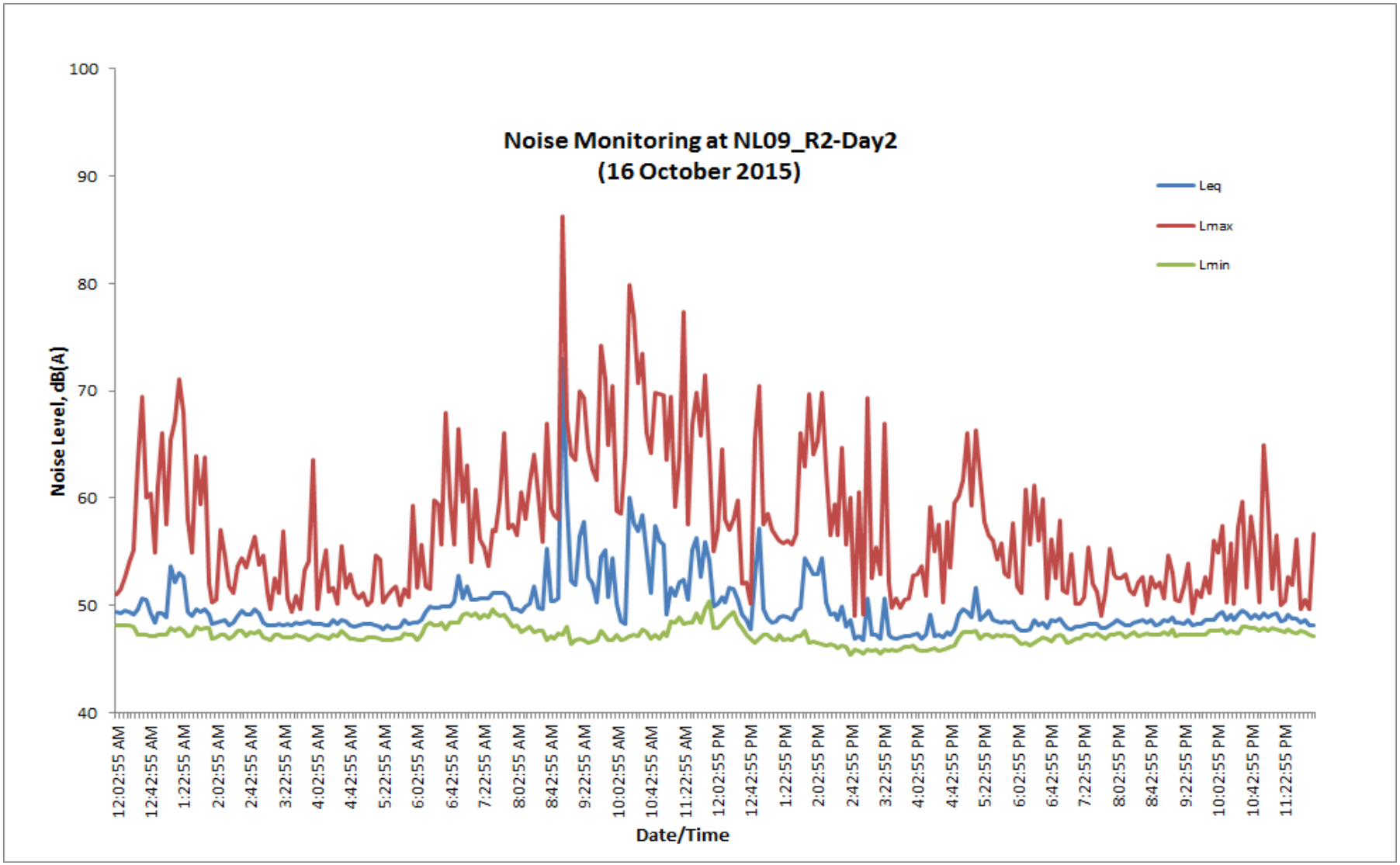

Figure 53: Daily noise level measured at Point NL09_R2 (Day 2)

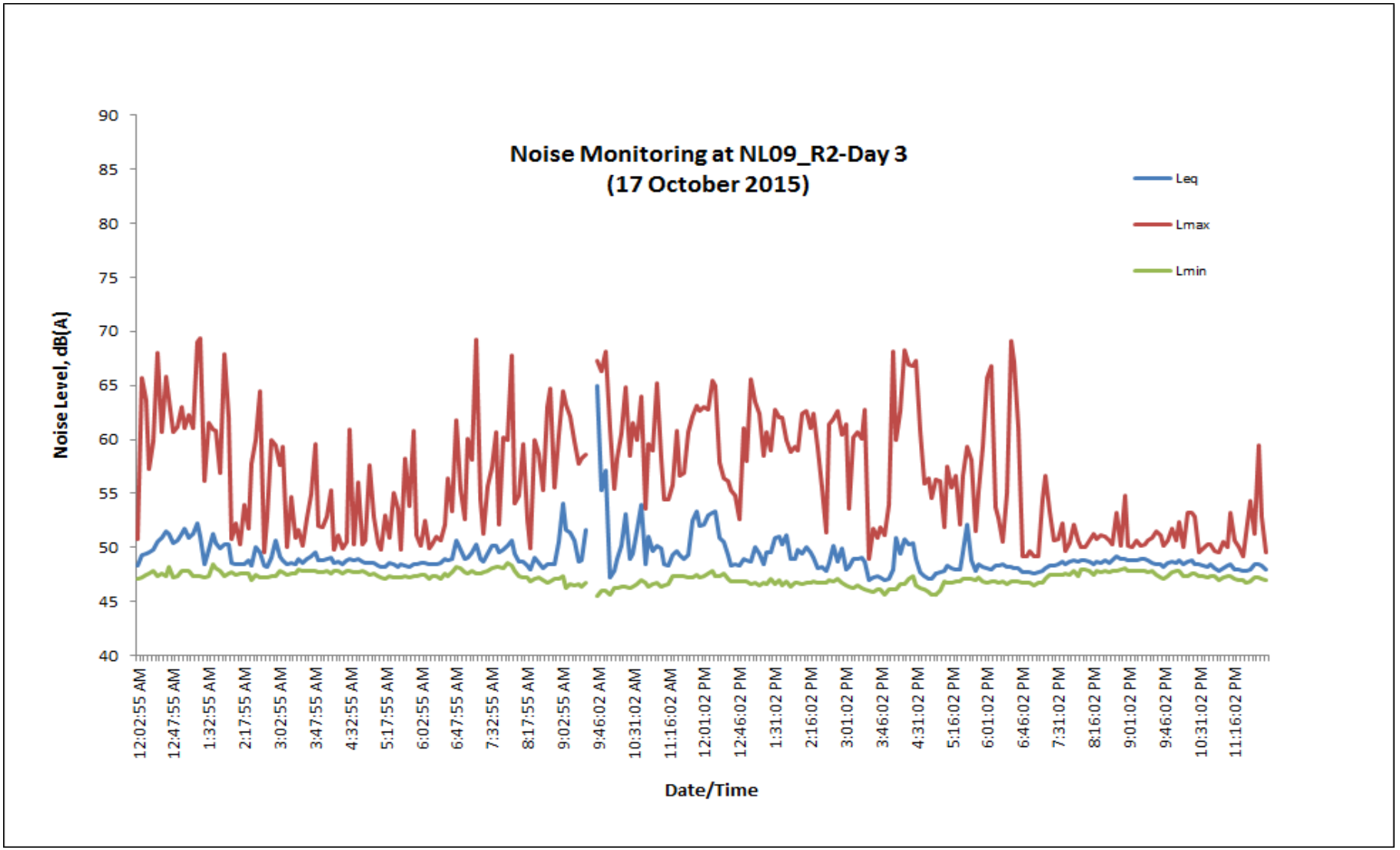

Figure 54: Daily noise level measured at Point NL09_R2 (Day 3)

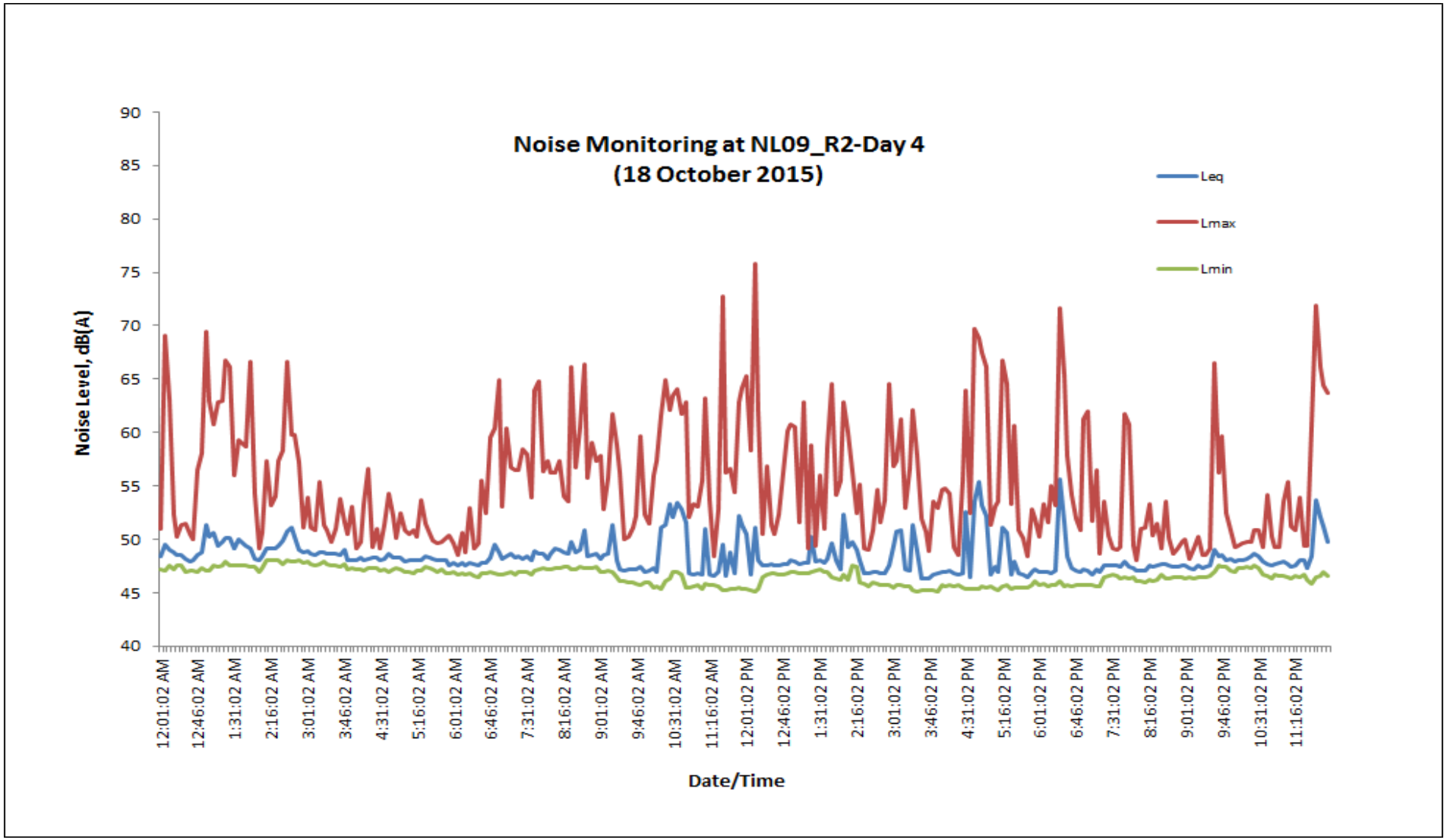

Figure 55: Daily noise level measured at Point NL09_R2 (Day 4)

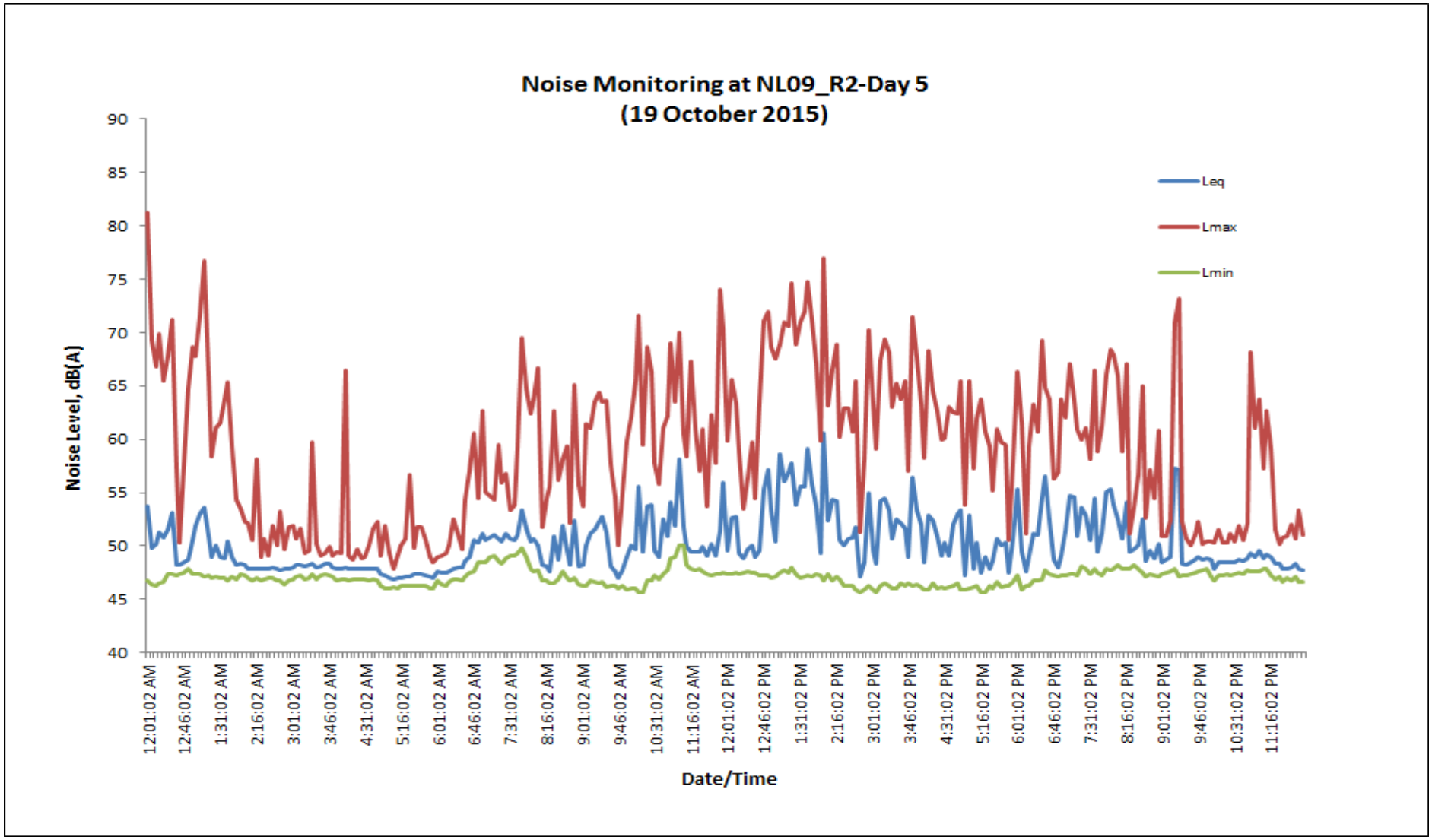

Figure 56: Daily noise level measured at Point NL09_R2 (Day 5)

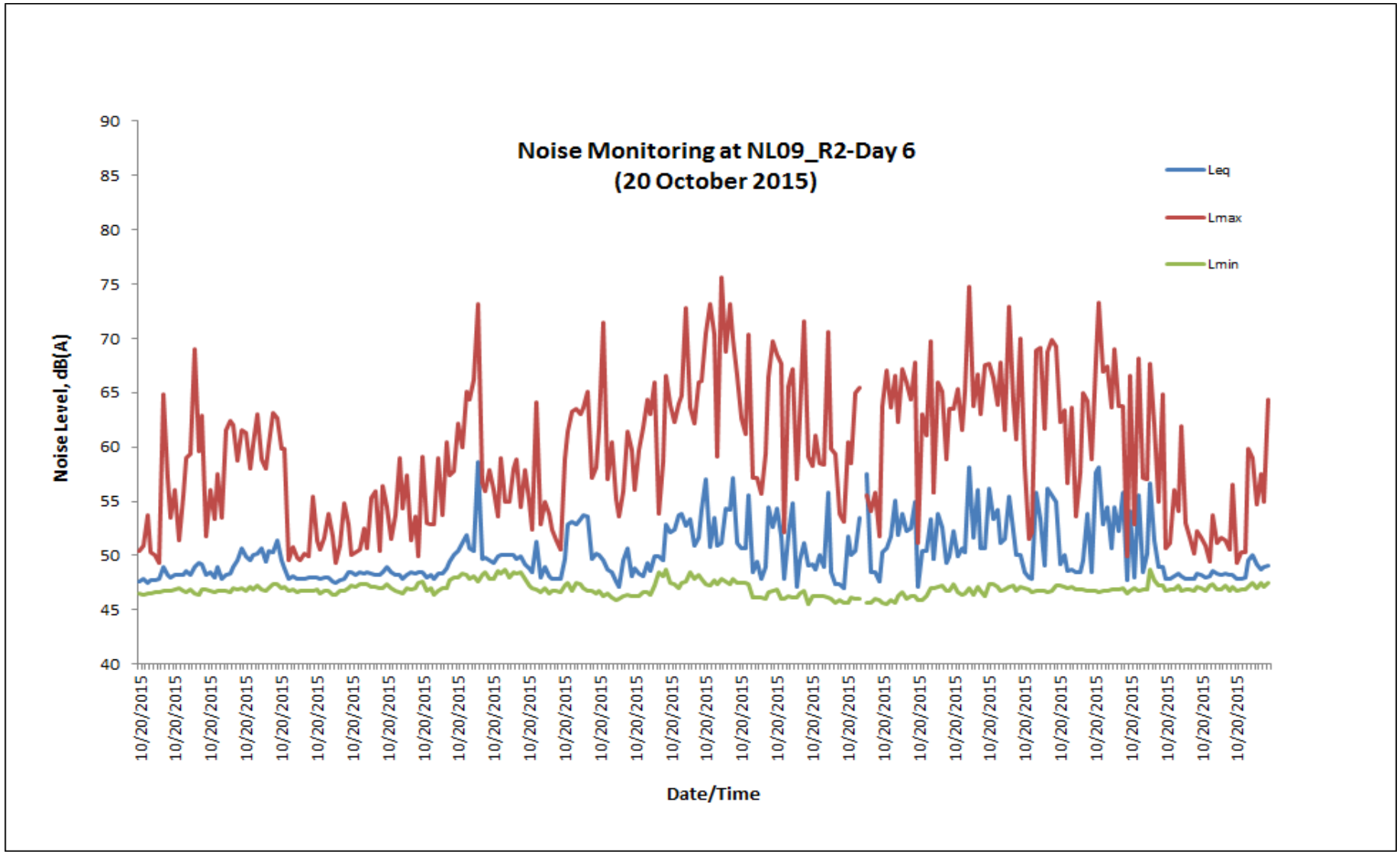

Figure 57: Daily noise level measured at Point NL09_R2 (Day 6)

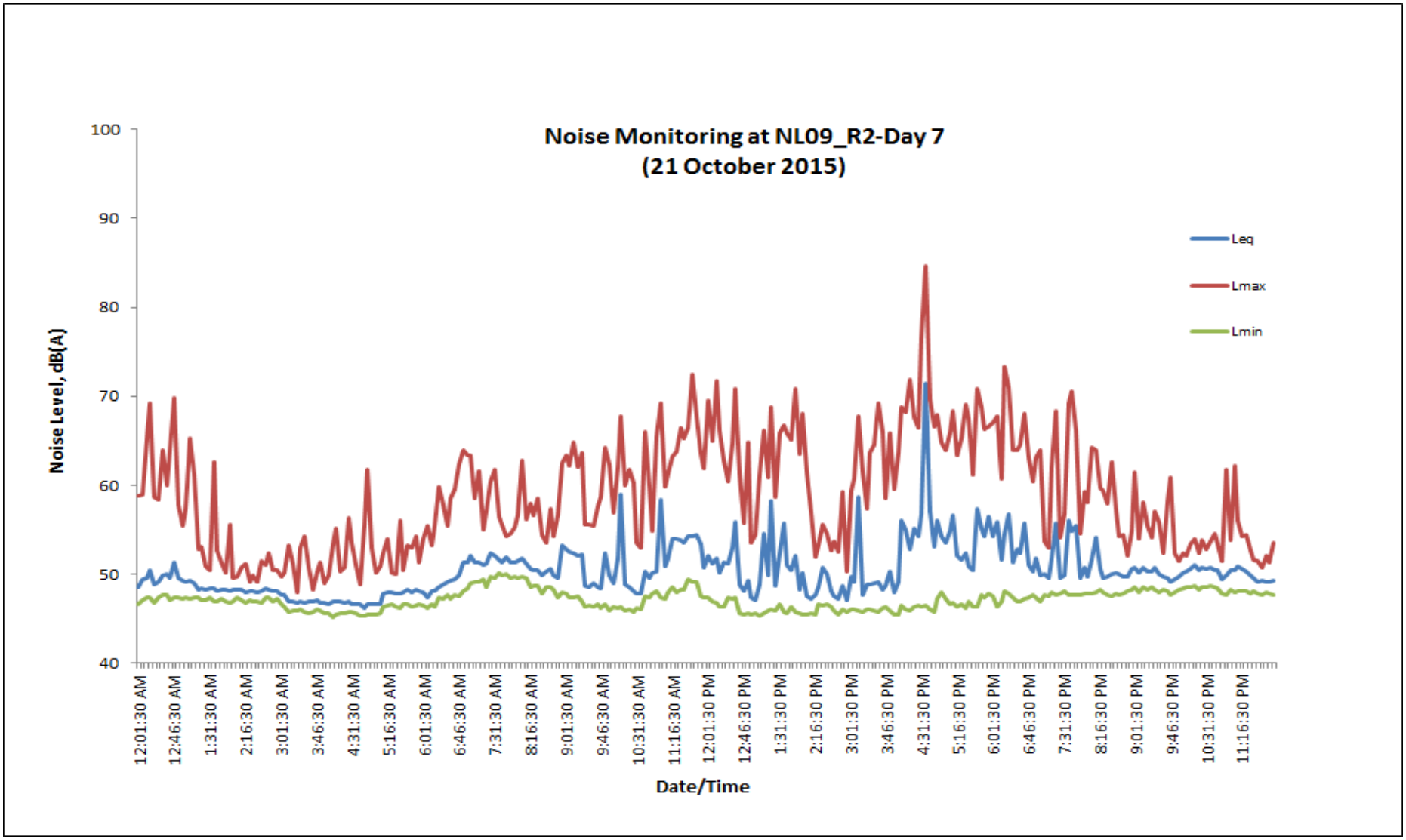

Figure 58: Daily noise level measured at Point NL09_R2 (Day 7)

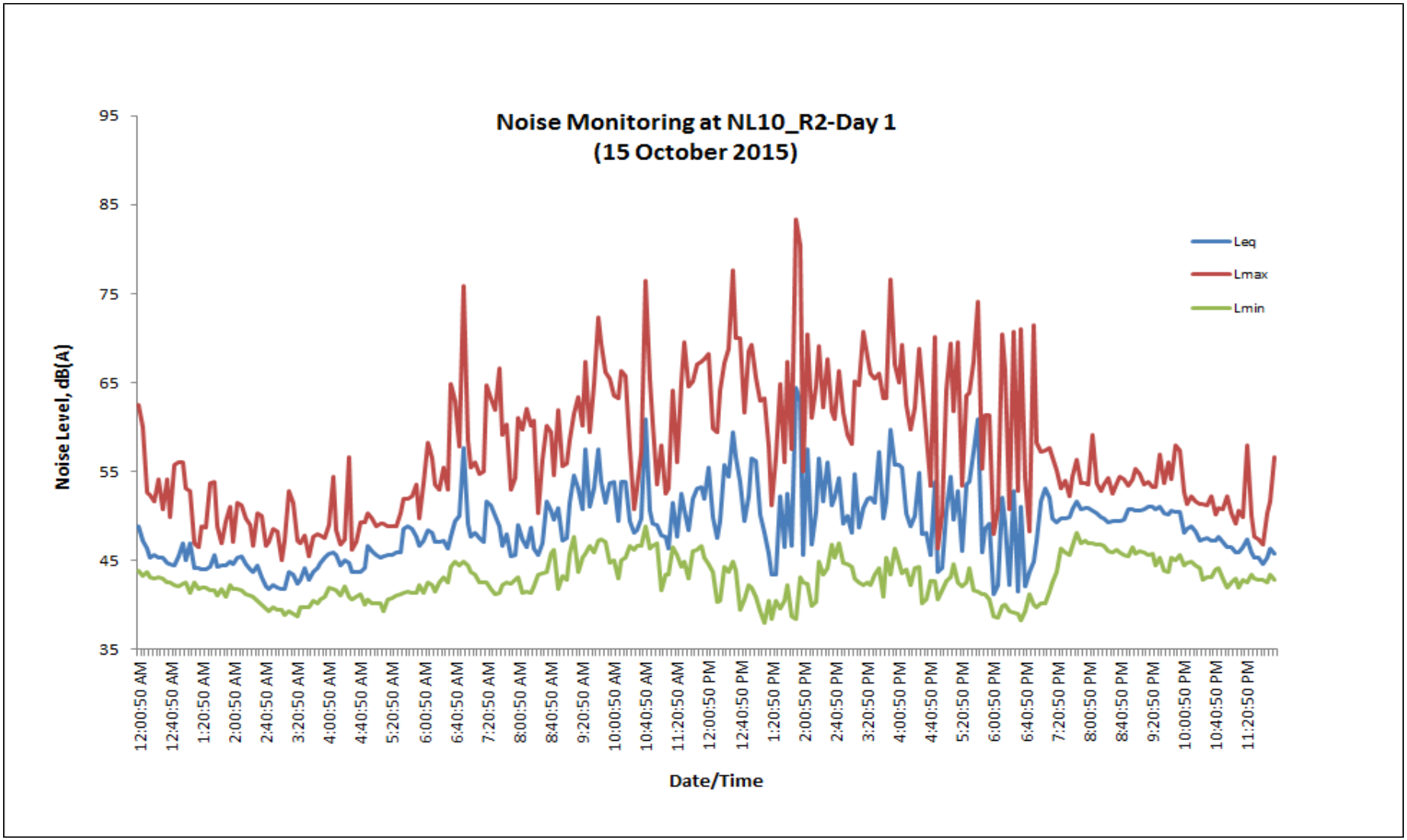

Figure 59: Daily noise level measured at Point NL10_R2 (Day 1)

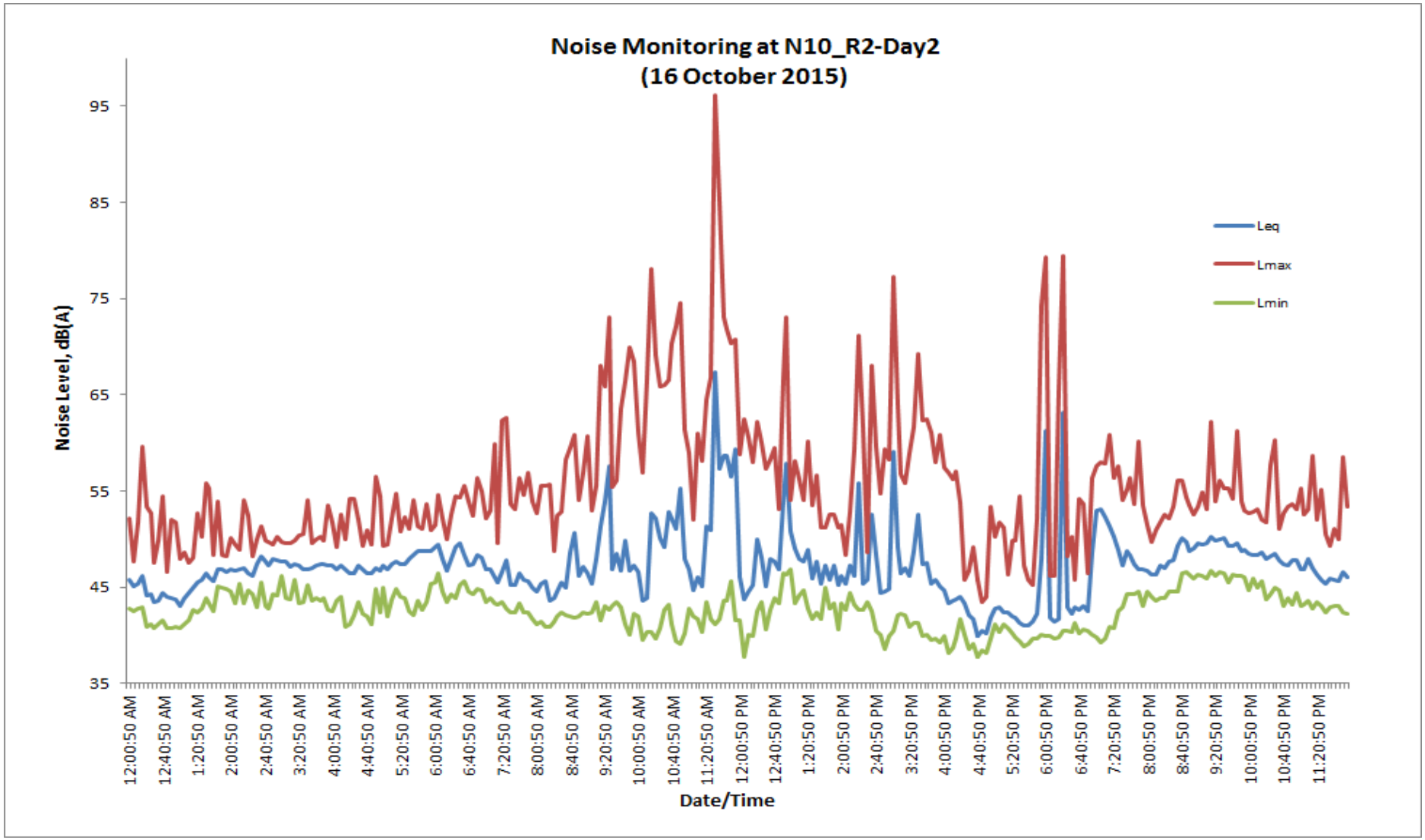

Figure 60: Daily noise level measured at Point NL10_R2 (Day 2)

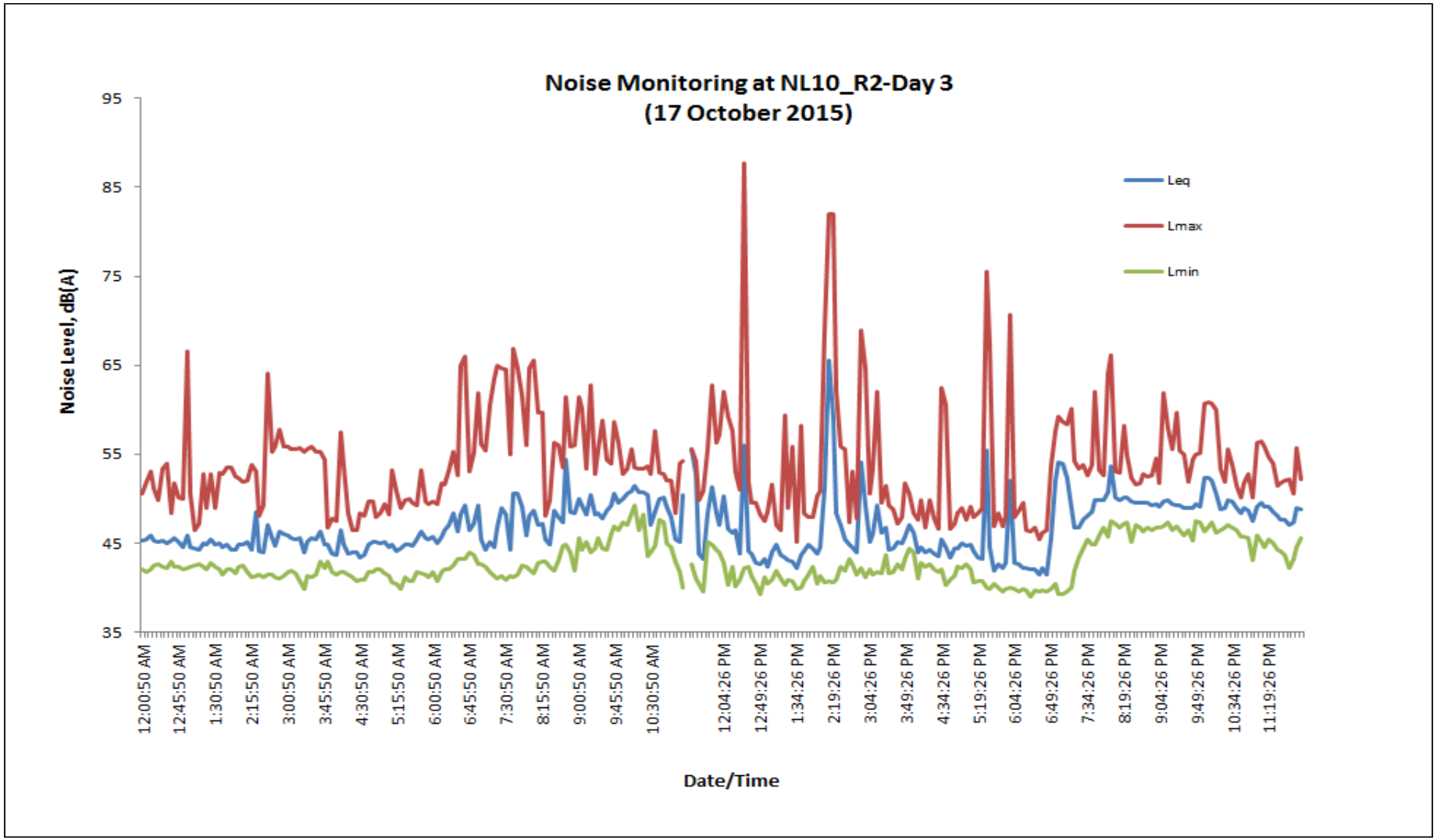

Figure 61: Daily noise level measured at Point NL10_R2 (Day 3)

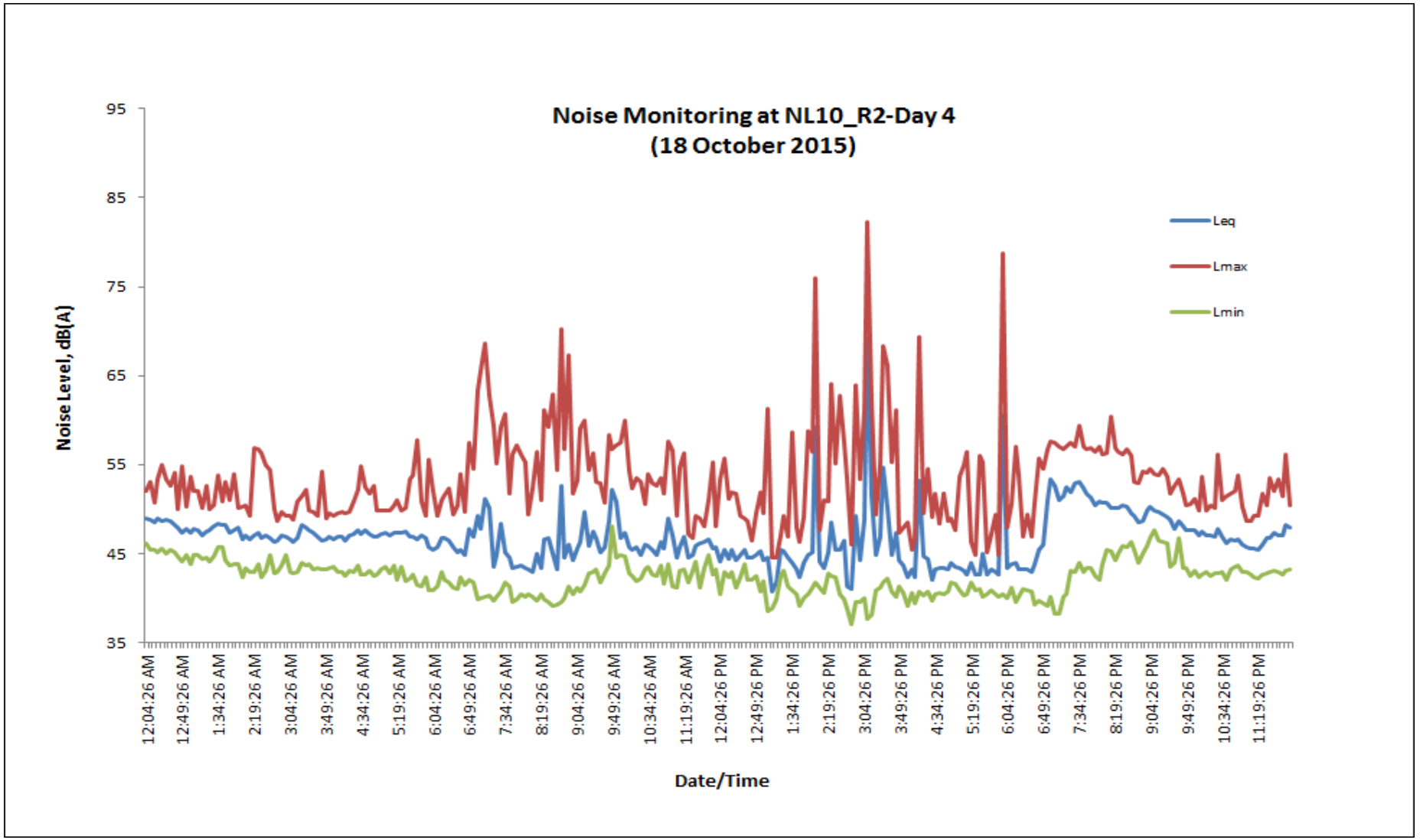

Figure 62: Daily noise level measured at Point NL10_R2 (Day 4)

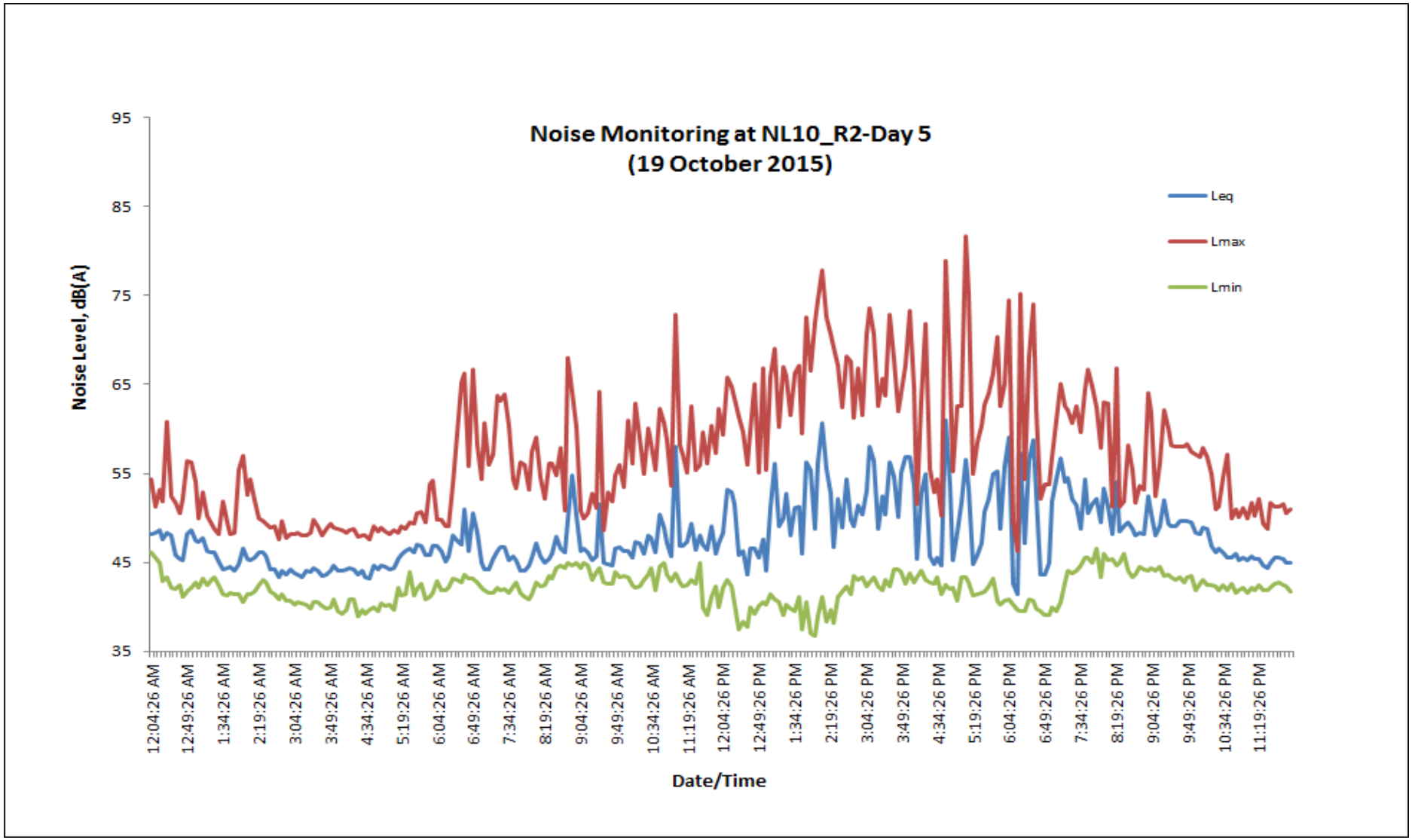

Figure 63: Daily noise level measured at Point NL10_R2 (Day 5)

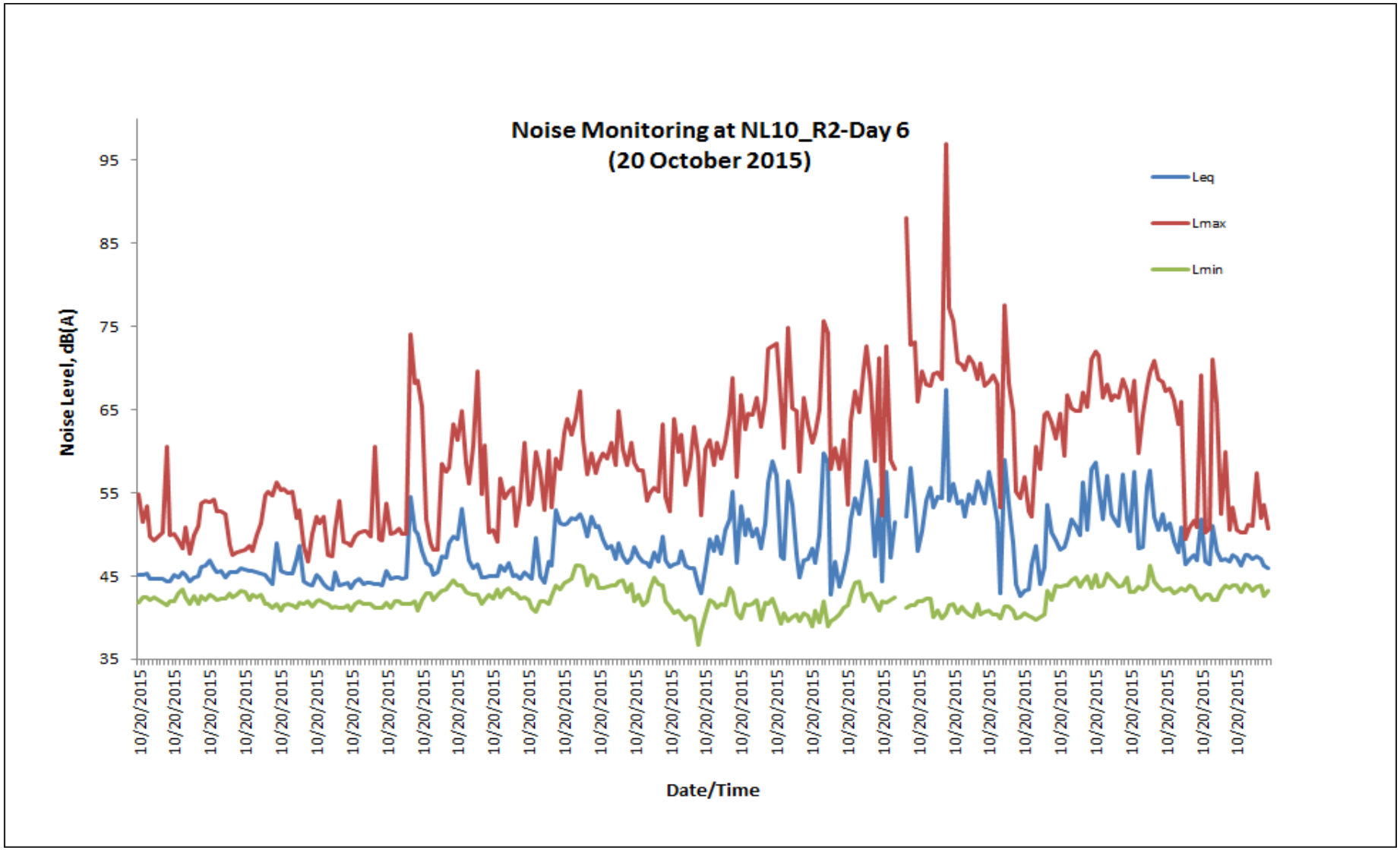

Figure 64: Daily noise level measured at Point NL10_R2 (Day 6)

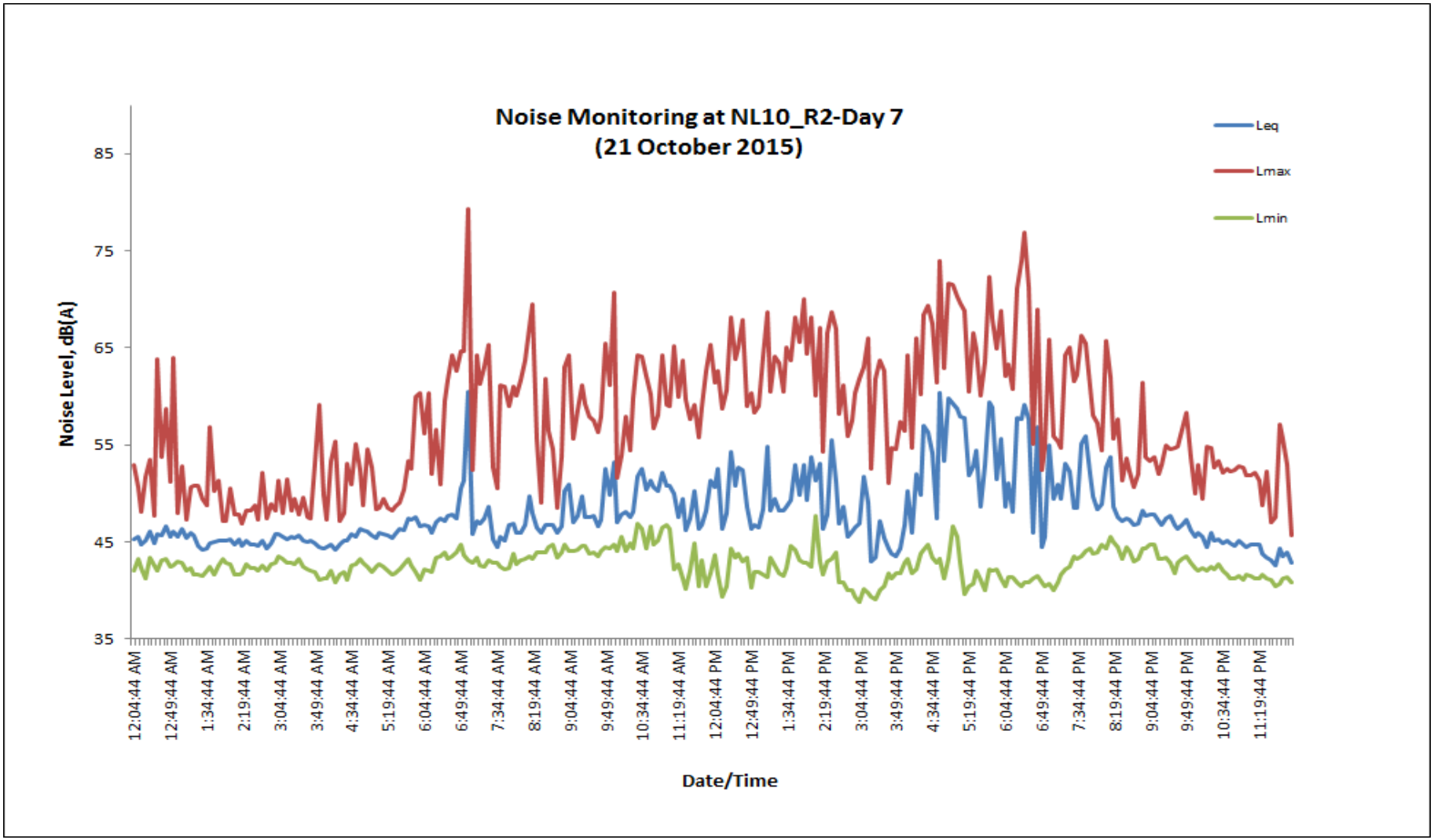

Figure 65: Daily noise level measured at Point NL10_R2 (Day 7)

5.0 Evaluation & discussion

In general, the results obtained at NL07_R2-NL09_R2 were in compliance with the National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites -Buildings other than above Part I & II) Regulations, 2011 Revised Ed. And there are no relevant limits for NL01_R2, NL03_R2-NL06_R2 and NL10_R2.

It should be noted that the Noise Monitoring project was carried out to the best of our knowledge and ability as well as responsibility towards the code of practice in the performance and reliability of our business to be accurate, precise and representative at the date/time and locations sampled so as to achieve a satisfactory baseline study.

6.0 REFERENCES

National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

Quest Technologies SoundPro Models SE/DL User Manual

APPENDIX 1

CALIBRATION CERTIFICATION OF FIELD EQUIPMENT

3M Oconomowoc
Personal Safety Division

3M Detection Solutions
1060 Corporate Center Drive
Oconomowoc, WI 53066-4828
www.3M.com/detection
262 567 9157 800 245 0779
262 567 4047 Fax

An ISO 9001 Registered Company

STS- BNV- 49442

3M

Certificate of Calibration

Certificate Number: 1410271124BJN100031

Model: SoundPro SP DL-1
S/N: BJN100031

Date Issued: 27-Oct-2014

On this day of manufacture and calibration, 3M certifies that the above listed product meets or exceeds the performance requirements of the following acoustic standard(s):

ANSI S1.4 1983 (R 2006) - Specification for Sound Level Meters / Type 1
ANSI S1.43 1997 (R 2007) - Specification for Integrating - Averaging Sound Level Meters / Type 1
IEC 61672-1 (2002) - Electro acoustics – Sound Level Meters – Part 1: Specifications / Class 1

Test Conditions: Temp: 18-25°C Humidity: 20-80% R.H. Barometric Pressure: 950-1050 mBar
Test Procedure: S053-899

Subassemblies:

B&K 4936	2661247
SPro Preamp	10140083

Reference Standard(s):

Device	Ref Standard Cal Due	Uncertainty - Estimated at 95% Confidence Level (k=2)
B&K Ensemble	1/23/2015	-/- 2.2% Acoustic (0.19dB)
Fluke 45	2/20/2015	+/- 1.4% AC Voltage, +/-0.1% DC Voltage

Calibrated By: Janet Pompe
Janet Pompe - Assembler

In order to maintain best instrument performance over time, and in the event of inspection, audit or litigation, we recommend the instrument be recalibrated annually. Any number of factors may cause the calibration to drift before the recommended interval has expired. See user manual for more information.

All equipment used in the test and calibration of this instrument is traceable to NIST, and applies only to the unit identified above. This report must not be reproduced, except in its entirety, without the written approval of 3M.

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3M Oconomowoc
Personal Safety Division

3M Detection Solutions
1060 Corporate Center Drive
Oconomowoc, WI 53066-4828
www.3M.com/detection
262 567 9157 800 245 0779
262 567 4047 Fax

An ISO 9001 Registered Company

AES-ENV-495(2)

3M

Certificate of Calibration

Certificate Number: 1410271125BJN100032

Model: SoundPro SP DL-1
S/N: BJN100032

Date Issued: 27-Oct-2014

On this day of manufacture and calibration, 3M certifies that the above listed product meets or exceeds the performance requirements of the following acoustic standard(s):

ANSI S1.4 1983 (R 2006) - Specification for Sound Level Meters / Type 1
ANSI S1.43 1997 (R 2007) - Specification for Integrating - Averaging Sound Level Meters / Type 1
IEC 61672-1 (2002) - Electro acoustics – Sound Level Meters – Part 1: Specifications / Class 1

Test Conditions: Temp: 18-25°C Humidity: 20-80% R.H. Barometric Pressure: 950-1050 mBar
Test Procedure: S053-899

Subassemblies:

B&K 4936	2861257
SPro Preamp	10140088

Reference Standard(s):

Device	Ref Standard Cal Due	Uncertainty - Estimated at 95% Confidence Level (k=2)
B&K Ensemble	1/23/2015	+/- 2.2% Acoustic (0.19dB)
Fluke 45	2/20/2015	+/- 1.4% AC Voltage, +/-0.1% DC Voltage

Calibrated By: Janet Pompe
Janet Pompe - Assembler

In order to maintain best instrument performance over time, and in the event of inspection, audit or litigation, we recommend the instrument be recalibrated annually. Any number of factors may cause the calibration to drift before the recommended interval has expired. See user manual for more information.

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345Q

LEE HUNG TEST SERVICES PTE LTD

(Sister company of Lee Hung Scientific Pte Ltd)

Business Reg. No. 200207853M

Certificate of Calibration

Certificate No. : 15/03/122
Submitted by : ALS TECHNICHEM (S) PTE LTD
121 GENTING LANE,
#04-01 ALS BUILDING,
SINGAPORE 349572

Date Submitted : 20 Mar 2015
Date of Calibration : 30 Mar 2015

Description of Equipment :

Subject : SOUND LEVEL METER TYPE 1
Brand : QUEST
Model No. : SOUNDPRO DL-1-1/3
Serial No. : BLK030008
Sub-Assemblies : B & K 4936 2619034

Ambient conditions :

Ambient Temp. : (23 ± 3) °C
Relative Humidity : (50 ± 10) %R.H.
Pressure : (1006.0 ± 4.0) hPa

The above-mentioned product/equipment has been calibrated at LHTS Lab under the ambient conditions stated above for conformity with certain specifications as laid down in the calibration procedure.

Method of Calibration

The method of calibration is Calibration Procedure : LHT-WI-CAL-S11 REV 7, generally as recommended by manufacturer. The calibration was carried out with reference to the following calibration and measurement standards which are traceable to the following below:

	Instrument	Serial Number	Cal. Report	Due Date
1.	QUEST-CAL	KZE040001	AL000641	18-Dec-15
2.	9004 GLOBAL MULTI TESTER	229007	RL000748	25-May-15
3.	HEWLETT PACKARD ATTENUATOR	1250U01894	RL000748	22-May-15

Results of Calibration

The results of the calibration are given on the Calibration Report as per attached.
The expanded uncertainties of measurement stated in this report are estimated at a level of confidence of approximately 95% with a coverage factor k=2.

The results of the above-mentioned instrument shown in the Calibration Report does not cover the full parameters of the Sound Level Meter. The user should determine the suitability of this instrument for its intended use.

* Recommended Next Calibration Date: 29Mar 2016
* This is only a suggested date, the recalibration interval should be determined based on the user's requirements.

Calibrated By,

Ryan Zhou Ran
Calibration Officer

Reviewed By,

Gavino delos Reyes
Senior Service Engineer

ALS TECHNICHEM (S) PTE LTD Reviewed By 14 Apr 2015

50 Bukit Batok Street 23 #05-10/11/12/13/14 Midview Building Singapore 659578
Tel: +65 6560 6903 Fax: +65 6567 6909
E-mail: service@leehung.com Website: http://www.leehung.com

416@

LEE HUNG TEST SERVICES PTE LTD

(Sister company of Lee Hung Scientific Pte Ltd)

Business Reg. No. 200207853M

Certificate of Calibration

Certificate No. : 15/03/123
Submitted by : ALS TECHNICHEM (S) PTE LTD
121 GENTING LANE,
#04-01 ALS BUILDING,
SINGAPORE 349572

Date Submitted : 20 Mar 2015
Date of Calibration : 30 Mar 2015

Description of Equipment :

Subject : SOUND LEVEL METER TYPE 1
Brand : QUEST
Model No. : SOUNDPRO DL-1
Serial No. : BJL080024
Sub-Assemblies : B & K 4936 2785695

Ambient conditions :

Ambient Temp : (23 ± 3) °C
Relative Humidity : (50 ± 10) %R.H.
Pressure : (1008.0 ± 4.0) hPa

The above-mentioned product/equipment has been calibrated at LHTS Lab under the ambient conditions stated above for conformity with certain specifications as laid down in the calibration procedure.

Method of Calibration

The method of calibration is Calibration Procedure : LHT-WI-CAL-S11 REV 7, generally as recommended by manufacturer. The calibration was carried out with reference to the following calibration and measurement standards which are traceable to the following below:

Instrument	Serial Number	Cal. Report	Due Date
1. QUEST-CAL	KZE040001	AL000641	18-Dec-15
2. 9004 GLOBAL MULTI TESTER	229007	RL000749	25-May-15
3. HEWLETT PACKARD ATTENUATOR	1250J01894	RL000748	22-May-15

Results of Calibration

The results of the calibration are given on the Calibration Report as per attached.
The expanded uncertainties of measurement stated in this report are estimated at a level of confidence of approximately 95% with a coverage factor k=2.

The results of the above-mentioned instrument shown in the Calibration Report does not cover the full parameters of the Sound Level Meter. The user should determine the suitability of this instrument for its intended use.

* Recommended Next Calibration Date: 29 Mar 2016
* This is only a suggested date, the recalibration interval should be determined based on the user's requirements.

Calibrated By,

Ryan Zhou Ran
Calibration Officer

Reviewed By,

Gavino delos Reyes
Senior Service Engineer

ALS TECHNICHEM (S) PTE LTD Reviewed By

14 Apr 2015

50 Bukit Batok Street 23 #05-10/11/12/13/14 Midview Building Singapore 659578
Tel: +65 6560 6903 Fax: +65 6567 6909
E-mail: service@leehung.com Website: http://www.leehung.com

A332

LEE HUNG TEST SERVICES PTE LTD

(Sister company of Lee Hung Scientific Pte Ltd)

Business Reg. No. 200207853M

Certificate of Calibration

Certificate No. : 15/03/167
Submitted by : ALS TECHNICHEM (S) PTE LTD
121 GENTING LANE,
#04-01 ALS BUILDING,
SINGAPORE 349572

Date Submitted : 30 Mar 2015
Date of Calibration : 15 Apr 2015

Description of Equipment :

Subject : SOUND LEVEL METER TYPE 1
Brand : QUEST
Model No. : SOUNDPRO DL-1
Serial No. : BJM030015
Sub-Assemblies : B & K 4936 2785930

Ambient conditions :

Ambient Temp. : (23 ± 3) °C
Relative Humidity : (50 ± 10) %R.H.
Pressure : (1006.0 ± 4.0) hPa

The above-mentioned product/equipment has been calibrated at LHTS Lab under the ambient conditions stated above for conformity with certain specifications as laid down in the calibration procedure.

Method of Calibration

The method of calibration is Calibration Procedure : LHT-WI-CAL-S11 REV 7, generally as recommended by manufacturer. The calibration was carried out with reference to the following calibration and measurement standards which are traceable to the following below:

	Instrument	Serial Number	Cal. Report	Due Date
1	QUEST-CAL	KZE040001	AL000641	18-Dec-15
2	9004 GLOBAL MULTI TESTER	229007	RL000749	25-May-15
3	HEWLETT PACKARD ATTENUATOR	1250J01894	RL000748	22-May-15

Results of Calibration

The results of the calibration are given on the Calibration Report as per attached.
The expanded uncertainties of measurement stated in this report are estimated at a level of confidence of approximately 95% with a coverage factor k=2.

The results of the above-mentioned instrument shown in the Calibration Report does not cover the full parameters of the Sound Level Meter. The user should determine the suitability of this instrument for its intended use.

* Recommended Next Calibration Date: 14 Apr 2016
* This is only a suggested date, the recalibration interval should be determined based on the user's requirements.

Calibrated By,

Ryan Zhou Ran
Calibration Officer

Reviewed By,

Gavino delos Reyes
Senior Service Engineer

ALS TECHNICHEM (S) PTE LTD Reviewed By 17 APR 2015

50 Bukit Batok Street 23 #05-10/11/12/13/14 Midview Building Singapore 659578
Tel: +65 6560 6903 Fax: +65 6567 6909
E-mail: service@leehung.com Website: http://www.leehung.com

APPENDIX 2

SITE PHOTO

NL01_R2

NL03_R2

NL04_R2

NL05_R2

NL06_R2

NL07_R2

NL08_R2

NL09_R2

NL10_R2

Annex 7.0

Surface Water

Annex 7.1

Surface Water Survey Locations

Figure A7.1: Photographs Surface Water Sampling Locations

Annex 7.2

Upper Seletar Reservoir Water Quality Data

Annex A7.2.1: Historical Monitoring Data for the Upper Seletar Reservoir between January 2013 and December 2014 (Interquartile Range, 25th percentile – 75th percentile)

Parameter	Unit	Interquartile Monitoring Results			
		25 Percentile	75 Percentile	Range[1]	Average[1]
Inorganic - Physical Properties					
pH	pH Unit	7.3	7.7	6.9 - 8.3	7.5
TSS	mg/L	3	4	<2.5 - 5	3.7
Turbidity	NTU	2.3	3.1	1.7 - 4.2	2.7
Inorganic – Non-metallic Constituents					
P	mg/L	0.006	0.015	<0.003 - 0.027	0.01
N	mg/L	0.36	0.43	0.28 - 0.53	0.39
NO_{3-}	mg/L	0.02	0.07	<0.01 - 0.14	0.046
NH_3	mg/L	<0.02	0.04	<0.02 - 0.07	0.028
Cl	mg/L	7	24	<5 - 37	17.5
Microbiological Parameters					
E.Coli	cfu/ 100 ml	<1	10	<1 - 20	3.9
Enterococci	cfu/100 ml	<1	13	<1 - 29	6.3
Organic – General					
BOD_5	mg/L	<2	<2	<2	<2
COD	mg/L	5	11.75	4 - 21	11.7
Chlorophyll-A	mg/m3	15.85	25.55	10.4 - 38.2	21.0
TOC	mg/L	3.9	4.4	3.2-5.1	4.13

Notes:

(1) Range and average presented with outliers 1.5 times interquartile range removed from calculations.

(2) TDS - Total Dissolved Solids; TSS - Total Suspended Solids; P - Total Phosphorus; N - Total Nitrogen; NO_{3-} - Nitrate; NH_3 – Ammonia; Cl – Chloride; BOD_5 – 5-day Biochemical Oxygen Demand; COD – Chemical Oxygen Demand; TOC – Total Organic Carbon

Annex A7.2.2: Historical Monitoring Data for the Sungei Mandai Water Catchment between January 2013 and December 2014

Parameter	Unit	Interquartile Monitoring Results			
		25 Percentile	75 Percentile	Range[1]	Average[1]
pH	pH Unit	7.9	8.1	7.8 - 8.3	7.99
Turbidity	NTU	4	13	2.7 - 20	8.98
P	mg/L	0.035	0.064	0.007 - 0.064	0.038
N	mg/L	0.59	0.72	0.54 - 0.75	0.65
NO_{3-}	mg/L	0.39	0.44	0.39 - 0.44	0.42
NH_3	mg/L	0.03	0.06	0.02 - 0.07	0.04
Cl	mg/L	<5	7	<5 - 7	5.3
E.Coli	cfu/ 100 ml	N/A [3]	N/A	N/A	N/A
Enterococci	cfu/100 ml	N/A [3]	N/A	N/A	N/A
BOD_5	mg/L	N/A [3]	N/A	N/A	N/A
COD	mg/L	N/A [3]	N/A	N/A	N/A
TOC	mg/L	3.3	4.3	3.3 - 5.2	4.2

Notes:

(1) Range and average presented with outliers 1.5 times interquartile range removed from calculations.

(2) TDS - Total Dissolved Solids; TSS - Total Suspended Solids; P - Total Phosphorus; N - Total Nitrogen; NO_{3-} - Nitrate; NH_3 – Ammonia; Cl – Chloride; BOD_5 – 5-day Biochemical Oxygen Demand; COD – Chemical Oxygen Demand; TOC – Total Organic Carbon

(3) Data set was too small (i.e. n ≤ 4) for an interquartile analysis.

Annex 7.3

Round 1 of Surface Water Survey Results (10 June 2015)

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **SG1509968**	Page	: 1 of 4
Client	: **ENVIRONMENTAL RESOURCES MANAGEMENT**	Project	: ----
Contact	: Ms Eva Yew	Order number	: ----
Address	: 120 Robinson Road #10-01 Singapore 068913	Quote number	: ----
E-mail	: Eva.Yew@erm.com	Date Received	: 10-JUN-2015
Telephone	: +65 6324 9636	Date Analysed	: 10-JUN-2015
Facsimile	: +65 6226 1636	Date Issued	: 01-JUL-2015
No. of samples received	: 6	No. of samples analysed	: 6

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*
Jeanette Wong	Technical Director
Pansy Teo	Senior Environmental Manager

General Comments

This report supersedes any previous report(s) with this reference. All pages of this report have been checked and approved for release. Results apply to the sample(s) as submitted. The laboratory declares that the test results relate only to the items tested and do not substitute any other documents. This report may not be reproduced except with prior written approval from the testing laboratory. This report may not be used for advertising purposes.

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, BS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : LOR = Limit of reporting

- **APHA method is referenced to APHA Standard Method, 22nd Ed, 2012**

Analytical Results

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Client sample ID: SW01_R1 Sampling date/time: 10-JUN-2015 11:50 SG1509968-001	Client sample ID: SW01_R1-dup Sampling date/time: 10-JUN-2015 11:50 SG1509968-002	Client sample ID: SW02_R1 Sampling date/time: 10-JUN-2015 11:40 SG1509968-003	Client sample ID: SW05_R1 Sampling date/time: 10-JUN-2015 10:57 SG1509968-004	Client sample ID: SW08_R1 Sampling date/time: 10-JUN-2015 10:35 SG1509968-005
INORGANIC- Physical Properties								
pH @ 25 deg C	APHA4500 H+B	0.1	pH Unit	**7.0**	**7.0**	**6.9**	**7.2**	**5.1**
Temperature of Discharge	APHA2550B	0.10	°C	**27.9**	**27.9**	**27.8**	**29.0**	**27.8**
Total Dissolved Solids	APHA2540C	5	mg/L	**85**	**72**	**65**	**137**	**35**
Total Suspended Solids	APHA2540D	5	mg/L	<5	<5	<5	<5	<5
Turbidity	APHA2130B	0.10	NTU	**5.50**	**5.30**	**9.20**	**1.50**	**1.30**
INORGANICS - Nonmetalllic Constituents								
Total Phosphorus as P	APHA4500P G	0.003	mg/L	<0.003	<0.003	<0.003	**0.072**	<0.003
Total Nitrogen as N	APHA4500N C	0.10	mg/L	**1.15**	**1.12**	**1.07**	**1.78**	**2.70**
Microbiological Parameters								
Escherichia coli by MPN	APHA9221F (MPN)	1.8	MPN/100 mL	**130**	**79.0**	**49.0**	**180**	**350**
ORGANICS-General								
Biochemical Oxygen Demand (5 days @ 20 deg C)	APHA5210B	2	mg/L	<2	<2	<2	<2	<2
Chemical Oxygen Demand	APHA5220C	1	mg/L	**8**	**8**	**9**	**9**	**6**
Chlorophyll a	APHA10200	1.00	mg/m³	<1.00	<1.00	<1.00	**4.53**	<1.00
Dissolved Oxygen	APHA4500OG	0.10	mg/L	**7.35**	**7.33**	**6.60**	**7.65**	**5.94**
Oil and Grease	APHA5520B	5	mg/L	<5	<5	<5	<5	<5

Analytical Results

Sub-Matrix: **WATER**				Client sample ID	**SW09_R1**	----	----	----	----
				Sampling date/time	10-JUN-2015 10:14	----	----	----	----
Compound	*Method*	*LOR*	*Unit*		**SG1509968-006**	**----**	**----**	**----**	**----**
INORGANIC- Physical Properties									
pH @ 25 deg C	APHA4500 H+B	0.1	pH Unit		**5.2**	----	----	----	----
Temperature of Discharge	APHA2550B	0.10	°C		**27.6**	----	----	----	----
Total Dissolved Solids	APHA2540C	5	mg/L		**56**	----	----	----	----
Total Suspended Solids	APHA2540D	5	mg/L		<5	----	----	----	----
Turbidity	APHA2130B	0.10	NTU		**2.90**	----	----	----	----
INORGANICS - Nonmetalllic Constituents									
Total Phosphorus as P	APHA4500P G	0.003	mg/L		<0.003	----	----	----	----
Total Nitrogen as N	APHA4500N C	0.10	mg/L		**3.40**	----	----	----	----
Microbiological Parameters									
Escherichia coli by MPN	APHA9221F (MPN)	1.8	MPN/100 mL		**79.0**	----	----	----	----
ORGANICS-General									
Biochemical Oxygen Demand (5 days @ 20 deg C)	APHA5210B	2	mg/L		<2	----	----	----	----
Chemical Oxygen Demand	APHA5220C	1	mg/L		**4**	----	----	----	----
Chlorophyll a	APHA10200	1.00	mg/m³		<1.00	----	----	----	----
Dissolved Oxygen	APHA4500OG	0.10	mg/L		**7.07**	----	----	----	----
Oil and Grease	APHA5520B	5	mg/L		<5	----	----	----	----

Work Order : SG1509968
Client : ENVIRONMENTAL RESOURCES MANAGEMENT
Project : ----

Analytical Results QA/QC Results

a) A duplicate analysis was performed on one of the water samples (SW01_R1) to gauge test differences within samples.

b) Method blank was run in each batch of analysis to check background interference, if any.

c) A summarized QC report on recoveries of Lab Control Samples(LCS) and Method Blank

Test(units in mg/L unless otherwise specified)	Method Blank
Chlorophyll a, mg/m^3	<1
Total Nitrogen	<0.10
Total Phosphorus	<0.003
Chemical Oxygen Demand	<1
Biochemical Oxygen Demand (5 days @ 20°C)	<2
Total Suspended Solid	<5
Total Dissolved Solid	<5

Test	LCS, % recovery	Acceptance Criteria, %
Total Nitrogen	107	90-110
Total Phosphorus	99.8	90-110
Chemical Oxygen Demand	100	75-125
Biochemical Oxygen Demand (5 days @ 20deg C)	97.0	75-125
pH	99.3	90-110

ALS Laboratory Group

Environmental Division

Chain of Custody / Analytical Request Form

www.alsglobal.com

SG1509968

Report to: Eva Yew	**Report Format / Distribution**	**Guidelines/Regulations**		
Company: **ERM**		x	PUB Public Sewers	Please put a cross(X) in the box beside the required guidelines/regulation
Contact:	Email 1: Eva.Yew@erm.com		NEA Watercourse	if necessary for reporting
Address: 120 Robinson Road, #10-01,	Email 2:		NEA Landfill criteria(TCLP)	
Singapore 068913	Email 3:			
	Invocie			
Phone: +65 66454408	COA:	**Analysis Request**		
Fax: +65 6226 1636		Please indicate the tests required in the below boxes and put a 'x' against the sample.		
Project: **ERM Project Mandai**				
PO no.:				
Sampler:				

Sample #	Sample Identification (This description will appear on the report)	Date	Time	Refer to attachement	Temperature on site, deg C
1	SW01_R1	10-Jun-15	1150	x	27.9
2	SW01_R1-dup	10-Jun-15	1150	x	27.9
3	SW02_R1	10-Jun-15	1140	x	27.8
4	SW05_R1	10-Jun-15	1057	x	29.0
5	SW08_R1	10-Jun-15	1035	x	27.8
6	SW09_R1	10-Jun-15	1014	x	27.6
7					
8					
9					
10					

ALS Technichem (S) Pte Ltd

Work Order

SG1509968

Telephone : +65 6589 0118

Special Instructions / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the adjacent worksheet.

Remarks:

Bottles: 1 X 1L Plastic, 1 X 1L Amber and 1 X 150ml Sterile Soil jar for each point

10/06 @ ag

Check By: GL

Tests	APHA Method 22nd Ed., 2012
Total Suspended Solid, mg/L	2540D
Oil & Grease (Total), mg/L	5520B
Chlorophyll-a	APHA 10200
Dissolved Oxygen, mg/L	4500 OG
Chemical Oxygen Demand, mg/L	5220C
Biochemical Oxygen Demand, mg/L (5 days @20°C)	5210B
Total Dissolved Solids, mg/L	2540C
pH @25 deg C	4500 H+B
Temperature, °C	2550B
Turbidity, NTU	2130B
Total E. Coli Count, MPN/100ml sample	9221E/F
Nutrients (ie Total phosphorus and total nitrogen	APHA 4500PG (Phosphorus) APHA 4500NC (Nitrogen)

Annex 7.4

Round 2 of Surface Water Survey Results (7 October 2015)

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **SG1518044**	Page	: 1 of 3
Client	: **ENVIRONMENTAL RESOURCES MANAGEMENT**	Project	: ERM Project Mandai
Contact	: Ms Eva Yew	Order number	: ----
Address	: 120 Robinson Road #10-01 Singapore 068913	Quote number	: ----
E-mail	: Eva.Yew@erm.com	Date Received	: 07-OCT-2015
Telephone	: +65 6324 9636	Date Analysed	: 07-OCT-2015
Facsimile	: +65 6226 1636	Date Issued	: 20-OCT-2015
No. of samples received	: 5	No. of samples analysed	: 5

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*
Jinny Wong	Microbiology Laboratory Manager
Pansy Teo	Senior Environmental Manager
Tan Teong Huat	Senior Environmental Manager

General Comments

This report supersedes any previous report(s) with this reference. All pages of this report have been checked and approved for release. Results apply to the sample(s) as submitted. The laboratory declares that the test results relate only to the items tested and do not substitute any other documents. This report may not be reproduced except with prior written approval from the testing laboratory. This report may not be used for advertising purposes.

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Key : LOR = Limit of reporting

- **APHA method is referenced to APHA Standard Method, 22nd Ed, 2012**

Analytical Results

Sub-Matrix: **WATER**				Client sample ID	SW01_R2	SW_R2-dup	SW02_R2	SW05_R2	SW08_R2
				Sampling date/time	07-OCT-2015 15:27	07-OCT-2015 14:42	07-OCT-2015 15:08	07-OCT-2015 14:35	07-OCT-2015 14:15
Compound	*Method*	*LOR*	*Unit*		**SG1518044-001**	**SG1518044-002**	**SG1518044-003**	**SG1518044-004**	**SG1518044-005**
INORGANIC- Physical Properties									
pH @ 25 deg C	APHA4500 H+B	0.1	pH Unit		**7.0**	**7.2**	**6.9**	**7.1**	**7.4**
Temperature of Discharge	APHA2550B	0.10	°C		**29.8**	**30.1**	**29.6**	**29.5**	**29.1**
Total Dissolved Solids	APHA2540C	5	mg/L		**104**	**120**	**75**	**119**	**163**
Total Suspended Solids	APHA2540D	5	mg/L		<5	<5	<5	<5	<5
Turbidity	APHA2130B	0.10	NTU		**9.40**	**1.80**	**7.30**	**1.80**	**3.90**
INORGANICS - Nonmetalllic Constituents									
Total Phosphorus as P	APHA4500P G	0.003	mg/L		**0.050**	**0.033**	**0.047**	**0.032**	**0.831**
Total Nitrogen as N	APHA4500N C	0.10	mg/L		**1.22**	<0.10	<0.10	<0.10	**8.10**
Microbiological Parameters									
Escherichia coli by MPN	APHA9221F (MPN)	1.8	MPN/100 mL		**350**	**220**	**47.0**	**220**	**430**
ORGANICS-General									
Biochemical Oxygen Demand (5 days @ 20 deg C)	APHA5210B	2	mg/L		<2	<2	<2	<2	**25**
Chemical Oxygen Demand	APHA5220C	1	mg/L		**7**	**11**	**11**	**11**	**68**
Chlorophyll a	APHA10200	1.00	mg/m³		<1.00	**4.51**	<1.00	**4.51**	**2.80**
Dissolved Oxygen	APHA4500OG	0.10	mg/L		**7.47**	**7.67**	**6.44**	**7.62**	**7.35**
Oil and Grease	APHA5520B	1	mg/L		<1	<1	<1	<1	<1
Oil and Grease (Hydrocarbon)	APHA5520F	1	mg/L		<1	<1	<1	<1	<1

ALS Laboratory Group

Environmental Division

Chain of Custody / Analytical Request Form

www.alsglobal.com

8044

Report to: Eva Yew	Report Format / Distribution	Guidelines/Regulations		
Company: **ERM**			PUB Public Sewers	Please put a cross(X) in the box beside the required guidelines/regulation
Contact:	Email 1: Eva.Yew@erm.com		NEA Watercourse	if necessary for reporting
Address: 120 Robinson Road, #10-01,	Email 2:		NEA Landfill criteria(TCLP)	
Singapore 068913	Email 3:			
	Invocie			
Phone: +65 66454408	COA:	**Analysis Request**		
Fax:' +65 6226 1636		Please indicate the tests required in the below boxes and put a 'x' against the sample.		
Project: **ERM Project Mandai**				
PO no.:				
Sampler: EC / SS				

Sample #	Sample Identification (This description will appear on the report)	Date	Time	Refer to attachement	Temperature on site, deg C
1	SW01_R2	07-Oct-15	1527	x	29.8
2	SW_R2-dup	07-Oct-15	1442	x	30.1
3	SW02_R2	07-Oct-15	1508	x	29.6
4	SW05_R2	07-Oct-15	1435	x	29.5
5	SW08_R2	07-Oct-15	1415	x	29.1
# 6	SW09_R2	07-Oct-15		x	
7					
8					
9					
10					

ALS Technichem (S) Pte Ltd

Work Order

SG1518044

Telephone : +65 6589 0118

Special Instructions / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the adjacent worksheet.

Remarks:

Bottles: 1 X 1L Plastic, 1 X 1L Amber and 1 X 150ml Sterile Soil jar for each point

Shaun 08/10

#Rescheduled another day.

check by: VM

OK

Tests	APHA Method 22nd Ed., 2012
Total Suspended Solid, mg/L	APHA2540D
Oil & Grease (Total and hydrocarbon), mg/L	APHA5520B
Chlorophyll-a, mg/m³	APHA 10200
Dissolved Oxygen, mg/L	APHA4500 OC
Chemical Oxygen Demand, mg/L	APHA5220C
Biochemical Oxygen Demand, mg/L (5 days @20°C)	APHA5210B
Total Dissolved Solids, mg/L	APHA2540C
pH @25 deg C, pH unit	APHA4500 H+B
Temperature, °C	APHA2550B
Turbidity, NTU	APHA2130B
Total E. Coli Count, MPN/100ml sample	APHA9221E/F
Nutrients (ie Total phosphorus and total nitrogen), mg/L	APHA 4500PG (Phosphorus) APHA 4500NC (Nitrogen)

Annex 7.5

Round 3 of Surface Water Survey Results (11 November 2015)

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **SG1520328**	Page	: 1 of 3
Client	: **ENVIRONMENTAL RESOURCES MANAGEMENT**	Project	: ERM Project Mandai
Contact	: Ms Eva Yew	Order number	: ----
Address	: 120 Robinson Road #10-01 Singapore 068913	Quote number	: ----
E-mail	: Eva.Yew@erm.com	Date Received	: 11-NOV-2015
Telephone	: +65 6324 9636	Date Analysed	: 11-NOV-2015
Facsimile	: +65 6226 1636	Date Issued	: 25-NOV-2015
No. of samples received	: 3	No. of samples analysed	: 3

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*
Jinny Wong	Microbiology Laboratory Manager
Pansy Teo	Senior Environmental Manager
Tan Teong Huat	Senior Environmental Manager

General Comments

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Key : LOR = Limit of reporting

- **APHA method is referenced to APHA Standard Method, 22nd Ed, 2012**

Analytical Results

Sub-Matrix: **WATER**				Client sample ID	**SW05**	**SW08**	**DUP01**	----	----
				Sampling date/time	11-NOV-2015 15:45	11-NOV-2015 16:05	11-NOV-2015 15:45	----	----
Compound	*Method*	*LOR*	*Unit*		**SG1520328-001**	**SG1520328-002**	**SG1520328-003**	**----**	**----**
INORGANIC- Physical Properties									
pH @ 25 deg C	APHA4500 H+B	0.1	pH Unit		**6.5**	**6.7**	**6.8**	----	----
Temperature of Discharge	APHA2550B	0.10	°C		**26.2**	**26.3**	**26.4**	----	----
Total Dissolved Solids	APHA2540C	5	mg/L		**28**	**168**	**30**	----	----
Total Suspended Solids	APHA2540D	5	mg/L		<5	**5**	<5	----	----
Turbidity	APHA2130B	0.10	NTU		**4.50**	**66.0**	**4.50**	----	----
INORGANICS - Nonmetalllic Constituents									
Total Phosphorus as P	APHA4500P G	0.003	mg/L		**0.091**	**0.362**	**0.085**	----	----
Total Nitrogen as N	APHA4500N C	0.10	mg/L		**0.82**	**1.92**	**0.82**	----	----
Microbiological Parameters									
Escherichia coli by MPN	APHA9221F (MPN)	1.8	MPN/100 mL		**>1600**	**>1600**	**>1600**	----	----
ORGANICS-General									
Biochemical Oxygen Demand (5 days @ 20 deg C)	APHA5210B	2	mg/L		**3**	**5**	**3**	----	----
Chemical Oxygen Demand	APHA5220C	1	mg/L		**11**	**37**	**10**	----	----
Chlorophyll a	APHA10200	1.00	mg/m³		**1.97**	**5.10**	**2.18**	----	----
Dissolved Oxygen	APHA4500OG	0.10	mg/L		**7.43**	**7.36**	**7.39**	----	----
Oil and Grease	APHA5520B	1	mg/L		<1	**3**	<1	----	----
Oil and Grease (Hydrocarbon)	APHA5520F	1	mg/L		<1	<1	<1	----	----

CHAIN OF CUSTODY DOCUMENTATION

ATS 7492

ALS TECHNICHEM

CLIENT: ERM Singapore Pte Ltd	LABORATORY BATCH NO.
POSTAL ADDRESS: 120 Robinson Road #10-01, S068913	SAMPLERS: EVA YEW
SEND REPORT TO: EVA YEW SEND INVOICE TO:	PHONE: 65882 7909 FAX:
DATA NEEDED BY: 25 Nov 2015 REPORT NEEDED BY: 25 Nov 2015	REPORT FORMAT: HARD ✓ FAX: DISK: email BULLETIN BOARD:
PROJECT ID: MANDAI QUOTE NO.:	QC LEVEL: QCS1 ____ QCS2 ____ QCS3 ____ QCS4 ____
P.O. NO.: COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:	
FOR LAB USE ONLY	
COOLER SEAL Yes ..... No ..... Broken ..... Intact	E MAIL RESULTS TO: EVA YEW @ ERM.COM
COOLER TEMP: ..... deg C	

20328

SAMPLE DATA				*CONTAINER DATA			ANALYSIS REQUIRED
SAMPLE ID	MATRIX	DATE	TIME	TYPE & PRESERVATIVE	NO.	pH	NOTES
SW 05	water	11/11/15	3:45p	–	01	–	
SW 08	water	11/11/15	4:05p	–	01	–	
DUP 01	water	11/11/15	3:45p	–	01	–	

ALS Technichem (S) Pte Ltd

Work Order

SG1520328

Telephone : +65 6589 0118

RELINQUISHED BY			RECEIVED BY		
NAME: EVA YEW	DATE: 11/11/15		NAME:	DATE:	METHOD OF SHIPMENT
OF: ERM	TIME:		OF:	TIME:	CONSIGNMENT NOTE NO.
NAME:	DATE:		NAME:	DATE:	TRANSPORT CO. NAME.
OF:	TIME:		OF:	TIME:	

*Container Type and Preservative Codes: **P** = Natural Plastic; **N** = Nitric Acid Preserved; **C** = Sodium Hydroxide Preserved; **J** = Solvent Washed Acid Rinsed Jar; **S** = Solvent Washed Acid Rinsed Glass Bottle; **VC** = Hydrochloric Acid Preserved Vial; **VS** = Sulphuric Acid Preserved Vial; **BS** = Sulphuric Acid Preserved Glass Bottle; **Z** = Zinc Acetate Preserved Bottle; **E** = EDTA Preserved Bottle; **S** = Sterile Bottle. **O** = Other.

ALS TECHNICHEM

sharon@111 check by : ok

Annex 8.0

Utility and Unexploded Ordnance Clearance Reports

Annex 8.1

Cable Detection Report

YCL ground surveys
5001 BEACH ROAD
#06-09 GOLDEN MILE COMPLEX
SINGPORE 199588
Tel :9846 8385 Fax :6234 3687
E-mail :ycl.2007@ymail.com
Biz Reg No. :53095224J

CABLE DETECTION REPORT

Project :

Proposed Environmental Base-Line Study at Mandai Road/ Singapore Zoo & Night Safari

Client :

GROUND INSTRUMENTATION & ENGINEERING PTE LTD

62 Ubi Road 1 #01-32 Oxley Bizhub

Singapore 408734

Job No.

2015-214/2

Dated

11-Nov-2015

YCL ground surveys
5001 Beach Road
#06-09 Golden Mile Complex
Singapore 199588
Tel :6296 8204
Fax :6234 3687
Email :ycl.2007@ymail.com
Co reg no :53095224J

Date :11th November 2015

Our Ref :Job-214/2-2015
Your Ref :

ENVIRONMENTAL RESOURCES MANAGEMENT (S) PTE LTD
120 Robinson Road
#10-01
Singapore 068913

Tel :6645 4416
Fax :6226 1636

Attention :Mr Desmond Leung

Dear Sir

CABLE DETECTION WORK FOR PROPOSED EBS AT MANDAI LAKE ROAD/ SINGAPORE ZOO & NIGHT SAFARI

We are pleased to submit the cable detection report for the above mentioned.

This Cable Detection Work was carried out as per our quotation ref :YCL-QTN-15014-05, dated 19th May 2015.

Thank you

Yours faithfully

Gary Lim
for and on behalf of
YCL ground surveys
(Mobile :9846 8385)

Location of Earthwork	:	**Mandai Lake Road/ Singapore Zoo & Night Safari**
Particular of Client / Company / Person-in-charge	:	**Mr Mohiuddin Ahmad** **Ground Instrumentation & Engineering Pte Ltd**
Address	:	**62 Ubi Road 1** **#01-32 Oxley Bizhub** **Singapore 408734**
Tel / Mobile No	:	**6345 7282**
Fax	:	**6345 7290**

1. Details of Work :

1. Detection conducted from : 7th November 2015
2. Detection was carried out for : Power cables, PowerGas, SingTel, Netlink Trust , StarHub Telco & PUB Water mains
3. Detection Area / Bore-hole : **See attached detection drawing**
   BH (1, 2, 3, 4, 5, 6, 7, 8)
4. Equipment used : RD-8000(Radiodetection, UK)
5. Earthwork contractor are not to carry out other type of earthwork not mention in this report.
6. This report is solely for the above mentioned client. No other earthwork Contractors/ Client are allowed to use this report as stated in the regulations.
7. Please read the site findings and findings/ comments of the detection works

Name of Client	:	**MOHIUDDIN AHAMAD**
Designation	:	**DIRECTOR**
NRIC / WP / FIN No.	:	
Date	:	

Signature / Company Stamp

YCL

2. **Findings / Comments** :

Proposed Site :

1. "Power mode" was used in the detection, NO signal was detected in the vicinity of the proposed work area.(See Detection Drawing)
2. "Radio mode" was used in the detection, UNKNOWN signal was detected in the vicinity of the proposed work area.(See Detection Drawing)
3. PowerGrid cable is NOT within the earthwork area as per SP PowerAssets cable route plan.
4. PowerGas mains is NOT within the earthwork area as per PowerGas Mains route plan.
5. SingTel is NOT within the earthwork area as per SingTel Plant Map.
6. Netlink Trust is NOT within the earthwork area as per Netlink Trust Plant Map.
7. StarHub Telco is NOT within the earthwork area as per StarHub Fixed Plant Map.
8. PUB Water mains is NOT within the earthwork area as per PUB Water Mains Plant Map.
9. Earthwork contractor is to take note of the existing underground utilities in the works area other than those mentioned above.
10. Earthwork contractor is to request underground utilities plans from the project owner which owned by the owner.
11. **Earthwork contractor are advised to dig trial pit (2.0 x 1.0 x 2.0)m adequate enough to identify and to account for the services prior to actual works.**
12. Proposed Trial Pits are to be carried out at ALL the Bore-hole/ earthwork locations as indicated in the detection drawings.
13. Please read the site instruction for earthwork, preventives measure and what to do when a cable or pipe is damaged.
14. Respective site supervisor must report to the manager/ engineer should the drilling crew encounter hard material in the process of drilling at a shallow depth or change of earthwork location.
15. Should you have any clarification, do contact us.

Name of LCDW / TCDW	:	**YEO KOK SENG**			
LCDW No.	:	**EMA 1997-0866**	Expiry Date	:	**Life-Time**
TCDW No.	:	**IDA 00177**	Expiry Date	:	**N.A.**
Contact No.	:	**9116 7326**	Fax	:	**6234 3687**

Name of Client	:	**MOHIUDDIN AHAMAD**
Designation	:	**DIRECTOR**
NRIC / WP / FIN No.	:	
Date	:	

Signature / Company Stamp

3. Site Instruction for Earthwork :

1. Each cable detection report is valid for 3 months only when the site is not hoarded up. A new set of service plan is to be obtains from the service provider. The plan must be endorsed by the client prior to the commencement of any site works. Trial holes must be carried out for all the services detected prior to any earthworks / construction / drilling.

2. Further detection is required for:
   Any cables diversion,
   Any newly laid services within the earthworks area.
   Any works beyond the detected area.
   When the existing road furniture referred to is removed, shifted and / or displaced. When the detection markings were removed, eroded by weather and / or by construction activities.

3. To avoid misreading / misinterpretation of cable detection report, the report shall not be passed to any third parties without consent of the LCDW / TCDW. Your sub-contractor has to engage LCDW / TCDW to carry out the work as required by the regulations. It is illegal for a company to carry out earthworks using a report / NCE(s) which was submitted by another company.

4. The cable detection drawing shown only the detected signal and NOT the actual number of cables. For the case of transmission line (400 /230 /66 KV), the detected signal contain groups of cables and occupies 3.0 metres or more in width or more than 1 layer in depth.

5. The cable detection on the ground surface is unable to pin point their exact positions. The actual depth / position of the underground cables need to be verified by means of trial holes / trenches. In certain critical location, trial holes / trenches are to confirm the absence of any cable. Failure to comply with the requirement is liable under relevant sections of the ELECTRICITY ACT / TELECOMMUNICATION ACT.

6. You are to inform the LCDW / TCDW should you relocate your earthworks boundary/ shifted of hoarding location and the change of site personnel.

7. Trial holes / trenches are to be dug by manual work only (STRICTLY NO MECHANICAL EXCAVATION) and notify the LCDW/ TCDW upon completion. Photographs on both wide angle and closed up shots must be taken for each and every trial hole for inspection by the relevant authorities. All photographs records must submit to LCDW/ TCDW for record.

8. Trial holes / trenches around Extra High Voltage Cables (66 /230 /400 KV) must be fully supervised and approval from the transmission office is needed. You are required to submit Notice for Commencement of Earthworks (NCE) to PowerGrid at least 7 days prior to *Earthwork in the vicinity of (HT /6.6 /22 /66 /230 /400 KV) under the provision of the Electricity Act, Chapter 89A.

9. The contractor is also required to submit a written notice to the telecommunication system licensee at least 7 days before the commencement of the earthworks and consult with the telecommunication system licensee on the necessary precautions to be taken to prevent damage to the cables. For a list of Telecommunication System Licensees to be Consulted/Notified please visit the web site at http://ida.gov.sg

3. **Site Instruction for Earthwork - Cont'd** :

10. ***Earthworks**
    Under Electricity Act, Chapter 89A:
    Any act of excavating earth, rock or other material (by whatever means) in connection with – Construction, reconstruction, extension, renovation, alteration, demolition or repair of any building, road, railway, bridge, viaduct, flyover, sewer or sewage works; Laying, inspecting, repairing or renewing of any mains, pipes, cables, fittings or other apparatus; any soil investigation works; or other works usually undertaken by person who carry out business as a contractor in the construction industry or as a professional engineer. Any act of boring, dredging, jacking, leveling, piling or tunneling on or under any premises or street by mechanical means; and the driving or sinking or any earth rod, casing or tube into the ground.

11. No further digging beyond the cable identification slab like red brick, PVC cable marker or any cable conduit/ duct is exposed. The SP PowerGrid/ Relevant authorities or the LCDW/ TCDW need to be informed immediately for the follow up action. The removal of any such slab without the consent of the relevant authorities is considered as vandalism.

12. Avoid disturbing the protective layers of soil and slabs surrounding the cables / pipes. Removing the slabs without the SP PowerGrid Ltd/ Authorities consent would be constructed as an act of vandalism. Please consult SP PowerGrid Ltd/ Authorities.

13. Trial holes are required for all the services detected and must be completed before any full-scale excavation, tunneling, piling, boring, pipe jacking or driving of earth rods etc.

14. Trial holes are deemed necessary to ascertain and account for the absence of services as required by the authorities.

15. Requirement for trial hole / trench :
    You are to manual dig adequate trial holes/ trenches. Depending on the site situation, long trenches must be carried out. Trial holes are needed to ascertain the presence or absence of any services prior to the earthworks location. Dimension of Trial hole (L = 2.0 x W = 0.8 x D = 1.2 – till services)metres. Depend on the site condition, longer length may be required as to fully expose the cables corridor. Please consult relevant authorities or cable detection worker.

16. Prior to approval from the relevant authorities are required for any excavation/ piling near the transmission cables/ cable ducts. No mechanical excavation within 1.5 metres from the nearest services (3.0 metres for the 66 /230 /400 KV cables).

17. The whole length of cable in the vicinity needs to be exposed prior to piling / boring etc.

18. Exposed cables/ cable ducts or its joint need to be protected / supported as specified by the relevant authorities.

19. Where tunneling or pipe jacking has to go under any cables, deeper trial holes beyond services are required in order to ascertain their clearance.

20. Experienced guide for the mechanical excavation needs to be deployed. He has to warn the operator when the type of soil changes during as it is a tell-tale sign for the services nearby.

21. In the event of any cable damages, the LCDW / TCDW must be informed immediately. (**See Item 5.1 to 5.5.13**)

3. Site Instruction for Earthwork - Cont'd :

22. The personnel briefed by the LCDW / TCDW must supervise the excavation near the services detected. Another person must be briefed to takeover this job when such excavation needs to be carried out in his absence. Another briefing must be arranged with the LCDW / TCDW for the new person when the briefed staffs resigned or transferred.

23. The cable detection will not be accurate as expected, if:
    1 The detection is carried out under noisy or under adverse conditions such as in the magnetic field, radio frequency environment or near to reinforce-concrete structure
    2 The site is not cleared or with obstruction.
    3 The cable detection worker is not supplied with the updated services details.
    4 The existing cables are not energized/ buried too deep/ cable sizing too small.

24. Telecommunication cables may not be detected due to their weak signal and Optic Fibre cables are undetectable. Joint site inspection with the relevant authorities is needed for such cases.

25. While every attempt is made to detect all cables, some cables might remain undetected under adverse conditions and weak signal, should an undetectable cable(s) be damaged, your company shall and agrees to bear the full coast of repair.

26. One copy of this Cable Detection Report must be clearly display on site. Copies of NCE(s) and Reply Letter (Requirement for Earthworks, etc) must be clearly display on site.

27. Implement a Permit to work system to monitor and ensure that all earthworks are properly tracked and controlled.

28. The earthwork contractor is to brief his / her site staffs on the prevention of damaging the services and on the location of the services in the vicinity of the earthwork area prior to any earthwork after the handover of this report. Do inform the LCDW/ TCDW if there are changes of site personnel.

4. Preventives Measure :

1. Care and diligence during earthworks are necessary to avoid damaging the underground electricity cables and gas pipes. Contractors play an important role in ensuring preventive measures are in place.

2. Implement a Permit-To-Work system to manage different levels of checks at every stage for close monitoring of earthworks activities within the site.

3. Mark out and peg all detected cable and gas pipe locations. Ensure these markings are continuously maintained.

4. Dig trial holes manually to be very sure that there are no underground cables or pipes at the proposed earthworks area, or to ascertain the exact locations if there are cables or pipes.

5. **Engage REOs or PREOs to operate excavation equipment and/or carry out mechanical excavation.**

6. Use manual excavation whenever earthworks come to within two metres of cables or pipes (except high-pressure transmission gas pipes). In cases where pre-mixed concrete and hardcore road surfaces need to be removed, mechanical excavation - under close supervision - should be restricted to the surface area only.

4. **Preventives Measure (Cont'd):**

7. Provide appropriate and adequate soil control measures - such as shoring and shuttering - to prevent soil movement which can cause cable or pipe damage in excavated areas.

8. Protect exposed underground cables by enclosing them with cut PVC pipes or other protective covering to prevent tools or falling objects from accidentally damaging the cables.

9. Do consult the relevant Service Providers for consultation.

5. **What to do when a cable / pipe is damaged :**

1. Stop all work activities in the vicinity of the damaged cable or pipe.

2. Keep out all personnel from the area.

3. Inform the Cable Detection Worker (LCDW/ TCDW).

4. Remain at site to assist the relevant authorities on their arrival.

5. List of Important Telephone Numbers.

S/No	Service Providers	Contact No.
1	**SP PowerGrid**	**6778 8888** **1800 778 8888**
2	**PowerGas**	**1800 752 1800**
3	**SingTel /** **OpenNet**	**1800 288 4099 (Office Hours) /** **1608 (After Office Hours)**
4	**StarHub Fixed**	**6825 6100 (Office Hours) /** **1800 782 7482 (After Office Hours)**
5	**StarHub CATV**	**6725 1570**
6	**SP Telecom**	**6778 8888 /** **1800 778 8888**
7	**France Telecom Long Distance /** **M1 Ltd /** **Pacnet Global (Singapore) /** **Reach International Telecom** **TATA Communications International /** **Telecom Italia Sparkle** **C/oRed Technologies**	**6846 7661**
8	**View Qwest**	**6824 0228**
9	**Flag Telecom**	**6498 6728**
10	**BlueTel**	**6556 2221**
11	**Matrix**	**6898 8888**
12	**Verizon Business**	**6248 6768 /** **9111 5320**
13	**PUB Water Department**	**6282 4344**

6. **Attachment** :

1. Form NCD (Notice to Carry out Cable Detection Work)
2. Cable Detection Drawing
3. PowerGrid's Letter & Plan (Ref :C201512219, 31/ 10/ 2015)
4. PowerGas's Letter & Plan (Ref :G201506013, 10/ 6/ 2015)
5. SingTel's Letter & Plan (Ref :20153551, 20/ 7/ 2015)
6. Netlink Trust's Letter & Plan (Ref : 20150709-1, 08/7/2015)
7. StarHub Fixed Plant Map (Ref :2015/07/142, 24/7/2015)
8. PUB Water Mains Plant Map (Ref :MK14-01540K, 13/ 7/ 2015)
9. List of Telecommunication System Licensees to be Consulted/Notified (For Information)
10. List of Personnel Briefed on Cable Prevention/ Cable Locations
11. Notes on Trial Holing

7. **Client's Acknowledgement** :

1. We fully understand the above site instructions and shall comply fully with the requirement as stated in the **Site Instruction for Earthwork (3.1 to 3.28), Preventives measures (4.1 to 4.9), What to do when cable / pipe are damaged (5.1 to 5.5) and the above mentioned attachments (6.1 to 6.11).**

2. I and my site's staffs had been briefed on the location of the underground services detected at the proposed site as indicated and the above mentioned statements.

3. We will inform the Cable Detection Worker if there are changes of site personnel/ new area that are not mentioned in this report.

4. We will ensure that all precautionary measures are taken to protect and avoid all services when carrying out earthworks within the prescribed boundaries. We also understand that the results of the detection works will not discharge us from any liabilities when any underground services are damaged by us during the course of any earthworks. We will stop all earthworks in the event of finding services that are not shown by the LCDW/ TCDW. In the event of any underground services that required diversion, cable isolation and termination, etc., I, the Contractor, will immediately inform the relevant authorities and Client site representative.

5. I received and acknowledge the contents of this report (2 sets).

Name of Client	:	**MOHIUDDIN AHAMAD**
Designation	:	**DIRECTOR**
NRIC / WP / FIN No.	:	
Date	:	Signature / Company Stamp

YCL

Date :11th November 2015

GROUND INSTRUMENTATION & ENGINEERING PTE LTD
62 Ubi Road 1
#01-32 Oxley Bizhub
Singapore 408734

Dear Sir

NOTES ON TRIAL HOLING WORK :

CABLE DETECTION WORK FOR PROPOSED EBS AT MANDAI LAKE ROAD/ SINGAPORE ZOO & NIGHT SAFARI

1. As you have been made aware, I have to reiterate that the cable detection markings on the ground provide an indication of the cable locations but may not pin point the entire corridor or group of buried cables. You, your agent, and/or your staff have to dig trial holes to expose the cable corridors.

2. Where required, trial holes are also deemed necessary to confirm the absence of underground cables.

3. To reduce the risk of damage to cables, Trial Holes are to be dug by Manual means. You are advised to backfill the trial holes with sandbags filled with quarry sand to limit soil settlement and erosion. The sandbags also serve as belowground markers for the buried cables.

4. While carrying out any mechanized ground-penetration work, your workers have to keep a minimum safety clearance (2.0 metres on each side) away from the cable routes – exposed by trial holing work.

5. Where 6.6/ 22/ 66/ 230/ 400 KV cables are detected/ exposed, you are to contact/ write to the SP PowerGrid Ltd to site for a joint inspection of the trial holing work.

6. Within the vicinity of high voltage cables, neither earth penetration nor trial Holing work is allowed before SP PowerGrid Ltd has been given 7 days' written notice. Earthwork is any earth penetration work by whatever means.

7. You are also advised not to pass the cable detection information to other parties without notifying and obtaining the LCDW's written concurrence. This is to avoid any misinterpretation of the information contained in the detection drawings and records.

8. Please instruct your sub-contractors to engage their own Licensed Cable Detection Workers.

Name of LCDW : _____

Client Acknowledgement

Signature / Company Stamp :

_____

Name : **MOHIUDDIN AHAMAD**
Designation : **DIRECTOR**

Date : _____

List of Telecommunication System Licensees to be Consulted/Notified (For Information, subject to change)

1. **Bluetel Networks Pte Ltd**
   Network Manager
   9 Tai Seng Drive #02-02J Geo-Tele Centre Lobby B Singapore 569510
   Tel: 6556 2221 Fax: 6556 2777

2. **Flag Telecom Singapore Pte Ltd**
   c/o Fibre Wind Projects Pte Ltd
   26 Kallang Place #03-16 Singapore 339157
   Tel :6498 6728 Fax :6342 1207

3. **Orange Carriers Singapore Pte Ltd**
4. **MobileOne Ltd**
5. **Pacnet Global (Singapore) Pte Ltd**
6. **Reach International Telecom (Singapore) Pte Ltd**
7. **Telecom Italia Sparkle Singapore Pte Ltd**
8. **TATA Communications International Pte Ltd**
9. **Superloop Singapore Pte Ltd**
   c/o RED Technologies (S) Pte Ltd
   100 Lorong 23 Geylang #09-01 D'Centennial Singapore 388398
   Tel: 6846 1784 Fax: 6846 1795

10. **Matrix Networks Pte Ltd**
    55 Changi North Crescent Singapore 499628
    Tel: 6898 8888 Fax: 6543 3648

11. **CityNet Infrastructure Management Pte Ltd**
    Netlink Trust Plant (formally known as OpenNet)
    750E Chai Chee Road #07-03 Technopark@Chai Chee (Lift Lobby 2) Singapore 469005
    Tel: 6718 2828 Fax: 6449 0221

12. **Singapore Telecommunications Limited (SingTel)**
    Outside Plant Planning Division
    375 Tanjong Katong Road #03-00
    Blk 1 Katong Telecommunication Complex Singapore 437132
    Tel: 6342 5900 / 6342 5910 Fax: 6440 6305

13. **SP Telecommunications Pte Ltd (SP Telecom) (Infrastructure Facilities & Services)**
    c/o PowerGrid Ltd (Earthworks Monitoring & Cable Protection Section)
    Pasir Panjang District Office
    25 Pasir Panjang Road Singapore 117536
    Tel: 6470 0621 Fax: 6475 9400 / 6479 5660

14. **StarHub Ltd**
15. **StarHub Cable Vision Ltd**
    Attn: Administrator for Sale of StarHub Plant Map
    67 Ubi Avenue 1 #05-01 StarHub Green Singapore 408942
    Tel: 6825 6374 Fax: 6720 5028

16. **ViewQuest Pte Ltd**
    Planning Manager (MIC Operation)
    c/o Lucky Joint Construction Pte Ltd
    10 Tuas Drive 2 Singapore 638645
    Tel: 6284 0288 Fax: 6283 2862

YCL

LIST OF PERSONNEL BRIEFED ON CABLE PREVENTION/ CABLE LOCATIONS/ SITE MEETING RECORDING SHEET

Location : **Proposed Environmental Investigation Works at Mandai Lake Road/ Singapore Zoo & Night Safari**

Job No. : 2015-214/2 *(See attached report)*

S/No	Name of Personnel Briefed	Designation	Contact No.	Company Name	Date Briefed	Signature
1	MOHIUDDIN AHAMAD	DIRECTOR	6345 7271	GROUND INSTRUMENTATION & ENGINEERING PTE LTD		

YEO KOK SENG **9116 7326**

Name of LCDW / TCDW *Mobile No.*

FORM NCD

Deputy Director
Earthworks Monitoring &
Cable Protection Section
Network Management Division
SP PowerGrid Ltd
25 Pasir Panjang Road
Singapore 117536

(This form is to be submitted with site plans indicating the detection zone clearly before the commencement of cable detection work.)

FAX NO. : 6475 9400
DID NO. : 6470 0604/5

NOTIFICATION OF COMMENCEMENT OF CABLE DETECTION WORK

I, the undersigned, intend to carry out cable detection work. The particulars are as follows:

1 Location of cable detection work : Mandai Lake Road/ Singapore Zoo & Night Safari

2 Particulars of contractor/client : Mohiuddin Ahamad
Company / Person-in-charge : Ground Instrumentation & Engineering Pte Ltd
Address: 62 Ubi Road 1 #01-32 Oxley Bizhub Singapore 408734
Tel No. : 6345 7282 Mobile No : -

3 Principal : Private Dept/Sect : -

4 Date cable route drawings obtained (LCDW to note mandatory requirement): 31-Oct-15

5 Date of cable detection to be carried out: 7-Nov-15

6 Voltage level of the cable in the vicinity ? No SPPA's cable /~~LV / HT*~~

7 Proposed date for earthwork:
Start : 12-Nov-15 Finish : 30-Jan-16

8 Purpose of earthwork : Environmental Investigation Works

I shall prepare and issue to my client a set of cable detection records and keep EMCP informed of any changes in the above particulars by fax. I will also remind my client to submit the Notice for Commencement of Earthworks (NCE) if there are High Voltage cables within the vicinity.

Signature

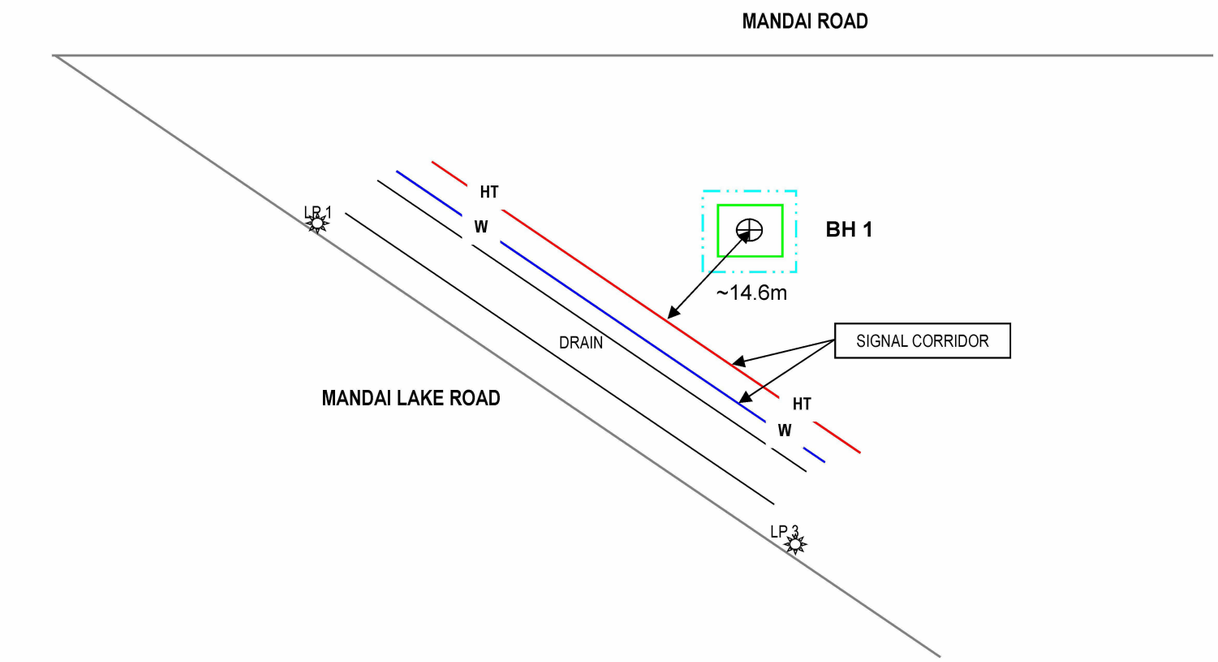
Yeo Kok Seng
Name of licensed cable detection worker

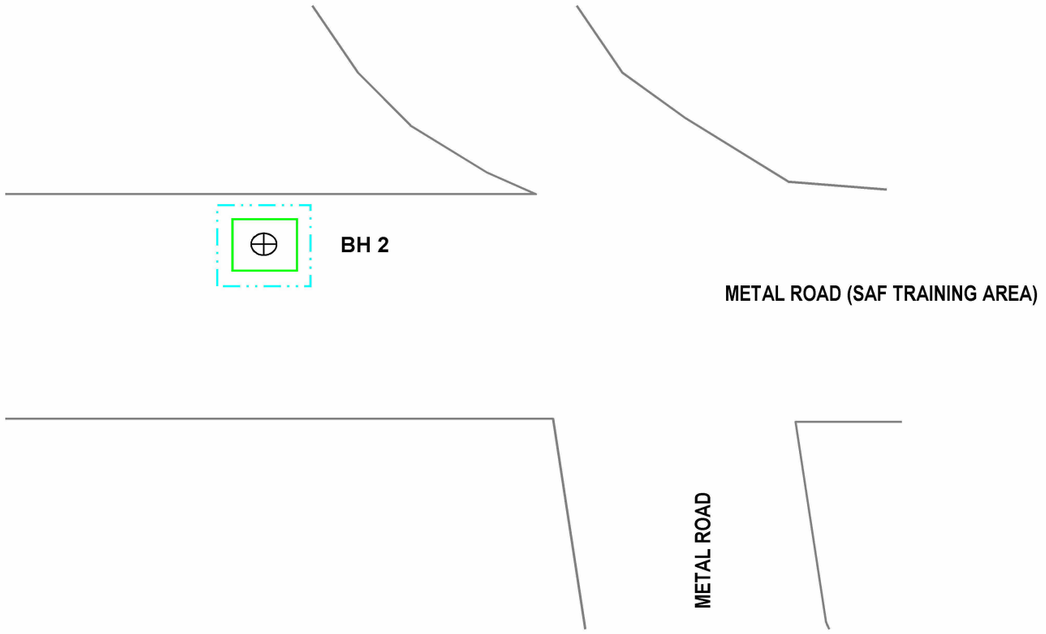
Date: 7-Nov-15 Licence No.: 97-0866

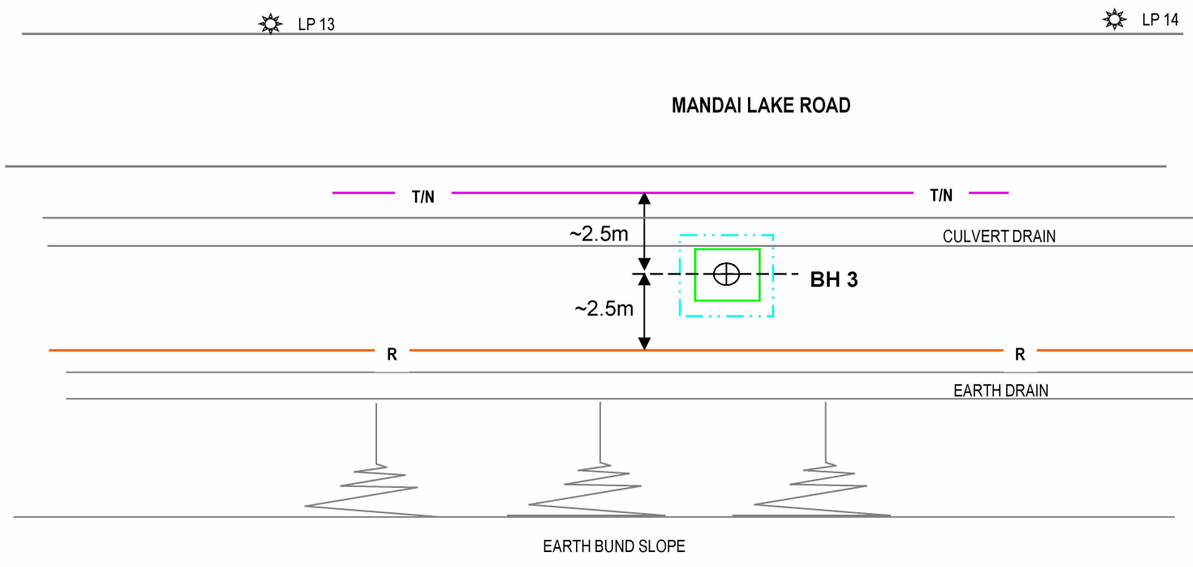
Tel No.: 9116 7326 Mobile No.: 9116 7326

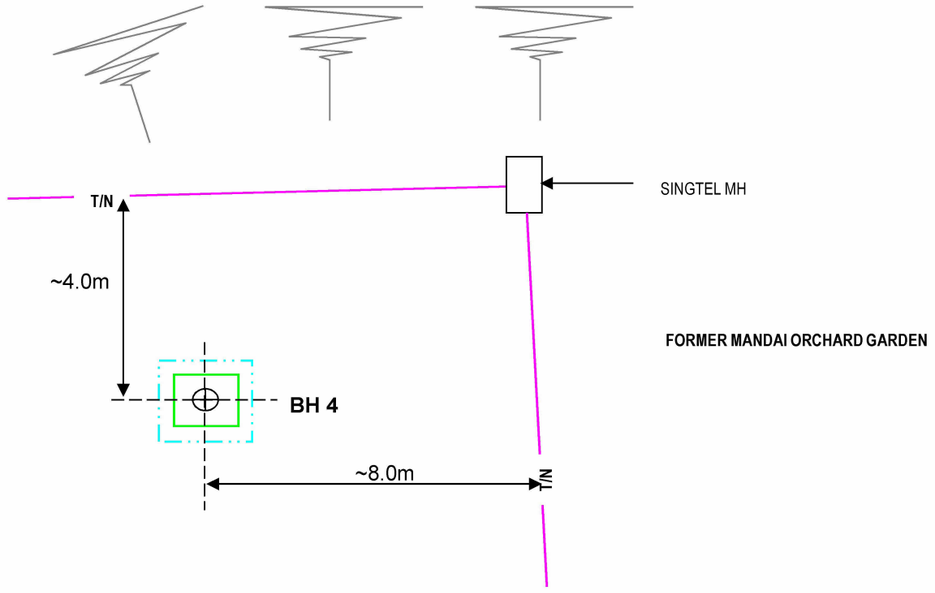
* Delete where applicable.

(Revision Feb 2006)









Legends :

C / LV / HT	POWER CABLE / LV / HT SIGNAL DETECTED
T / N	SINGTEL / OPENNET CABLE DUCTS
SH / SCV	STARHUB / STARHUB CATV CABLE DUCTS
G	GAS MAINS (Indicative)
W	PUB WATER MAINS (Indicative)
SP	SP TELECOM CABLE DUCTS
R	RADIO SIGNAL DETECTED
	PROPOSED TRIAL HOLE (TH)
	LAMP-POLE (LP)
	PROPOSED BORE-HOLE (BH / CPT)
	AREA OF DETECTION (5.0 x 5.0)m²

Notes :

1. While every attempts is made to detect all cables, some cables might remain undetected under adverse conditions and weak signals, should an undetected cables be damaged, your company shall and agrees to bear the full cost of repair.
2. The earthwork contractor shall instruct his workers **NOT** to risk earthworks by mechanical means for trial holes. No commencement of any earthworks in the vicinity of HT & Telecommunications cables until NCE(s) had been submitted & replied.
3. The cable detection marking and dimensions taken at the site are valid for a period 3/ 6 months from the date of cables detection being performed or when the existing road furniture are removed, shifted and/ or displaced or when detection markings are eroded or removed by the elements of weather and/ or other activity whichever comes first.
4. The contractor shall put up warning sign along the detected HT cables. Do not allow mechanical excavation work near the HT.
5. Avoid disturbing the protective layers of soil & slabs surrounding the HT cables (400/230/66KV). Removing the slabs without PowerGrid consent would be constructed as act of vandalism. Contractor to verify with SP PowerGrid.
6. Any damages to any cables are chargeable offence.
7. When in doubt, Please contact the authorities or LCDW/ TCDW.
8. Please read this drawing inconjuction with the attached report.

Drawing Title :	Cable Detection Drawing		
SP PowerGrid Dwg (Ref / Date) :	C201512219	/	31-Oct-15
SingTel Dwg (Ref / Date) :	20153551	/	20-Jul-15
Dimension in Metres (m) & Approximated	Scale :	N.T.S.	
Drawing Ref :	YCL/214/2-15/GIE/MANDAILAKERD/01		

Project Title :	PROPOSED ENVIRONMENTAL BASE-LINE STUDY AT MANDAI LAKE ROAD/ SINGAPORE ZOO & NIGHT SAFARI
Client :	GROUND INSTRUMENTATION & ENGINEERING PTE LTD 62 Ubi Road 1 #01-32 Oxley Bizhub Singapore 408734

I, have been briefed by our LCDW/ TCDW on the cable detection done and to comply all the requirements and necessary precaution to prevent damage to any utilities as required by the authorities.

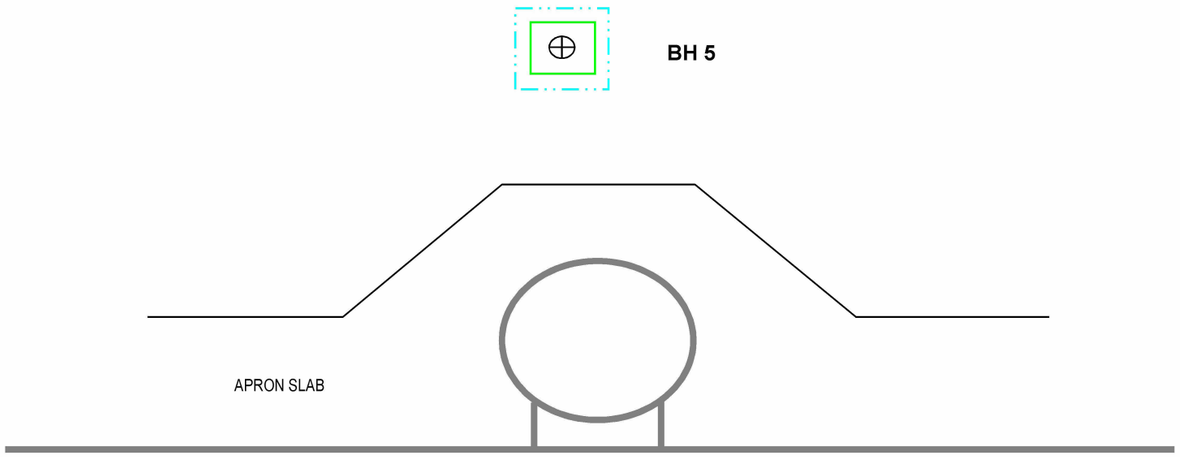
MOHIUDDIN AHAMAD / DIRECTOR

Name / Signature / Company Stamp / Date

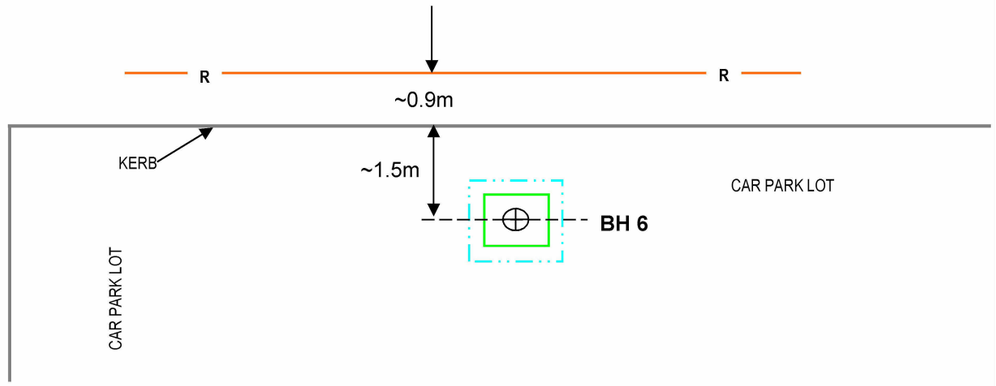
YCL Ground Surveys
5001 Beach Road #06-09
Golden Mile Complex Singapore 199588

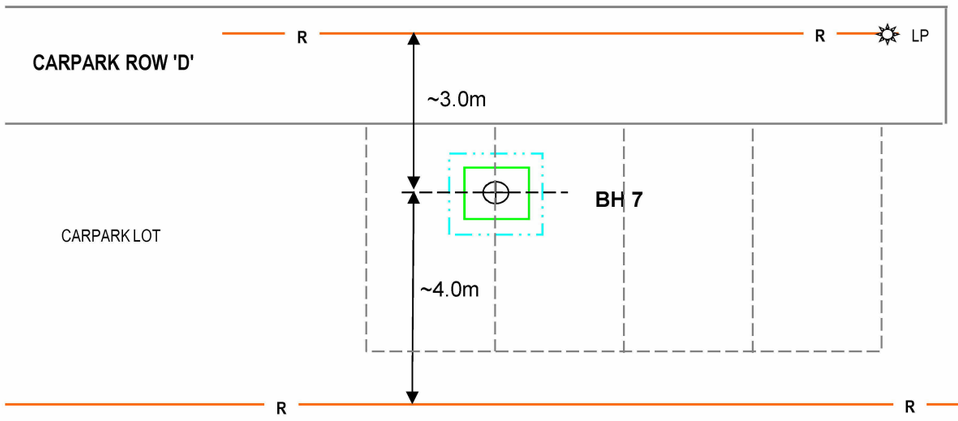
Project Ref :	2015-214/2	Rev. :	Date :	11-Nov-15

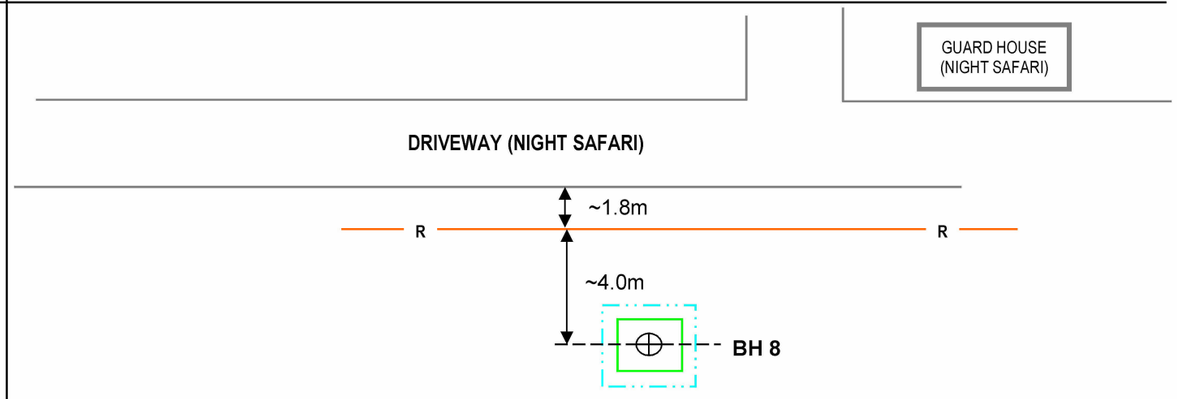
LCDW / TCDW Signature



MULTI-STOREY CARPARK







Legends :

C / LV / HT	POWER CABLE / LV / HT SIGNAL DETECTED
T / N	SINGTEL / OPENNET CABLE DUCTS
SH / SCV	STARHUB / STARHUB CATV CABLE DUCTS
G	GAS MAINS (Indicative)
W	PUB WATER MAINS (Indicative)
SP	SP TELECOM CABLE DUCTS
R	RADIO SIGNAL DETECTED

PROPOSED TRIAL HOLE (TH)
LAMP-POLE (LP)
PROPOSED BORE-HOLE (BH / CPT)
AREA OF DETECTION (5.0 x 5.0)m²

Notes :

1. While every attempts is made to detect all cables, some cables might remain undetected under adverse conditions and weak signals, should an undetected cables be damaged, your company shall and agrees to bear the full cost of repair.
2. The earthwork contractor shall instruct his workers **NOT** to risk earthworks by mechanical means for trial holes. No commencement of any earthworks in the vicinity of HT & Telecommunications cables until NCE(s) had been submitted & replied.
3. The cable detection marking and dimensions taken at the site are valid for a period 3/ 6 months from the date of cables detection being performed or when the existing road furniture are removed, shifted and/ or displaced or when detection markings are eroded or removed by the elements of weather and/ or other activity whichever comes first.
4. The contractor shall put up warning sign along the detected HT cables. Do not allow mechanical excavation work near the HT.
5. Avoid disturbing the protective layers of soil & slabs surrounding the HT cables (400/230/66KV). Removing the slabs without PowerGrid consent would be constructed as act of vandalism. Contractor to verify with SP PowerGrid.
6. Any damages to any cables are chargeable offence.
7. When in doubt, Please contact the authorities or LCDW/ TCDW.
8. Please read this drawing inconjuction with the attached report.

Drawing Title :	Cable Detection Drawing		
SP PowerGrid Dwg (Ref / Date) :	C201512219	/	31-Oct-15
SingTel Dwg (Ref / Date) :	20153551	/	20-Jul-15
Dimension in Metres (m) & Approximated	Scale :	N.T.S.	
Drawing Ref :	YCL/214/2-15/GIE/MANDAILAKERD/01		

Project Title :	PROPOSED ENVIRONMENTAL BASE-LINE STUDY AT MANDAI LAKE ROAD/ SINGAPORE ZOO & NIGHT SAFARI
Client :	GROUND INSTRUMENTATION & ENGINEERING PTE LTD 62 Ubi Road 1 #01-32 Oxley Bizhub Singapore 408734

I, have been briefed by our LCDW/ TCDW on the cable detection done and to comply all the requirements and necessary precaution to prevent damage to any utilities as required by the authorities.

MOHIUDDIN AHAMAD / DIRECTOR

Name / Signature / Company Stamp / Date

YCL Ground Surveys
5001 Beach Road #06-09
Golden Mile Complex Singapore 199588

Project Ref :	2015-214/2	Rev. :	Date : 11-Nov-15

LCDW / TCDW Signature

Annex 8.2

Unexploded Ordnance Report

EXPLOMO TECHNICAL SERVICES PTE LTD

Company Registration No. 198804389R

FINAL REPORT FOR ENVIRONMENTAL RESOURCES MANAGEMENT(S) PTE LTD

Geophysical Survey, Detection of UXO



From: 22nd July 2015

EXPLOMO TECHNICAL SERVICES PTE LTD
62 Burn Road
#06-01 TSH Centre
Singapore 369976
Tel: 65-6281 2105 Fax: 65-6281 2106
http: //www.explomo.com.sg

TABLE OF CONTENT

SCANNING AT MANDAI ZOO AREA

From July 2015

1. INTRODUCTION

1.1 Explomo Technical Services Pte Ltd was awarded a contract by Environmental Resources Management(S) Pte Ltd to carry out a scanning operation by means of a geophysical survey for the detection of UXOs.

1.2 The worksite is at around Mandai Zoo area.

1.3 This contracted area will be as follow:

A) Total number of Plots not exceeding more than 20 individual plots.
B) Each individual plot not measuring more than 2m x 2m.
C) Depth of scanning is limited to 3m.

1.4 These individual plots are designated for bore holes testing to conduct soil investigation.

2. SCOPE OF WORK

2.1 Explomo shall do a scanning operation to detect any Unexploded Explosive Ordnance (UXO) that may not been discovered.

2.2 Explomo specialist will first conduct a surface sweep at the area for any UXO or metallic object which will influence the detection of the operation.

2.3 The EM61 MK2A detector will be deployed for the deep scanning and it is capable to detect any UXO up to a depth of 3 meters depending on the size and position of the ordnance

3. REMEDIATION METHOD

3.1 Surface Clearance (Visual)

3.1.1 The surface clearance phase shall include a physical walk by specialists thoroughly inspecting the site to be cleared.

3.1.2 Ordnance or ordnance residues that are located will be marked and reported.

3.1.3 The purpose of the surface clearance is to detect and identify all surface ordnance or ordnance residues and removal of all metallic objects which will disrupt the detection of the scanning operation.

3.2 Pre-Geophysical Survey

The remediation area and depth for this project was agreed at the following.

3.2.1 Remediation area: Mandai Zoo area

3.2.2 Depth of scan: Limited to 3m

3.2.3 Location of Plots: See annex A

3.2.4 Number of plots: Not more than 20 individual plots

3.2.5 Size of plots: Not more than 2m by 2m

3.2.6 The geophysical survey team will comprise of an operator who will manually tow the EM61 MK2A over the area provided by ERM and 1 x Specialist who will program the equipment.

3.3 Geophysical Investigation

3.3.1 Geophysical investigation will be conducted for all the UXO Clearance Footprints specified in the scope of work. ETS used three types of Detectors include the Schonstedt and the Geonics EM61 Mk2 HP Time Domain Electro Magnetic Induction Instrument (TDEMI). TDEMI instruments are one of the most reliable technologies of detecting buried metallic and non-metallic items.

Fig 3 Using of EM61 MK2A

3.3.2 Geonics EM61-MK2A detector will be deployed for scanning of the area, the geophysical survey system. The TDEMI detector utilizes 1m x 0.5m wide for the transmitter and receiver coils.

3.4 On completion of an area survey, the results of the findings will be downloaded in the computer and a survey report will be printed out.

3.5 With the assistant of the survey printout, Explomo specialist will indicate to ERM POC which area within the plot they should avoid when drilling the bore holes for soil investigation.

3.6 Alternative to using EM61 MK2A in unfavorable conditions, the Schonstedt GA-74Cd will be use instead. The Schonstedt GA-74Cd will not have any survey printout.

4 QUALIFICATION OF STAFF

4.1 The appointment holder's involved in this project are as follows:

▪ Mr. Ronald Samy	-	Program Manager
▪ Mr. Eric Tan Kuan Lung	-	Project Manager
▪ Mr Lim Jun Shan	-	Specialist
▪ Mr. Victor Kwek	-	Specialist
▪ Mr. Tan Boon Guay	-	General Worker
▪ Mr. Wong Jian Fei	-	General Worker

5 DURATION OF PROJECT

5.1 The project schedule is as follow:

Mobilization	-	From 15th July 2015
Field Detection	-	From 22nd to 23rd July 2015
Data Interpretation	-	From 22nd to 23rd July 2015

6 FINDINGS OF SURVEY

6.1 SS 01
This area had been scanned by EM61 MK2A, no anomaly was detected. (Annex C-1)

6.2 SS 02
This area had been scanned by EM61 MK2A, some anomalies were detected and ERM POC have been inform and advised on which spot to be used for the boring of bore holes. (Annex C-2)

6.3 SS 03
This area had been scanned by EM61 MK2A, no anomaly was detected. (Annex C-3)

6.4 SS 04
This area had been scanned by EM61 MK2A, some anomalies were detected and ERM POC have been inform and advised on which spot to be used for the boring of bore holes. (Annex C-4)

6.5 SS 05

This area had been scanned by EM61 MK2A, no anomaly was detected. (Annex C-5)

6.6 SS 05A

This area had been scanned by EM61 MK2A, some anomalies were detected and ERM POC have been inform and advised on which spot to be used for the boring of bore holes. (Annex C-5A)

6.7 SS 06

This area had been scanned by EM61 MK2A, some anomalies were detected and ERM POC have been inform and advised on which spot to be used for the boring of bore holes. (Annex C-6)

6.8 SS 07

This area had been scanned by EM61 MK2A, no anomaly was detected. (Annex C-7)

6.9 SS 08

This area had been scanned by EM61 MK2A, no anomaly was detected. (Annex C-8)

6.10 SS 09

This area had been scanned by EM61 MK2A, some anomalies were detected and ERM POC have been inform and advised on which spot to be used for the boring of bore holes. (Annex C-9)

6.11 SS 09a

This area had been scanned by EM61 MK2A, some anomalies were detected and ERM POC have been inform and advised on which spot to be used for the boring of bore holes. (Annex C-9a)

6.12 SS 10

This area had been scanned by EM61 MK2A, no anomaly was detected. (Annex C-10)

6.13 SS 11

This area had been scanned by EM61 MK2A, some anomalies were detected and ERM POC have been inform and advised on which spot to be used for the boring of bore holes. (Annex C-11)

6.14 SS12

This area had been scanned by Schonstedt GA-72Cd, some anomalies were detected and ERM POC have been informed and advised on which spot to be used for the boring of bore holes

6.15 SS 13
This area had been scanned by EM61 MK2A, some anomalies were detected and ERM POC have been inform and advised on which spot to be used for the boring of bore holes. (Annex C-13)

6.16 SS 14
This area had been scanned by EM61 MK2A, no anomaly was detected. (Annex C-14)

6.17 SS 15
This area had been scanned by EM61 MK2A, no anomaly was detected. (Annex C-15)

7 CONCLUSION

7.1 The Geophysical Survey was conducted and completed from 22nd July 2015 to 23rd July 2015.

7.2 A total of 18 plots of 2m x 2m were scanned.

7.3 Most of the anomalies detected was due to existing installation with metallic parts which causes distortion in the magnetic field which in turns disrupts the Geophysical detection.

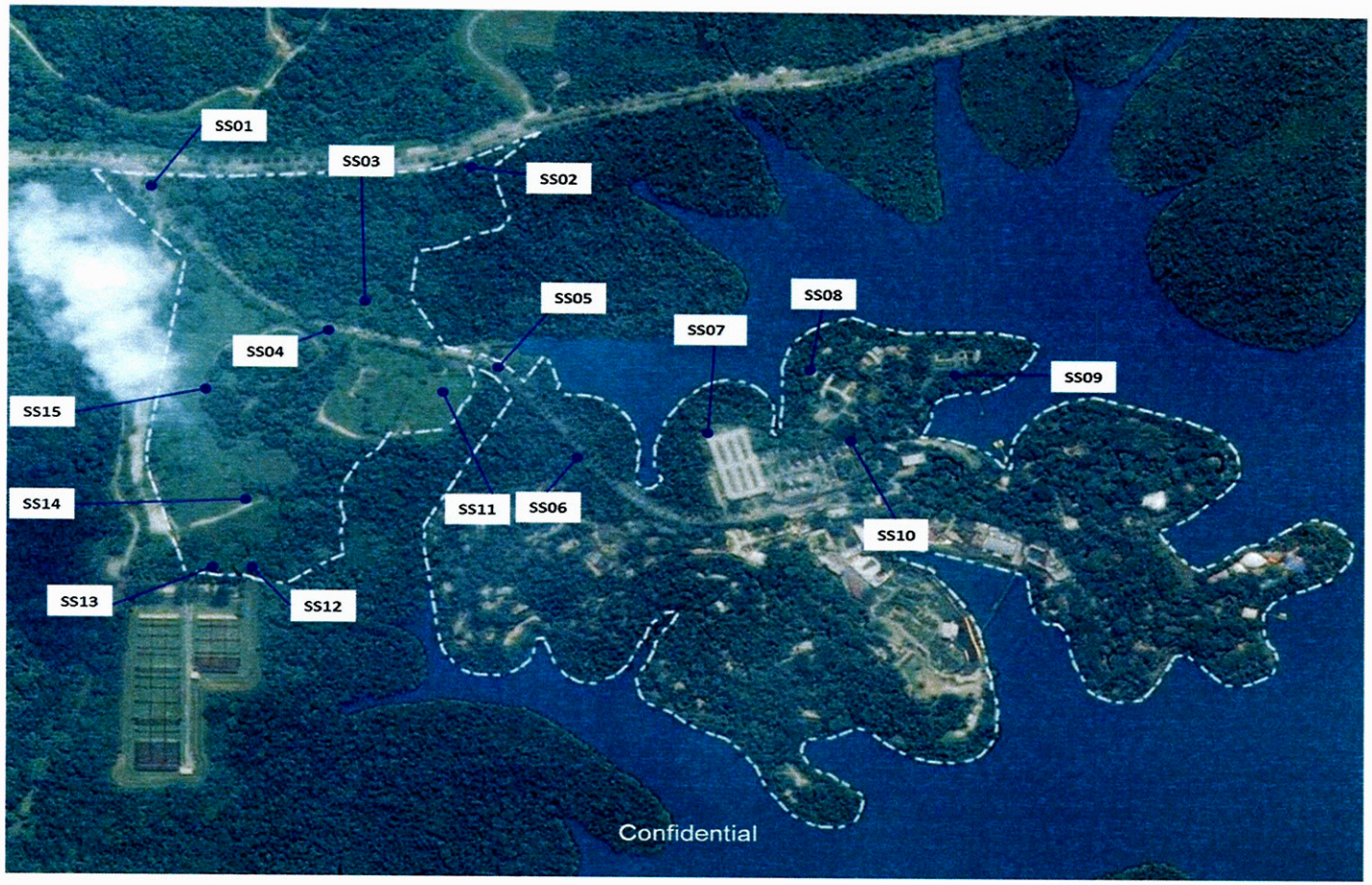
8 RECOMMENDATION

8.1 As there is a recent increase of Explosive Remnants of War (ERW) cases in Singapore being reported during excavation, all contractors should be mindful of the danger it possess when an ordinance is inappropriately handled.

Prepared by

Mr. Eric Tan Kuan Lung
Assistant Manager
Ordnance Explosives Specialists (OES)
Explomo Technical Services Pte Ltd

Annex A-1


SS01
SS03
SS02
SS05
SS08
SS07
SS04
SS09
SS15
SS14
SS11
SS06
SS10
SS13
SS12
Confidential

Annex B-1

SCANNING AT MANDAI ZOO AREA

	
Tool Box briefing	Tool Box briefing
	
Geophysical Scanning	Geophysical Scanning
	
Geophysical Scanning	Geophysical Scanning

Annex B-2

SCANNING AT MANDAI ZOO AREA

	
GPS of area	GPS of area
	
Geophysical Scanning	Geophysical Scanning
	
GPS of area	Geophysical Scanning

Annex B-3

SCANNING AT MANDAI ZOO AREA

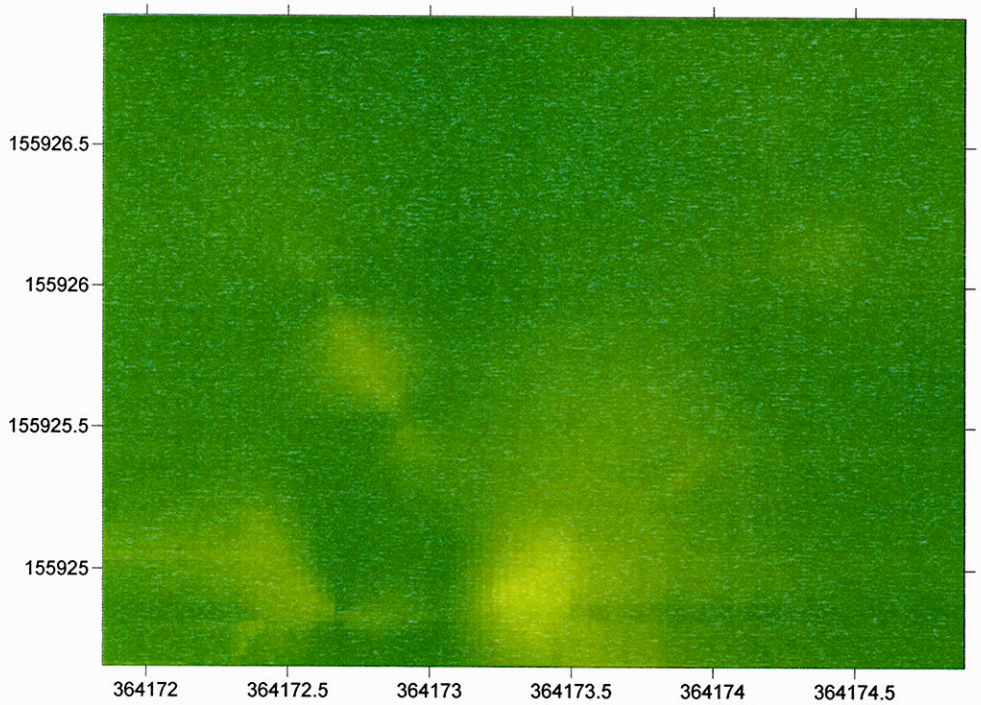
	
Geophysical Scanning	GPS of area
	
Geophysical Scanning	Geophysical Scanning
	
Geophysical Scanning	Geophysical Scanning

Annex B-4

SCANNING AT MANDAI ZOO AREA

	
Geophysical Scanning	Geophysical Scanning
	
Geophysical Scanning	Geophysical Scanning
	
Geophysical Scanning	Geophysical Scanning

Annex C-1



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EXPLOMO TECHNICAL SERVICES PTE LTD
Company Registration No. 199004809R

Acquisition Parameters

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Datum: WGS 1984
Map Projection: UTM

Processing Parameters

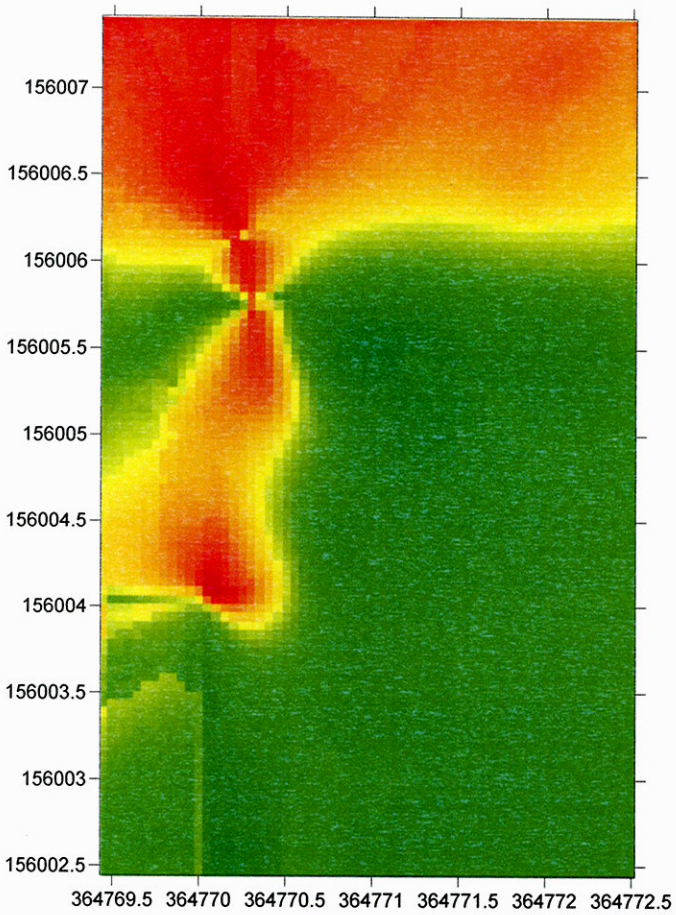
Data filtering: 60point median
Gridding method: Kriging
Grid cell size: 0.2 x 0.2 metres
Grid filtering: Nill
Other Processing: Nill

Legend

Enterra Anomaly 13
Chan 1 EM Image

Project: Scanning Project at Mandai Zoo Area
Client: Environmental Resources Management(S) Pte Ltd
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 220715

Annex C-2



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EXPLOMO TECHNICAL SERVICES PTE LTD
Company Registration No. 198004898R

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Map Projection: UTM

Processing Parameters

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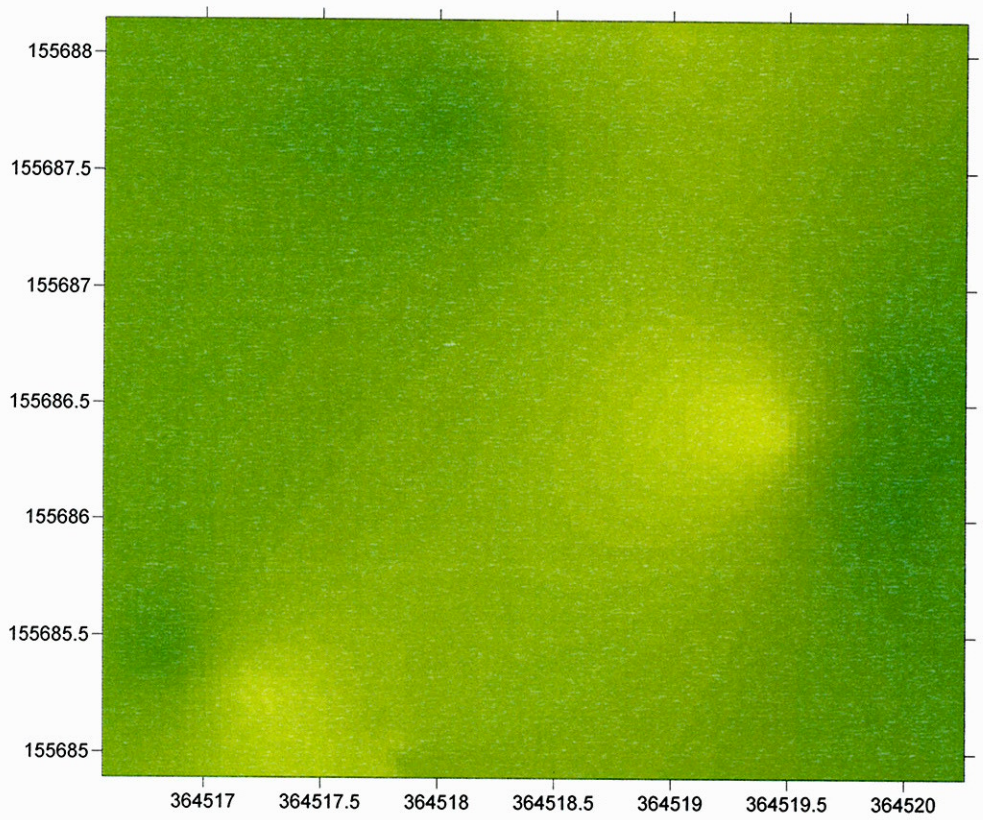
Grid cell size: 0.2 x 0.2 metres
Grid filtering: Nill
Other Processing: Nill

Legend

Enterra Anomaly 13 Chan 1 EM Image

Project: Scanning Project Mandai Zoo Area
Client: Enviornmental Resources Management(S) Pte Lte
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 220715



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EXPLOMO TECHNICAL SERVICES PTE LTD
Company Registration No. 199004389R

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Map Projection: UTM

Processing Parameters

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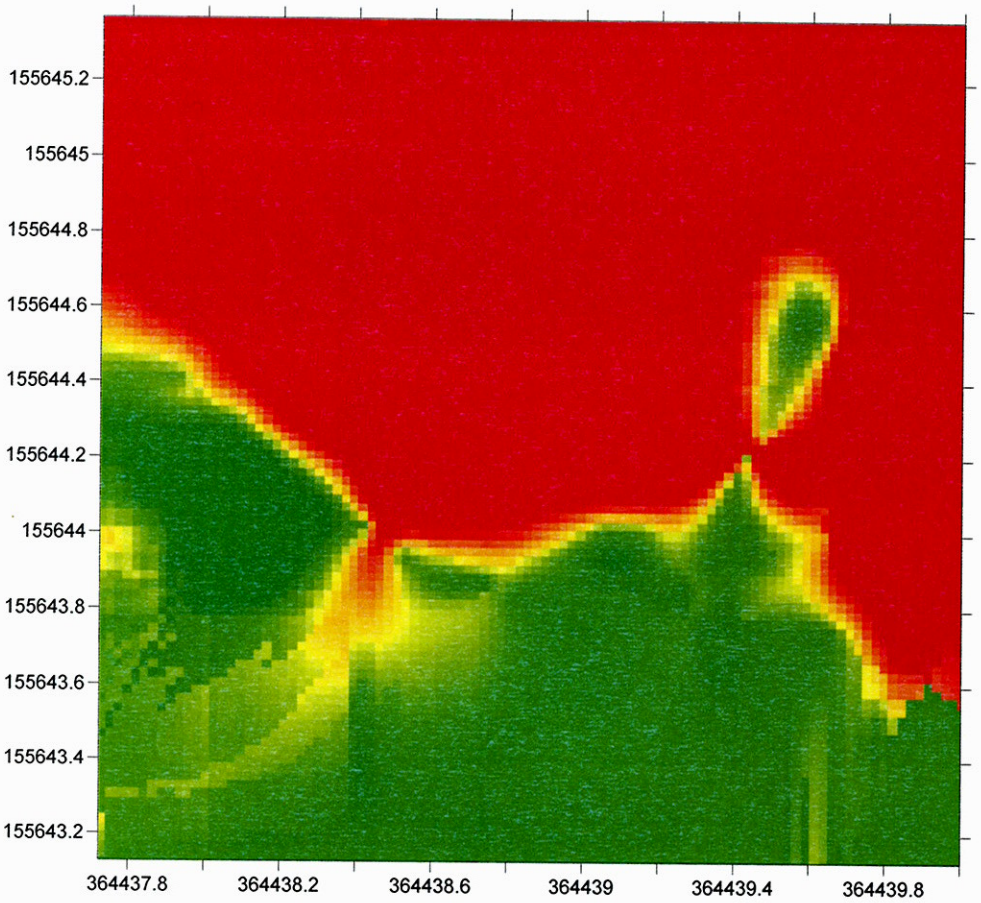
Legend

Enterra Anomaly 13 Chan 1 EM Image

Project: Scanning Project Mandai Zoo Area
Client: Enviornmental Resources Management(S) Pte Lte
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 220715

Annex C-4



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Company Registration No. 198004309R

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Legend

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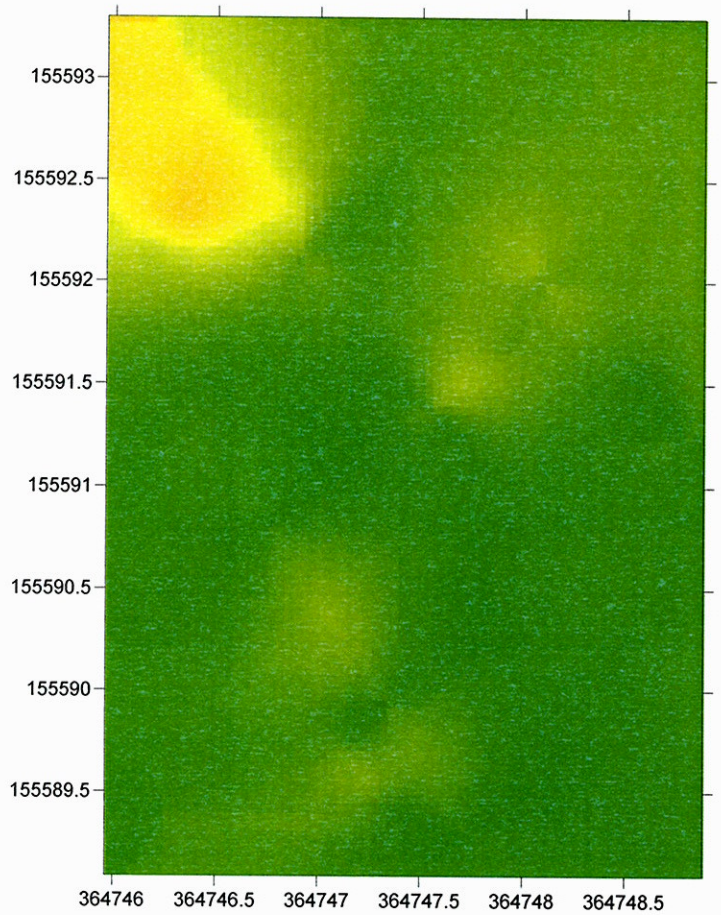
Project: Scanning Project Mandai Zoo Area
Client: Enviornmental Resources Management(S) Pte Lte
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 220715

Annex C-5



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Map Projection: UTM

Processing Parameters

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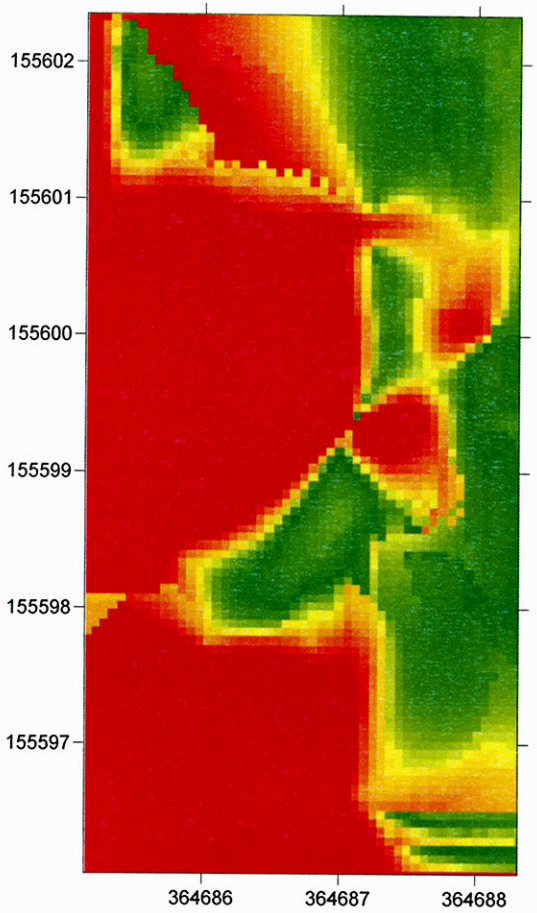
Grid filtering: Nill
Other Processing: Nill

Legend

Enterra Anomaly 13 Chan 1 EM Image

Project: Scanning Project Mandai Zoo Area
Client: Enviornmental Resources Management(S) Pte Lte
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 220715

Annex C-5a



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EXPLOMO TECHNICAL SERVICES PTE LTD
Company Registration No. 199804389F

Acquisition Parameters

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Datum: WGS 1984
Map Projection: UTM

Processing Parameters

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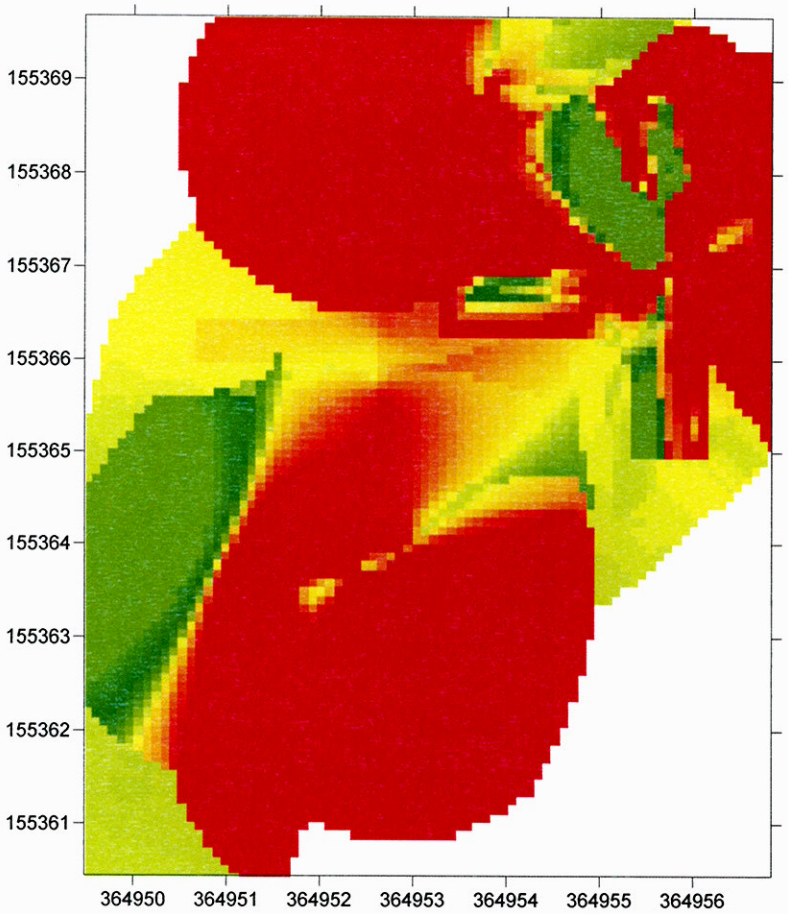
Gridding method: Kriging
Grid cell size: 0.2 x 0.2 metres
Grid filtering: Nill
Other Processing: Nill

Legend

Enterra Anomaly 13 Chan 1 EM Image

Project: Scanning Project Mandai Zoo Area
Client: Enviornmental Resources Management(S) Pte Lte
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 220715

Annex C-6



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EXPLOMO TECHNICAL SERVICES PTE LTD
Company Registration No. 196004839R

Acquisition Parameters

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Map Projection: UTM

Processing Parameters

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Gridding method: Kriging
Grid cell size: 0.2 x 0.2 metres
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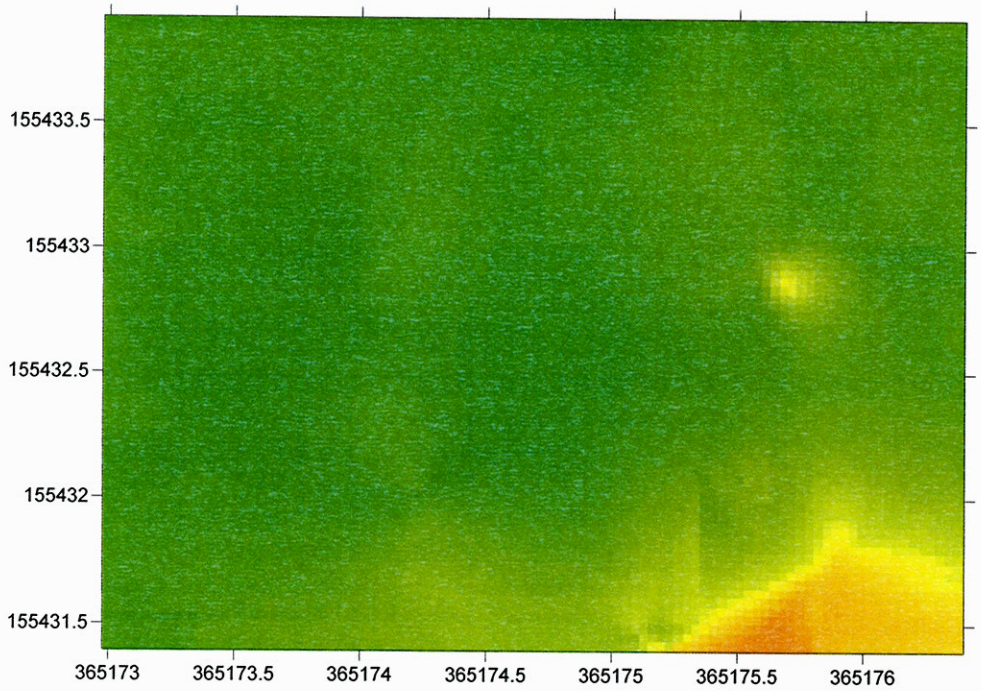
Other Processing: Nill

Legend

Enterra Anomaly 13 Chan 1 EM Image

Project: Scanning Project Mandai Zoo Area
Client: Enviornmental Resources Management(S) Pte Lte
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 220715

Annex C-7



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EXPLOMO TECHNICAL SERVICES PTE LTD
Company Registration No. 198004389R

Acquisition Parameters

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Line spacing: 1.0 metre
Datum: WGS 1984
Map Projection: UTM

Processing Parameters

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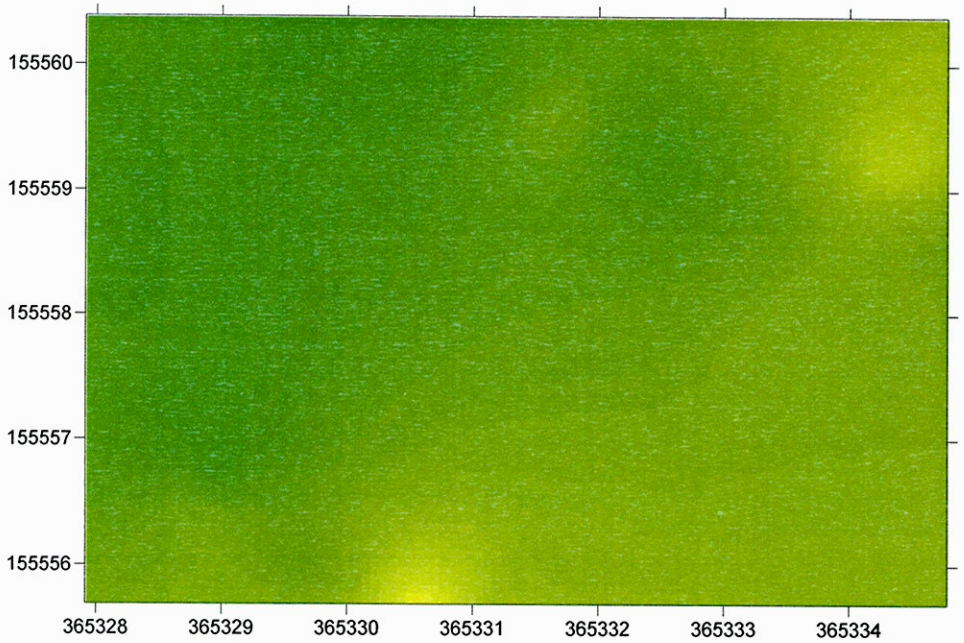
Gridding method: Kriging
Grid cell size: 0.2 x 0.2 metres
Grid filtering: Nill
Other Processing: Nill

Legend

Enterra Anomaly 13 Chan 1 EM Image

Project: Scanning Project Mandai Zoo Area
Client: Enviornmental Resources Management(S) Pte Lte
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 220715

Annex C-8



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EXPLOMO TECHNICAL SERVICES PTE LTD
Company Registration No. 198004889R

Acquisition Parameters

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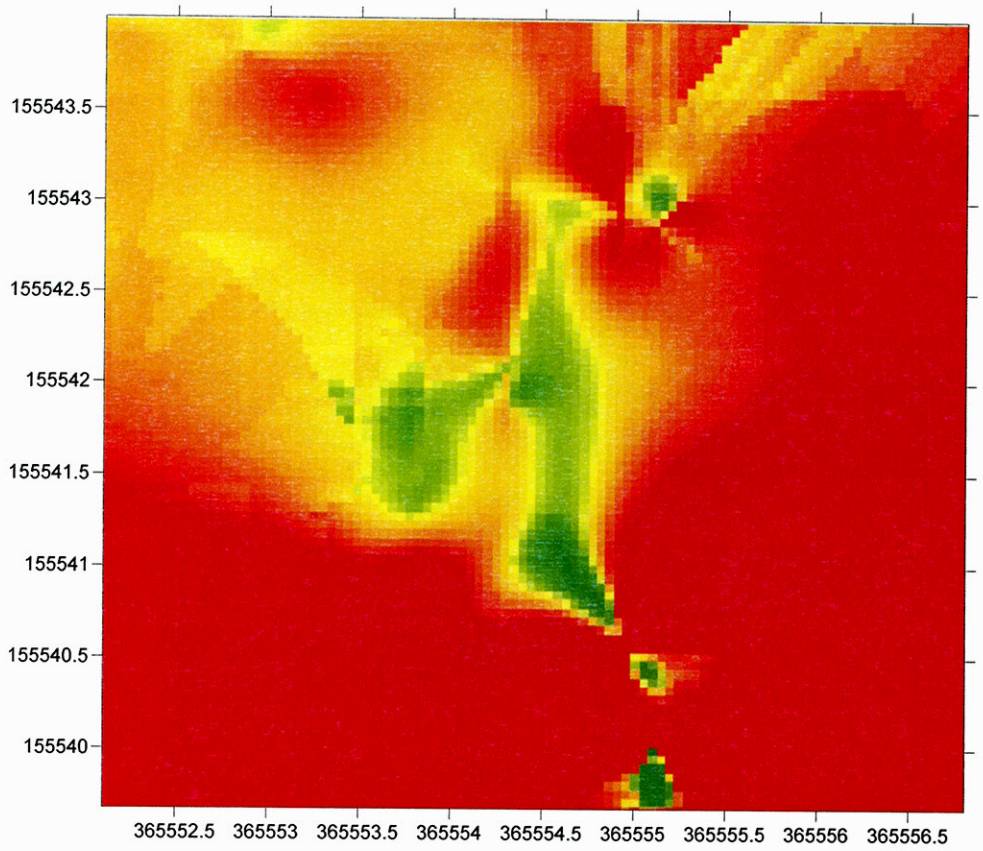
Other Processing: Nill

Legend

Enterra Anomaly 13
Chan 1 EM Image

Project: Scanning Project Mandai Zoo Area
Client: Enviornmental Resources Management(S) Pte Lte
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 220715

Annex C-9



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EXPLOMO TECHNICAL SERVICES PTE LTD
Company Registration No. 199004309R

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Map Projection: UTM

Processing Parameters

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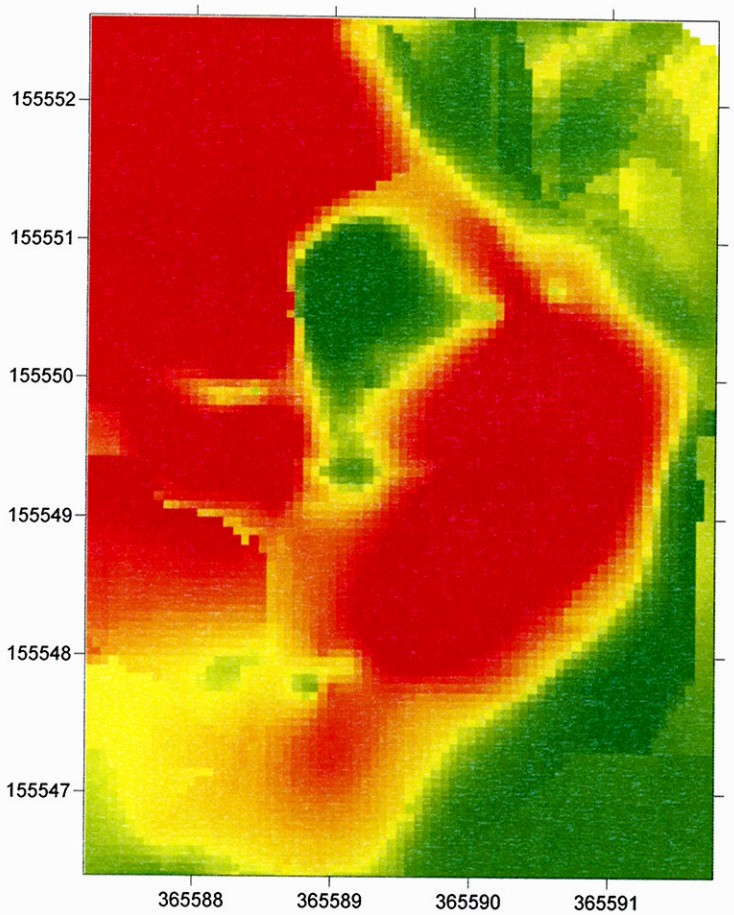
Other Processing: Nill

Legend

Enterra Anomaly 13
Chan 1 EM Image

Project: Scanning Project Mandai Zoo Area
Client: Enviornmental Resources Management(S) Pte Lte
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 220715

Annex C-9a



SS09a

EXPLOMO TECHNICAL SERVICES PTE LTD
Company Registration No. 199804809R

Acquisition Parameters

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Processing Parameters

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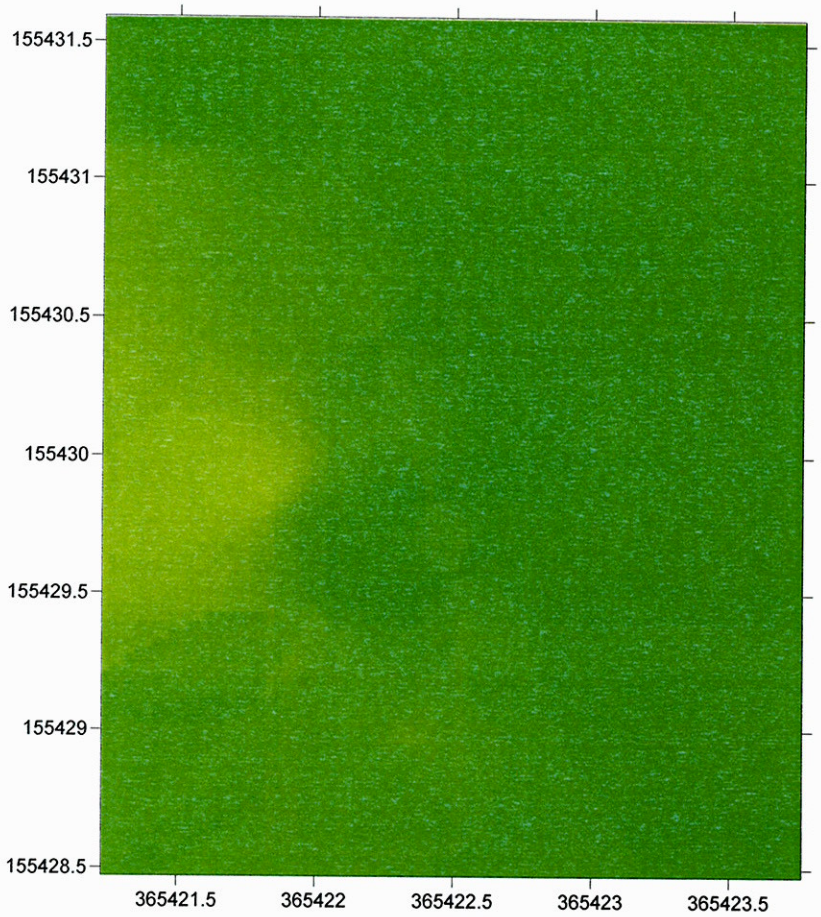
Other Processing: Nill

Legend

Enterra Anomaly 13 Chan 1 EM Image

Project: Scanning Project Mandai Zoo Area
Client: Enviornmental Resources Management(S) Pte Lte
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 220715

Annex C-10



SS010

EXPLOMO TECHNICAL SERVICES PTE LTD
Company Registration No. 198004389R

Acquisition Parameters

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Line spacing: 1.0 metre
Datum: WGS 1984
Map Projection: UTM

Processing Parameters

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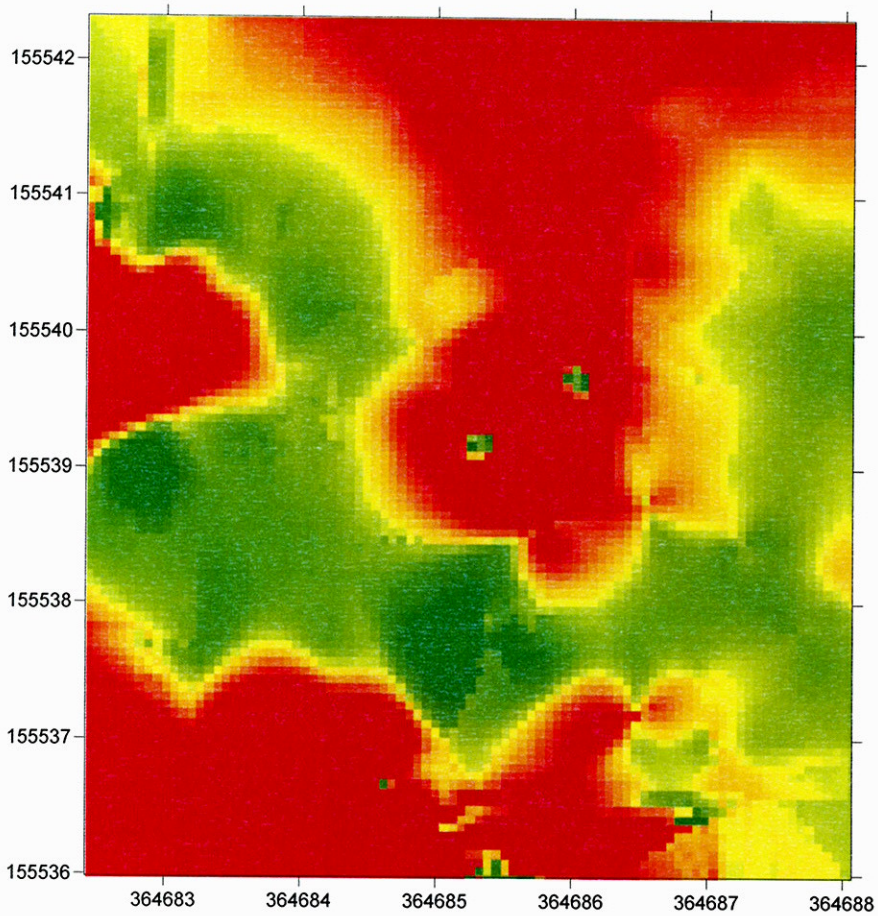
Gridding method: Kriging
Grid cell size: 0.2 x 0.2 metres
Grid filtering: Nill
Other Processing: Nill

Legend

Enterra Anomaly 13 Chan 1 EM Image

Project: Scanning Project Mandai Zoo Area
Client: Enviornmental Resources Management(S) Pte Lte
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 220715



SS011

Annex C-11

EXPLOMO TECHNICAL SERVICES PTE LTD
Company Registration No. 198004389R

Acquisition Parameters

Survey Date: 230715
Instrument: Geonics EM61 MK2A
Sampling rate: 10 Hz
Location mode: DGPS/AGPS
Line spacing: 1.0 metre
Datum: WGS 1984
Map Projection: UTM

Processing Parameters

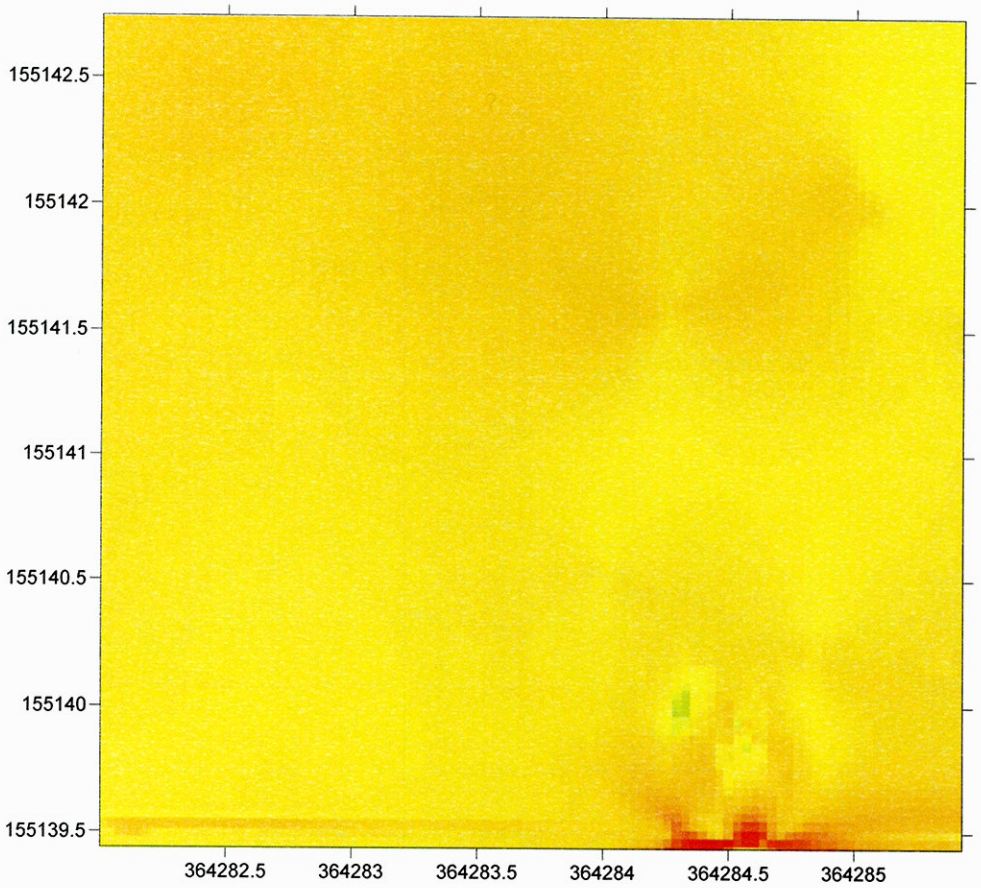
Data filtering: 60point median
Gridding method: Kriging
Grid cell size: 0.2 x 0.2 metres
Grid filtering: Nill
Other Processing: Nill

Legend

Enterra Anomaly 13 Chan 1 EM Image

Project: Scanning Project Mandai Zoo Area
Client: Enviornmental Resources Management(S) Pte Lte
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 230715

Annex C-13



SS013

EXPLOMO TECHNICAL SERVICES PTE LTD
Company Registration No. 199804809R

Acquisition Parameters

Survey Date: 230715
Instrument: Geonics EM61 MK2A
Sampling rate: 10 Hz
Location mode: DGPS/AGPS
Line spacing: 1.0 metre
Datum: WGS 1984
Map Projection: UTM

Processing Parameters

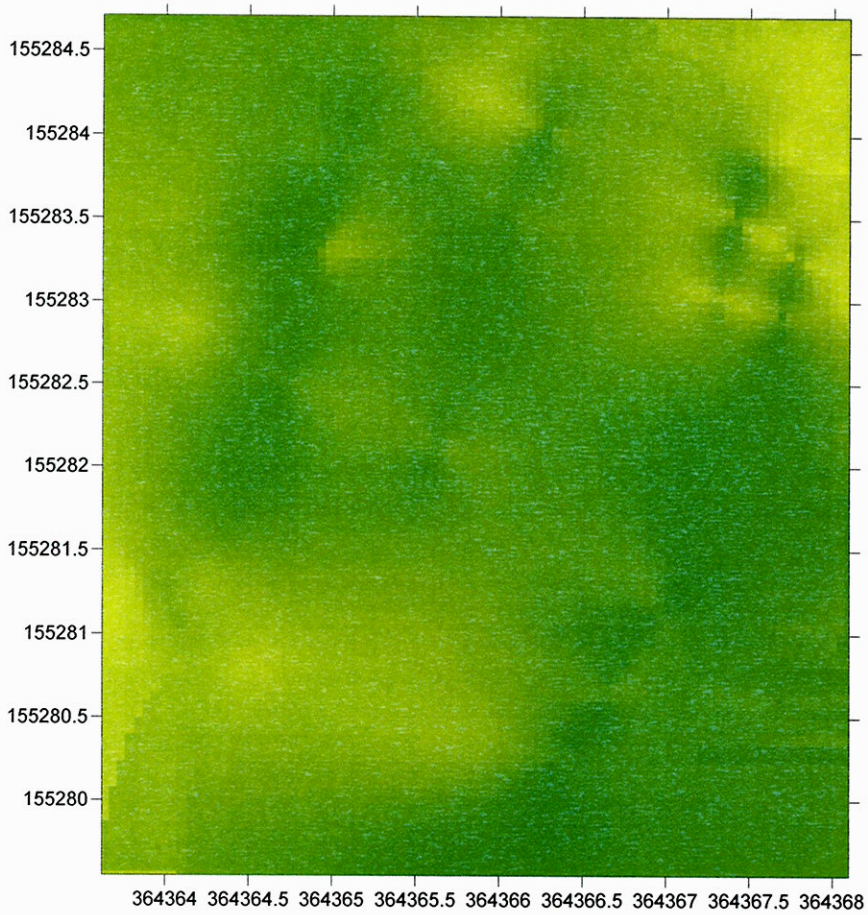
Data filtering: 60point median
Gridding method: Kriging
Grid cell size: 0.2 x 0.2 metres
Grid filtering: Nill
Other Processing: Nill

Legend

Enterra Anomaly 13 Chan 1 EM Image

Project: Scanning Project Mandai Zoo Area
Client: Enviornmental Resources Management(S) Pte Lte
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 230715

Annex C-14



SS014

EXPLOMO TECHNICAL SERVICES PTE LTD
Company Registration No. 199803480R

Acquisition Parameters

Survey Date: 230715
Instrument: Geonics EM61 MK2A
Sampling rate: 10 Hz
Location mode: DGPS/AGPS
Line spacing: 1.0 metre
Datum: WGS 1984
Map Projection: UTM

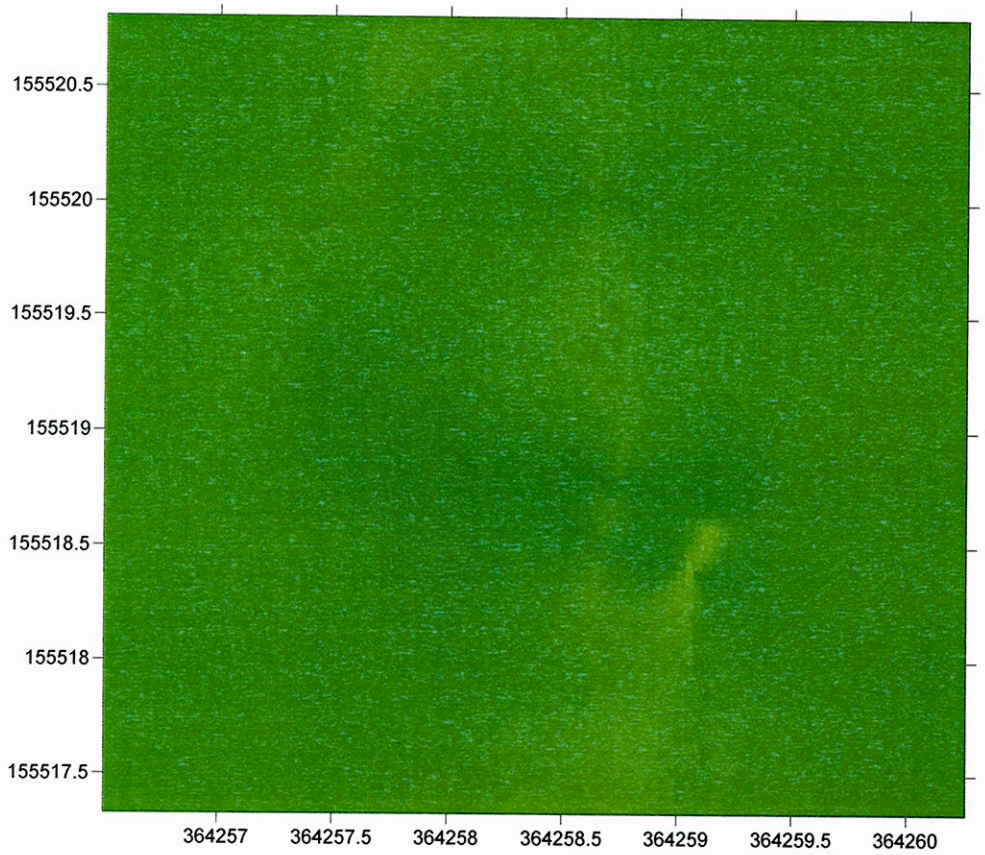
Processing Parameters

Data filtering: 60point median
Gridding method: Kriging
Grid cell size: 0.2 x 0.2 metres
Grid filtering: Nill
Other Processing: Nill

Legend

Enterra Anomaly 13 Chan 1 EM Image

Project: Scanning Project Mandai Zoo Area
Client: Enviornmental Resources Management(S) Pte Lte
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 230715



SS015

EXPLOMO TECHNICAL SERVICES PTE LTD
Company Registration No. 198004809R

Acquisition Parameters

Survey Date: 230715
Instrument: Geonics EM61 MK2A
Sampling rate: 10 Hz
Location mode: DGPS/AGPS
Line spacing: 1.0 metre
Datum: WGS 1984
Map Projection: UTM

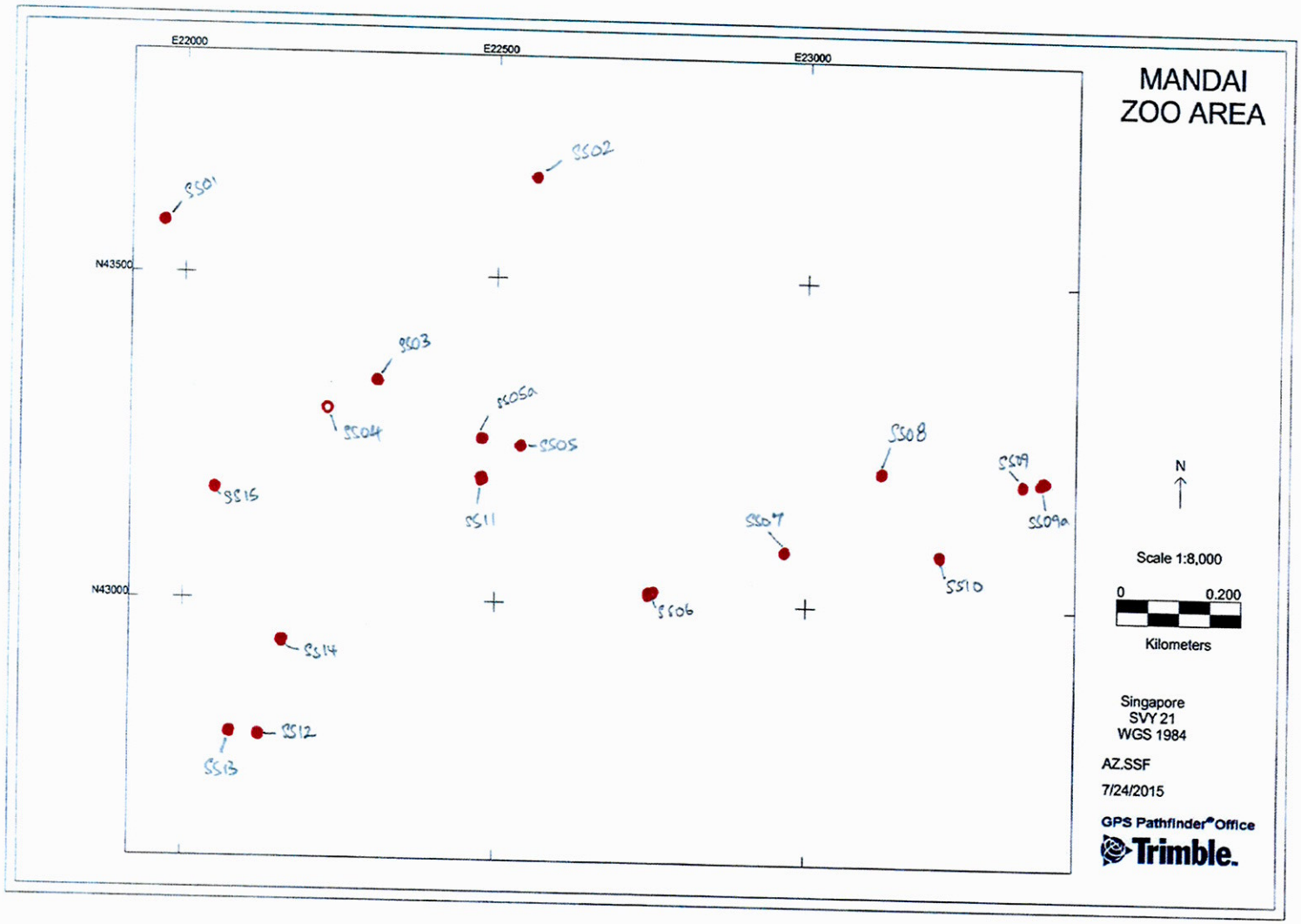
Processing Parameters

Data filtering: 60point median
Gridding method: Kriging
Grid cell size: 0.2 x 0.2 metres
Grid filtering: Nill
Other Processing: Nill

Legend

Enterra Anomaly 13 Chan 1 EM Image

Project: Scanning Project Mandai Zoo Area
Client: Enviornmental Resources Management(S) Pte Lte
Processed by: Lim Jun Shan
Interpreted by: Eric Tan
Plot date: 230715


MANDAI
ZOO AREA
E22000
E22500
E23000
N43500
N43000
SS01
SS02
SS03
SS04
SS05a
SS05
SS15
SS11
SS08
SS09
SS09a
SS07
SS10
SS06
SS14
SS12
SS13
N
Scale 1:8,000
0
0.200
Kilometers
Singapore
SVY 21
WGS 1984
AZ.SSF
7/24/2015
GPS Pathfinder Office
Trimble.

EXPLOMO TECHNICAL SERVICES PTE LTD

Registration No. 198804389R

Cert No. 2000-2-1195
ISO 9001:2008

GEOPHYSICAL SURVEY CERTIFICATE AND FORMAL DECLARATION		
Location		
1. Client name:	Environmental Resources Management(S) Pte Ltd	8. Location of Cleared Area. (Description and GRID) **(Include map and diagram of cleared area)** Refer to Annex A, C & D
2. Edition:	N/A	
3. Sheet Number:	01	
4. Scale:	N/A	
5. Series:	N/A	
6. Location:	Mandai Zoo Area	
7. Clearance depth:	3m	

DETAILS OF CLEARANCE OPERATIONS	
9. Number and Type of UXO/ERW Cleared: N/A	**10. Final Disposal Method of Recovered UXO / ERW:** N/A
11. Methods and Technology Used: Electro Magnetic Survey	**12. Is Area Metal Free:** N/A
13. Quality Assurance Methodology: N/A	
14. UXO field Serial Number: N/A	**15. Date of Completion and Hand Over:** 23rd July 2015

DECLARATION BY SENIOR REPRESENTATIVE OF THE ORGINISATION

I Certify that to the best of my knowledge and belief that the area specified in this Completion Certificate has been scanned to the depth specified in this Completion Certificate.

16. Signature of Senior Specialist and Organization Authority Stamp:

Eric Tan Kuan Lung
S 7821723 E

EXPLOMO TECHNICAL SERVICES PTE LTD

THIS DOCUMENT HAS BEEN DISTRIBUTED AS SHOWN BELOW	
a. Original to: Environmental Resources Management(S) Pte Ltd	**b. Copy to:** Explomo Technical Services Pte Ltd
c. Copy to: Finance Division Explomo Technical Services Pte Ltd.	**d. Copy to:**

No. 62 Burn Road #06-01 TSH Centre Singapore 369976
Tel: 62812105 Fax . 62812106
http://www.explomo.com.sg Email: enquiry@explomo.com.sg

Annex 9.0

Soil & Groundwater

Annex 9.1

Shallow Soil Sampling & Analysis

- Photographs of Sampling Locations
- Hand Auger Soil Boring Logs
- Soil Analytical Results Summary
- Analytical Laboratory Report

Figure A9.1a: Photographs of Shallow Soil Sampling Locations

SS01

SS02

SS03

SS04

SS05

SS06

SS07

SS08

SS09

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SOIL BORING LOG

Soil bore No. SS01

Project No: 0292668
Project: Project Darwin EIA
Client: Mandai Park Holdings

Logged by: LO
Reviewed by: DL
Approved by: CF
Page: 1/15

SUBSURFACE PROFILE			SAMPLE		
Depth (m)	Symbol	Description	Sample ID	Lab Analysis	Monitoring Well Completion Details
		GROUND SURFACE			
0.0		Grass			
0.3		SILT with sand, reddish brown with some olive grey colour, slightly moist, soft, low plasticity. No stain or odour observed.	SS01 - 0.3	Yes	No Monitoring Well Constructed
1.0					
2.0					
2.1			SS01 - 2.1	Yes	
2.2		SILT, reddish brown with light brown colour, moist, soft, low plasticity. No stain or odour observed.			
		Borehole termination			

Hole Size:	0.1 m	Screen Interval:	NA	Drilled By:	LO,LD
Casing Size:	NA	Initial Water Level:	NA	Drill Date:	30 July 2015
End of Borehole:	2.2 m	Static Water Level:	NA	Drill Method:	Hand Auger

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Debris, Sandy GRAVEL, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Gravelly SILT, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Project No:	0292668	**Soil bore No.**	SS02
Project:	Project Darwin EIA	Logged by:	LO
Client:	Mandai Park Holdings	Reviewed by:	DL
		Approved by:	CF
		Page:	2/15

SUBSURFACE PROFILE			SAMPLE		
Depth (m)	Symbol	Description	Sample ID	Lab Analysis	Monitoring Well Completion Details
		GROUND SURFACE			
0.0		Grass			
0.3		Gravelly SILT, brown, slightly moist, soft, low plasticity. No stain or odour observed.	SS02 - 0.3m	Yes	
1.0		SILT, brown, slightly moist, soft, low plasticity. No stain or odour observed.			No Monitoring Well Constructed
2.0					
3.0		SILT with some sand, reddish brown with yellow sandy silt, moist, soft, low plasticity. No stain or odour observed.	SS02 - 3m	Yes	
		Borehole termination			

Hole Size:	0.1 m	Screen Interval:	NA	Drilled By:	LO,LD
Casing Size:	NA	Initial Water Level:	NA	Drill Date:	30 July 2015
End of Borehole:	3.1 m	Static Water Level:	NA	Drill Method:	Hand Auger

BENTONITE	Concrete Slab	GRAVEL	SILT	Gravelly SILT
GROUT	Debris	SAND	Clayey SILT	Boulders
ASPHALT	Sandy GRAVEL	Silty SAND	CLAY	FIRST APPEARANCE LEVEL
SCREEN	Gravelly SAND	Sandy CLAY	Silty CLAY	STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Soil bore No. SS03

Project No: 0292668
Project: Project Darwin EIA
Client: Mandai Park Holdings

Logged by: LO
Reviewed by: DL
Approved by: CF
Page: 3/15

SUBSURFACE PROFILE			SAMPLE		
Depth (m)	Symbol	Description	Sample ID	Lab Analysis	Monitoring Well Completion Details
		GROUND SURFACE			
0.0		Grass			
0.3		Sandy SILT, brown, dry, firm, low plasticity. No stain and odour observed.	SS03 - 0.3m	Yes	
0.5		Clayey SILT with sand, yellowish brown, dry, soft, medium plasticity. No stain and odour observed.			
1.0					No Monitoring Well Constructed
2.0					
2.2		Clayey SILT with sand, yellowish brown, moist, soft, medium plasticity. No stain and odour observed.	SS03 - 2.2m	Yes	
		Borehole termination			

Hole Size:	0.1 m	Screen Interval:	NA	Drilled By:	LO,DL, DC
Casing Size:	NA	Initial Water Level:	NA	Drill Date:	28 July 2015
End of Borehole:	2.3 m	Static Water Level:	NA	Drill Method:	Hand Auger

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Debris, Sandy GRAVEL, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Gravelly SILT, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Soil bore No. SS04

Project No: 0292668
Project: Project Darwin EIA
Client: Mandai Park Holdings

Logged by: LO
Reviewed by: DL
Approved by: CF
Page: 4/15

SUBSURFACE PROFILE			SAMPLE		
Depth (m)	Symbol	Description	Sample ID	Lab Analysis	Monitoring Well Completion Details
		GROUND SURFACE			
0.0		Grass			
0.3		Clayey SILT with sand and cobbles, brown with shades of black and white, dry, soft to firm, low plasticity, some black and white shades? No stain and odour observed.	SS04 - 0.3m	Yes	
1.0		Silty CLAY with sand, blackish brown with shades of white, slightly moist, soft, medium plasticity. No stain and odour observed.			No Monitoring Well Constructed
1.9		SAND, dark green, moist to wet, dense. Slight odour.	SS04 - 1.9m	Yes	
2.0					
2.2		Groundwater encountered Borehole termination			

Hole Size:	0.1 m	Screen Interval:	NA	Drilled By:	LO,DC
Casing Size:	NA	Initial Water Level:	2.2 m	Drill Date:	28 July 2015
End of Borehole:	2.2 m	Static Water Level:	NA	Drill Method:	Hand Auger

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Debris, Sandy GRAVEL, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Gravelly, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Soil bore No. SS05

Project No: 0292668
Project: Project Darwin EIA
Client: Mandai Park Holdings

Logged by: LO
Reviewed by: DL
Approved by: CF
Page: 5/15

SUBSURFACE PROFILE			SAMPLE		
Depth (m)	Symbol	Description	Sample ID	Lab Analysis	Monitoring Well Completion Details
		GROUND SURFACE			
0.0		Grass			
		SILY with sand, yellowish brown, dry, low plasticity. No stain or odour observed.	SS05 - 0.3 m	Yes	
0.3					
1.0					No Monitoring Well Constructed
2.0		Silty CLAY, reddish brown with some yellow silt, slightly moist, medium plasticity. No stain or odour observed.			
2.7					
3.0		Borehole termination	SS05 - 3 m	Yes	

Hole Size:	0.1 m	Screen Interval:	NA	Drilled By:	LO, DL
Casing Size:	NA	Initial Water Level:	NA	Drill Date:	24 July 2015
End of Borehole:	3.0 m	Static Water Level:	NA	Drill Method:	Hand Auger

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Debris, Sandy GRAVEL, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Gravelly SILT, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Soil bore No. SS06

Project No: 0292668
Project: Project Darwin EIA
Client: Mandai Park Holdings

Logged by: LO
Reviewed by: DL
Approved by: CF
Page: 6/15

SUBSURFACE PROFILE			SAMPLE		
Depth (m)	Symbol	Description	Sample ID	Lab Analysis	Monitoring Well Completion Details
		GROUND SURFACE			
0.0					
		Sandy SILT, light brown with olive grey and yellowish silt, moist, soft, low plasticity, no stain and odour observed.	SS06 - 0.3m	Yes	
0.3					
1.0					
1.2		Gravelly SILT, reddish brown with greenish brown silt, moist, soft, low plasticity, no stain and odour observed.			No Monitoring Well Constructed
1.9		Gravelly SILT, reddish brown with bits of olive grey silt, moist, soft, low plasticity, no stain and odour observed.	SS06 - 1.9m	Yes	
		Boulder encountered. Borehole termination			

Hole Size:	NA	Screen Interval:	NA	Drilled By:	LO, LD
Casing Size:	NA	Initial Water Level:	NA	Drill Date:	30 July 2015
End of Borehole:	NA	Static Water Level:	NA	Drill Method:	Hand Auger

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Debris, Sandy GRAVEL, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Gravelly SILT, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Soil bore No. SS07

Project No: 0292668
Project: Project Darwin EIA
Client: Mandai Park Holdings

Logged by: LO
Reviewed by: DL
Approved by: CF
Page: 7/15

SUBSURFACE PROFILE			SAMPLE		
Depth (m)	Symbol	Description	Sample ID	Lab Analysis	Monitoring Well Completion Details
		GROUND SURFACE			
0.0		GRASS			
0.3		SILT with sand and course gravels, yellowish brown, dry, firm, low plasticity. No stain and odour observed.	SS07 - 0.3m	Yes	
0.8					
1.0		SILT with sand, brown, dry, firm, low plasticity. No stain or odour observed.			No Monitoring Well Constructed
2.0		Clay, brown, moist, soft, high plasticity, black hydrocarbon stain and odour.			
2.4		Borehole termination	SS07 - 2.4m	Yes	

Hole Size:	0.1 m	Screen Interval:	NA	Drilled By:	LO,DL,ZY
Casing Size:	NA	Initial Water Level:	NA	Drill Date:	27 July 2015
End of Borehole:	2.4 m	Static Water Level:	NA	Drill Method:	Hand Auger

BENTONITE	Concrete Slab	GRAVEL	SILT	Gravelly SILT
GROUT	Debris	SAND	Clayey SILT	Boulders
ASPHALT	Sandy GRAVEL	Silty SAND	CLAY	FIRST APPEARANCE LEVEL
SCREEN	Gravelly SAND	Sandy CLAY	Silty CLAY	STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Soil bore No. SS08

Project No: 0292668
Project: Project Darwin EIA
Client: Mandai Park Holdings

Logged by: LO
Reviewed by: DL
Approved by: CF
Page: 8/15

SUBSURFACE PROFILE			SAMPLE		
Depth (m)	Symbol	Description	Sample ID	Lab Analysis	Monitoring Well Completion Details
		GROUND SURFACE			
0.0		GRASS			
		Clayey SILT, yellowish brown, slightly moist, firm, medium plasticity. No odour and stain observed.	SS08-0.5m	Yes	No Monitoring Well Constructed
0.5					
1.0		Silty Clay, yellowish brown, slightly moist, firm, medium plasticity. No odour and stain observed.	SS08-1.2m	Yes	
1.2					
1.5		Refusal at 1.5 m: Silty Clay with cobbles, yellowish brown, slightly moist, stiff, medium plasticity. No odour and stain observed.			
		Borehole termination			

Hole Size:	0.1 m	Screen Interval:	NA	Drilled By:	LO,DL,ZY
Casing Size:	NA	Initial Water Level:	NA	Drill Date:	27 July 2015
End of Borehole:	1.5 m	Static Water Level:	NA	Drill Method:	Hand Auger

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Debris, Sandy GRAVEL, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Gravelly SILT, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Soil bore No. SS09a

Project No: 0292668
Project: Project Darwin EIA
Client: Mandai Park Holdings

Logged by: LO
Reviewed by: DL
Approved by: CF
Page: 9/15

SUBSURFACE PROFILE			SAMPLE		
Depth (m)	Symbol	Description	Sample ID	Lab Analysis	Monitoring Well Completion Details
		GROUND SURFACE			
0.0		GRASS			
		SILT with sand, reddish brown, slightly moist, low plasticity. No odour or stain observed, some roots.	SS09a - 0.3 m	Yes	
0.3					
1.0		SILT with sand, reddish brown, slightly moist, low plasticity. No odour or stain observed.			No Monitoring Well Constructed
2.0				Yes	
2.2		SILT with sand, reddish brown, wet, low plasticity. No odour or stain observed.	SS09a - 2.2 m		
		Borehole termination			

Hole Size:	0.1 m	Screen Interval:	NA	Drilled By:	LO,DL,ZY
Casing Size:	NA	Initial Water Level:	NA	Drill Date:	27 July 2015
End of Borehole:	2.2 m	Static Water Level:	NA	Drill Method:	Hand Auger

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Debris, Sandy GRAVEL, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Gravelly SILT, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Soil bore No. SS10

Project No: 0292668
Project: Project Darwin EIA
Client: Mandai Park Holdings

Logged by: LO
Reviewed by: DL
Approved by: CF
Page: 10/15

SUBSURFACE PROFILE			SAMPLE		
Depth (m)	Symbol	Description	Sample ID	Lab Analysis	Monitoring Well Completion Details
		GROUND SURFACE			
0.0		Grass			
		SILT with sand, reddish brown, dry, firm, low plasticity. No stain or odour observed.	SS10 - 0.4 m	Yes	
0.4					
1.0		SILT with sand, yellowish brown, dry, firm, low plasticity. No stain or odour observed.			No Monitoring Well Constructed
2.0					
3.0		SILT with sand, yellowish brown, dry, firm, low pasticity. No stain or odour observed.	SS10 - 3 m	Yes	
		Borehole termination.			

Hole Size:	0.1 m	Screen Interval:	NA	Drilled By:	LO,DL,ZY
Casing Size:	NA	Initial Water Level:	NA	Drill Date:	27 July 2015
End of Borehole:	3.1 m	Static Water Level:	NA	Drill Method:	Hand Auger

BENTONITE	Concrete Slab	GRAVEL	SILT	Gravelly SILT
GROUT	Debris	SAND	Clayey SILT	Boulders
ASPHALT	Sandy GRAVEL	Silty SAND	CLAY	FIRST APPEARANCE LEVEL
SCREEN	Gravelly SAND	Sandy CLAY	Silty CLAY	STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Soil bore No. SS11

Project No: 0292668
Project: Project Darwin EIA
Client: Mandai Park Holdings

Logged by: LO
Reviewed by: DL
Approved by: CF
Page: 11/15

SUBSURFACE PROFILE			SAMPLE		
Depth (m)	Symbol	Description	Sample ID	Lab Analysis	Monitoring Well Completion Details
		GROUND SURFACE			
0.0		GRASS			
		Sandy GRAVEL with cobbles, brown, dry, medium dense. No stain or odour observed, backfill material observed.			
0.5			SS11-0.5m	Yes	
		CLAY, orange brown, moist, low plasticity. No stain or odour observed.			No Monitoring Well Constructed
0.8					
1.0					
1.2					
1.5					
1.6			SS11-1.6m	Yes	
		Refusal encountered. Borehole termination			

Hole Size:	0.1 m	Screen Interval:	NA	Drilled By:	LO, DL
Casing Size:	NA	Initial Water Level:	NA	Drill Date:	24 July 2015
End of Borehole:	1.7 m	Static Water Level:	NA	Drill Method:	Hand Auger

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Debris, Sandy GRAVEL, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Gravelly SILT, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Soil bore No. SS12

Project No: 0292668
Project: Project Darwin EIA
Client: Mandai Park Holdings

Logged by: LO
Reviewed by: DL
Approved by: CF
Page: 12/15

Depth (m)	Symbol	Description	Sample ID	Lab Analysis	Monitoring Well Completion Details
		SUBSURFACE PROFILE	**SAMPLE**		
		GROUND SURFACE			
0.0		GRASS			
0.3		SILT with sand and cobbles, reddish brown, dry, soft. No stain and odour observed, some backfill materials observed.	SS12-0.3 m	Yes	No Monitoring Well Constructed
0.5					
0.8					
1.0					
1.2					
1.5		Clayey SILT with gravels, blackish brown, dry, low plasticity. No stain and odour observed.	SS12-1.5 m	Yes	
		Borehole termination.			

Hole Size:	0.1 m	Screen Interval:	NA	Drilled By:	LO,DC,DL
Casing Size:	NA	Initial Water Level:	NA	Drill Date:	28 July 2015
End of Borehole:	1.6 m	Static Water Level:	NA	Drill Method:	Hand Auger

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Debris, Sandy GRAVEL, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Gravelly SILT, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Soil bore No. SS13

Project No: 0292668
Project: Project Darwin EIA
Client: Mandai Park Holdings

Logged by: LO
Reviewed by: DL
Approved by: CF
Page: 13/15

SUBSURFACE PROFILE			SAMPLE		
Depth (m)	Symbol	Description	Sample ID	Lab Analysis	Monitoring Well Completion Details
		GROUND SURFACE			
0.0		GRASS			
0.3		SILT with sand, yellowish brown, dry, firm, low plasticity. No stain or odour observed.	SS13-0.3 m	Yes	
0.5					
0.8					No Monitoring Well Constructed
1.0					
1.2					
1.5			SS13-1.5 m	Yes	
		Boulder encountered. Borehole termination.			

Hole Size:	0.1 m	Screen Interval:	NA	Drilled By:	LO,LD
Casing Size:	NA	Initial Water Level:	NA	Drill Date:	31 July 2015
End of Borehole:	1.6 m	Static Water Level:	NA	Drill Method:	Hand Auger

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Debris, Sandy GRAVEL, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Gravelly SILT, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Soil bore No. SS14

Project No: 0292668
Project: Project Darwin EIA
Client: Mandai Park Holdings

Logged by: LO
Reviewed by: DL
Approved by: CF
Page: 14/15

SUBSURFACE PROFILE			SAMPLE		
Depth (m)	Symbol	Description	Sample ID	Lab Analysis	Monitoring Well Completion Details
		GROUND SURFACE			
0.0		GRASS			
		Silty SAND with some gravel, brownish grey, dry, loose. No stain and odour observed, some construction material encountered.	SS14 - 0.4 m	Yes	No Monitoring Well Constructed
0.4		Concrete slab encountered, Borehole termination			

Hole Size:	0.1 m	Screen Interval:	NA	Drilled By:	LO, LD
Casing Size:	NA	Initial Water Level:	NA	Drill Date:	31 July 2015
End of Borehole:	0.5 m	Static Water Level:	NA	Drill Method:	Hand Auger

BENTONITE	Concrete Slab	GRAVEL	SILT	Gravelly SILT
GROUT	Debris	SAND	Clayey SILT	Boulders
ASPHALT	Sandy GRAVEL	Silty SAND	CLAY	FIRST APPEARANCE LEVEL
SCREEN	Gravelly SAND	Sandy CLAY	Silty CLAY	STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Soil bore No. SS15

Project No: 0292668
Project: Project Darwin EIA
Client: Mandai Park Holdings

Logged by: LO
Reviewed by: DL
Approved by: CF
Page: 15/15

Depth (m)	Symbol	Description	Sample ID	Lab Analysis	Monitoring Well Completion Details
		GROUND SURFACE			
0.0		GRASS			
0.3		Sandy GRAVEL, grey, dry, medium to high density. Fine sand, fine to coarse gravel. No stain or odour observed.	SS15-0.3 m	Yes	
		SILT with gravels and cobbles, reddish brown, dry, firm, low plasticity. No stain and odour observed.			
1.0					No Monitoring Well Constructed
1.2		Sandy CLAY, yellowish brown, dry, firm, low plasticity. No stain and odour.			
		CLAY, black, slightly moist, firm, medium plasticity, slight odour.			
1.5					
2.0			SS15-2.0 m		
		CLAY, dark green, moist, soft, medium plasticity. No stain and odour observed.		Yes	
		Borehole Termination			

Hole Size:	0.1 m	Screen Interval:	NA	Drilled By:	LO,DC,DL
Casing Size:	NA	Initial Water Level:	NA	Drill Date:	31 July 2015
End of Borehole:	2.1 m	Static Water Level:	NA	Drill Method:	Hand Auger

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Debris, Sandy GRAVEL, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Gravelly SILT, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

Soil Concentrations for Metals, Cyanide, Chlorinated Hydrocarbons, PAHs, Pesticides, VOC, SVOC, and TPH (mg/kg dry basis)
Shallow Soil Sampling

Test Parameter				**Metals**												**Inorganic Compunds**	**Chlorinated Hydrocarbons**	**Pesticides**	**Polynuclear Aromatic Hydrocarbons (PAHs)**	**Volatile Organic Compounds (VOC)**	**Semi - Voltaile Organic Compunds (SVOC)**	**Others**														**Conventional (%)**			**Other Pollutants**	**Total Petroleum Hydrocarbon (TPH)**			
				Arsenic	Barium	Cadium	Chromium	Cobalt	Cooper	Mercury	Lead	Molybdenum	Nickel	Zinc	Antimony	Cyanide	All Compunds	All Compunds	All Compunds	All Other Compounds	All Other Compounds	Phosphorus as P	Potassium as K	Calcium as Ca	Magnesium as Mg	Iron as Fe	Boron as B	Manganease as Mn	Dissolved Nitrogen as N	Sulphur as S	Chlorine as Cl2	Total Faecal Coliform Count, MPN/ g sample	pH @25°C	Organic Matter , %	Moisture , %	Mineral Oil	TPH (C_6-C_9)	TPH (C_{10}-C_{14})	TPH (C_{15}-C_{28})	TPH (C_{29}-C_{36})
LOR (ppm)				0.5	0.5	0.5	0.5	0.5	0.5	0.02	0.5	0.5	0.5	0.5	0.5	0.1	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	15	50	0.5	0.1	0.1	0.1	50	5	5	10	10
Soil Sample																																										
Sample ID	*Coordinates*	*Sample Depth (m)*	*Sample Date*																																							
SS01	103.779065° E	0.3	30-Jul-15	**170**	**17**	1.3	**13.5**	**1**	**17.2**	**0.18**	**19.6**	**1.8**	**3.1**	**55**	**2.60**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**296**	**125**	**1320**	**164**	**26755**	<LOR	**59**	**11.1**	<LOR	<LOR	>1,100	**6.2**	**2.8**	**25.6**	<LOR	<LOR	<LOR	**14.0**	**19**
		2.1	30-Jul-15	**196**	**5.0**	1.4	**9.3**	**0.7**	**6.6**	**0.05**	**6.50**	**3.5**	**1.2**	**6.6**	**3.30**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**39.4**	**111.0**	**226.0**	**104.0**	**32135.0**	<LOR	**26.1**	**3.67**	<LOR	<LOR	<3	**5.6**	<LOR	**23.6**	<LOR	<LOR	<LOR	<LOR	<LOR
SS02	1.411088° N	0.3	30-Jul-15	**19.6**	**4.3**	<LOR	**12.2**	**0.6**	**101**	**0.08**	**11.1**	**1.2**	**2.1**	**84.4**	**3.20**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**113**	**70.5**	**350**	**58.8**	**28450**	<LOR	**22.1**	**5.8**	<LOR	<LOR	**23**	**5.2**	**1.2**	**16.6**	<LOR	<LOR	<LOR	<LOR	<LOR
	103.784479° E	3	30-Jul-15	**25.1**	**2.2**	<LOR	**6.5**	<LOR	**0.6**	**0.04**	**2.60**	**0.9**	**1.2**	**7**	**3.20**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**33**	**36.3**	**20.6**	**16.5**	**24785**	<LOR	**14.9**	**4.65**	<LOR	<LOR	<3	**5.2**	**1.7**	**23.3**	<LOR	<LOR	<LOR	<LOR	<LOR
SS03	1.408245° N	0.3	28-Jul-15	**1.1**	<LOR	<LOR	**0.6**	<LOR	<LOR	**0.1**	**0.5**	<LOR	<LOR	**3.6**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**26.9**	**5.2**	**38.6**	**8.3**	**23395**	<LOR	**1.8**	**5.95**	<LOR	<LOR	**240**	**5.2**	**2.3**	**19.8**	<LOR	<LOR	<LOR	<LOR	<LOR
	103.782185° E	2.2	28-Jul-15	**1.9**	<LOR	<LOR	**0.8**	<LOR	<LOR	**0.1**	<LOR	<LOR	<LOR	**0.8**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**3**	**8.2**	**9.5**	**3.9**	**35765**	<LOR	**0.8**	**3.65**	**38.9**	<LOR	<3	**4.7**	**0.4**	**20.3**	<LOR	<LOR	<LOR	<LOR	<LOR
SS04	1.407833° N	0.3	28-Jul-15	**24.3**	**69**	<LOR	**8.9**	**1.5**	**13.7**	**0.06**	**16.80**	**1**	**2.5**	**40.0**	**1.60**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**232**	**539**	**2399**	**246**	**16408**	<LOR	**63.7**	**7.05**	**52**	<LOR	>1,100	**7.4**	**1.8**	**18.9**	**54**	<LOR	<LOR	**19.0**	**35**
	103.782185° E	1.9	28-Jul-15	**11**	**21.5**	<LOR	**7.0**	**0.9**	**18.8**	**0.07**	**21.90**	**0.9**	**3.2**	**113.0**	**1.70**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**2525**	**157**	**1375**	**158**	**16310**	<LOR	**71.9**	**9.88**	**19.4**	<LOR	>1,100	**6.2**	**1.0**	**19.2**	<LOR	<LOR	<LOR	<LOR	**26**
SS05	1.407422° N	0.3	24-Jul-15	**43.7**	**5.2**	<LOR	**12.8**	**0.7**	**14.7**	**0.13**	**5.00**	**1.5**	**2.3**	**22.4**	**4.00**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**526**	**69.2**	**701**	**108**	**30845**	<LOR	**15.4**	**6.47**	**43**	<LOR	<3	**5.4**	**1.1**	**23.3**	<LOR	<LOR	<LOR	<LOR	**12**
	103.783685° E	2.7	24-Jul-15	**48.2**	**2.3**	<LOR	**9.7**	<LOR	**0.8**	**0.04**	**3.10**	**1.4**	**1.5**	**4.9**	**3.80**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**17.4**	**202**	**47.9**	**15.9**	**33130**	<LOR	**7**	**8.49**	**39.7**	<LOR	<3	**4.7**	**0.1**	**30.3**	<LOR	<LOR	<LOR	<LOR	<LOR
SS06	1.405277° N	0.3	30-Jul-15	**98.5**	**1.1**	<LOR	**8.9**	<LOR	**2.5**	**0.08**	**5.10**	**1.3**	**1.3**	**8.2**	**2.30**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**52.9**	**20.6**	**353**	**11.5**	**20685**	<LOR	**5.1**	**4.26**	**33.5**	<LOR	<3	**4.4**	**0.8**	**22.9**	<LOR	<LOR	<LOR	<LOR	<LOR
	103.786087° E	1.9	30-Jul-15	**56.9**	**2.3**	<LOR	**11.5**	<LOR	**3**	**0.06**	**5.30**	**1.2**	**2.3**	**8.3**	**3.50**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**28.4**	**53**	**598**	**39.6**	**26760**	<LOR	**8.2**	**4.79**	**45.1**	<LOR	>1,100	**4.8**	**0.8**	**22.9**	<LOR	<LOR	<LOR	**10.0**	**13**
SS07	1.405864° N	0.3	27-Jul-15	**43.8**	**15.6**	<LOR	**11.8**	**1**	**3.6**	**0.13**	**12.90**	**1**	**1.8**	**16.1**	**3.50**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**36**	**265**	**4234**	**257**	**26790**	<LOR	**68.5**	**3.95**	**44.6**	<LOR	**240**	**8**	**0.1**	**16.6**	<LOR	<LOR	<LOR	<LOR	<LOR
	103. 790267° E	2.4	27-Jul-15	**32.2**	**2.1**	<LOR	**10.2**	0.5	**1.4**	**0.11**	**5.00**	**1.6**	**1.2**	**6.0**	**3.60**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**30.7**	**99.5**	**589**	**51.7**	**34870**	<LOR	**7**	**9.03**	<LOR	<LOR	<3	**6**	**1.2**	**24.0**	<LOR	<LOR	<LOR	<LOR	<LOR
SS08	1.407044° N	0.3	27-Jul-15	**21.1**	**1.2**	<LOR	**7.9**	<LOR	**1.7**	**0.1**	**2.80**	**2.7**	**1**	**5.8**	**2.60**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**39.7**	**72.5**	**308**	**31.3**	**23225**	<LOR	**6.7**	**6.19**	**59.9**	<LOR	<3	**4.6**	**1.9**	**27.9**	<LOR	<LOR	<LOR	<LOR	<LOR
	103.789451° E	1.2	27-Jul-15	**23.9**	**1.3**	<LOR	**9.5**	<LOR	**1.2**	<LOR	**1.60**	**3**	**1**	**5.9**	**3.00**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**20.8**	**69.3**	**212**	**29.5**	**28990**	<LOR	**6.8**	**4.03**	**81.2**	<LOR	<3	**4.8**	**0.9**	**28.5**	<LOR	<LOR	<LOR	<LOR	<LOR
Assessment Criteria																																									
DUTCH (2000)	**Target Value**			29	160	0.8	100	9.0	36	0.3	85	3.0	35	140	3.0	1	ns	ns	1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	50	ns	ns	ns	ns
	Intervention Value			55	625	12	380	240	190	10	530	200	210	720	15	20	ns	ns	40	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	5000	ns	ns	ns	ns

Notes:

All units in mg/kg unless stated otherwise
LOR = Limit of Reporting
<LOR = below laboratory's Limit of Reporting
na = not analysed
ns = not specified
Target Value - Dutch (2000) Target Values
Intervention Value - Dutch (2000) Intervention Values

XX	Indicates concentration exceeds Dutch "I" Value
XX	Indicates concentration exceeds Dutch "I" Value

Soil Concentrations for Metals, Cyanide, Chlorinated Hydrocarbons, PAHs, Pesticides, VOC, SVOC, and TPH (mg/kg dry basis)
Shallow Soil Sampling

Test Parameter				**Metals**											**Inorganic Compunds**	**Chlorinated Hydrocarbons**	**Pesticides**	**Polynuclear Aromatic Hydrocarbons (PAHs)**					**Volatile Organic Compounds (VOC)**	**Semi - Voltaile Organic Compounds (SVOC)**	**Others**											**Conventional (%)**			**Other Pollutants**	**Total Petroleum Hydrocarbon (TPH)**			
				Arsenic	Barium	Cadium	Chromium	Cobalt	Cooper	Mercury	Lead	Molybdenum	Nickel	Zinc	Antimony	Cyanide	All Compunds	All Compunds	Fluoranthrene	Benzo(a)anthracene	Chrysene	Sum PAH (soil with OM up to 10%)	All other compunds	All Other Compounds	All Other Compounds	Phosphorus as P	Potassium as K	Calcium as Ca	Magnesium as Mg	Iron as Fe	Boron as B	Manganease as Mn	Dissolved Nitrogen as N	Sulphur as S	Chlorine as Cl2	Total Faecal Coliform Count, MPN/g sample	pH @25°C	Organic Matter	Moisture	Mineral Oil	TPH (C_6-C_9)	TPH (C_{10}-C_{14})	TPH (C_{15}-C_{28})	TPH (C_{29}-C_{36})
LOR (ppm)				0.5	0.5	0.5	0.5	0.5	0.5	0.02	0.5	0.5	0.5	0.5	0.5	0.1	-	-	0.1	0.1	0.1	0.2	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0.5	15	50	0.5	0.1	0.1	0.10	50	5	5	10	10
Soil Sample																																													
Sample ID	***Coordinates***	***Sample Depth (m)***	***Sample Date***																																										
SS09	1.40698° N	0.3	27-Jul-15	**10.8**	**6.5**	<LOR	**10.4**	**0.5**	**9.2**	**0.08**	**5.3**	**1.0**	**11.6**	**9.6**	**3.20**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**55.1**	**16.1**	**1019.0**	**57.3**	**31105**	<LOR	**10.5**	**3.6**	**27.2**	<LOR	**240**	**6.2**	**0.7**	**21.0**	<LOR	<LOR	<LOR	**12**	**14**
	103.791811° E	2.2	27-Jul-15	**12**	**2.1**	<LOR	**9.1**	**0.6**	**1.2**	**0.02**	**5.70**	**0.7**	**1.2**	**8.5**	**3.30**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**64.5**	**88.3**	**175.0**	**16.9**	**26775**	<LOR	**8.4**	**6.74**	**68.1**	<LOR	**23**	**5**	**0.2**	**26.3**	<LOR	<LOR	<LOR	<LOR	<LOR
SS10	1.406057° N	0.4	27-Jul-15	**2.3**	<LOR	<LOR	**0.6**	<LOR	<LOR	0.1	<LOR	<LOR	<LOR	**0.9**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**6.2**	**6.2**	**64.1**	**3.3**	**20435**	<LOR	**0.8**	**7.17**	**34.8**	<LOR	>1,100	**5.5**	**2.2**	**22.6**	<LOR	<LOR	<LOR	<LOR	**12**
	103.788056° E	3	27-Jul-15	**83**	**2.2**	<LOR	**11.1**	**0.8**	**0.6**	**0.07**	**2.80**	**1.2**	**1.3**	**9.8**	**4.30**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**39.2**	**212**	**224.0**	**20.3**	**59430**	<LOR	**9.6**	**6.08**	**67.6**	<LOR	<3	**4.7**	**0.2**	**24.3**	<LOR	<LOR	<LOR	<LOR	<LOR
SS11	1.406944° N	0.3	24-Jul-15	**44.3**	**59.7**	**0.5**	**22.2**	**3.1**	**44.6**	**0.03**	**30.30**	**6.3**	**7.1**	**109**	**7.80**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**275**	**864**	**47250**	**1815**	**14242**	**0.9**	**273**	**6.43**	**83.4**	<LOR	>1,100	**8.5**	**4.1**	**14.3**	**265.0**	<LOR	<LOR	**79**	**186**
	103.783793° E	1.6	24-Jul-15	**22**	**3.4**	<LOR	**22.3**	**0.5**	**1.9**	**0.06**	**1.60**	**1.6**	**1.5**	**10.2**	**3.10**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**433**	**102**	**1334.0**	**85.9**	**25385**	<LOR	**25.7**	**5.14**	**71.2**	<LOR	>1,100	**6.6**	**0.5**	**18.5**	<LOR	<LOR	<LOR	<LOR	<LOR
SS12	1.403223° N	0.3	28-Jul-15	**56.1**	**40.9**	<LOR	**16.8**	**0.8**	**12**	**0.07**	**24.10**	**1.4**	**2.4**	**170.0**	**3.80**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**69.1**	**345**	**5602**	**186**	**24938**	<LOR	**25.9**	**7.82**	**26.3**	<LOR	<3	**8.1**	**0.7**	**16.3**	<LOR	<LOR	<LOR	<LOR	<LOR
	103.780507° E	1.5	28-Jul-15	**51.1**	**90.9**	0.5	**18.6**	**1.4**	**21.6**	**0.08**	**81.60**	**1.9**	**6.5**	**444.0**	**4.30**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**134**	**315**	**10876**	**562**	**23250**	<LOR	**108.0**	**2.89**	**212.0**	**74.6**	>1,100	**8.3**	**2.0**	**16.1**	**335.0**	<LOR	<LOR	**62**	293
SS13	1.403314° N	0.3	31-Jul-15	**37.2**	**6.5**	<LOR	**19.7**	<LOR	**13.3**	<LOR	**3.80**	**2.3**	**1.5**	**12.2**	**7.20**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**26.4**	**148**	**1191.0**	**50.9**	**32120**	<LOR	**9.6**	**7.99**	**24.3**	<LOR	**23**	**7.3**	**0.4**	**18.9**	<LOR	<LOR	<LOR	<LOR	<LOR
	103.780121° E	1.5	31-Jul-15	**25**	**28.4**	<LOR	**31.4**	**1.5**	**17.7**	**0.11**	**15.00**	**2**	**5.1**	**72.0**	**3.70**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**84.6**	**402**	**16665.0**	**462**	**27790**	<LOR	**61.8**	**4.74**	**85.1**	**77.0**	**240**	**8**	**0.9**	**18.2**	**65.0**	<LOR	<LOR	**31**	**34**
SS14	1.404604° N 103.780813° E	0.4	31-Jul-15	**45.7**	**60.2**	<LOR	**24.0**	**3.9**	**26.2**	**0.05**	**25.90**	**3.4**	**7**	**76.6**	**2**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**178**	**638**	**71875**	**1980**	**18895**	**7.9**	**174**	**2.67**	**160.0**	<LOR	<3	**10.8**	**1.2**	**13.0**	**65.0**	<LOR	<LOR	**26**	**39**
SS15	1.406636° N	0.3	31-Jul-15	**15.7**	**64.7**	<LOR	**81.1**	**12.7**	**39.9**	**0.06**	**16.40**	**1.6**	**17.1**	**72.8**	**3.40**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**261**	**793**	**37675**	**1664.0**	**38055**	**1**	**269**	**8.82**	**126.0**	**69.7**	<3	**10.4**	**0.9**	**17.4**	<LOR	<LOR	<LOR	<LOR	**28**
	103.779860° E	2	31-Jul-15	**47**	**3.7**	<LOR	**8.6**	**0.6**	**6.3**	**0.09**	**11.70**	**0.8**	**5.2**	**28.0**	**2.00**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**227**	**106**	**648.0**	**53**	**22150**	<LOR	**19.2**	**5.7**	**21.3**	**56.1**	<3	**6.2**	**1.8**	**18.5**	<LOR	<LOR	<LOR	<LOR	<LOR
Assessment Criteria																																													
DUTCH (2000)	**Target Value**			29	160	0.8	100	9.0	36	0.3	85	3.0	35	140	3.0	1	ns	ns	ns	ns	ns	1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	50	ns	ns	ns	ns
	Intervention Value			55	625	12	380	240	190	10	530	200	210	720	15	20	ns	ns	ns	ns	ns	40	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	5000	ns	ns	ns	ns

Notes:
All units in mg/kg unless stated otherwise
LOR = Limit of Reporting
<LOR = below laboratory's Limit of Reporting
na = not analysed
ns = not specified
Target Value - Dutch (2000) Target Values
Intervention Value - Dutch (2000) Intervention Values

XX	Indicates concentration exceeds Dutch "T" Value
XX	Indicates concentration exceeds Dutch "I" Value

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REPORT

Our ref : ATS/ENV/P8/30-58/15/pl

Date : 19 August, 2015

Company : Environmental Resources Management (S) Pte Ltd
120 Robinson Road #10-01
Singapore 068913

Date received : 31 July, 2015

Date Analyse Started 31 July, 2015

Date Completed 19 August, 2015

Description : Twenty nine samples of Soils were collected on 31 July, 2015 with references :-

Sample ID		
SS01-0.3m	SS06-0.3m	SS11-0.3m
SS01-2.1m	SS06-1.9m	SS11-1.6m
SS02-0.3m	SS07-0.3m	SS12-0.3m
SS02-3m	SS07-2.4m	SS12-1.5m
SS03-0.3m	SS08-0.3m	SS13-0.3m
SS03-2.2m	SS08-1.2m	SS13-1.5m
SS04-0.3m	SS09-0.3m	SS14-0.4m
SS04-1.9m	SS09-2.2m	SS15-0.3m
SS05-0.3m	SS10-0.4m	SS15-2.0m
SS05-2.70m	SS10-3m	

RESULTS : On analysis, the following results were obtained :-

Test Parameter	Test Methods	Dutch Std-Soil		Level of Reporting	SAMPLE MARKINGS / RESULTS									
		Target Value	Inter-vention Value		SS01-0.3m	SS01-2.1m	SS02-0.3m	SS02-3m	SS03-0.3m	SS03-2.2m	SS04-0.3m	SS04-1.9m	SS05-0.3m	SS05-2.70m
Metals on dry basis, mg/kg														
Arsenic	EPA 3050B/6010B	29	55	0.5	170	196	19.6	25.1	1.1	1.9	24.3	11.0	43.7	48.2
Barium	EPA 3050B/6010B	160	625	0.5	17.0	5.0	4.3	2.2	<0.5	<0.5	69.0	21.5	5.2	2.3
Cadmium	EPA 3050B/6010B	0.8	12	0.5	1.3	1.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium Total	EPA 3050B/6010B	100	380	0.5	13.5	9.3	12.2	6.5	0.6	0.8	8.9	7.0	12.8	9.7
Cobalt	EPA 3050B/6010B	9	240	0.5	1	0.7	0.6	<0.5	<0.5	<0.5	1.5	0.9	0.7	<0.5
Copper	EPA 3050B/6010B	36	190	0.5	17.2	6.6	101	0.6	<0.5	<0.5	13.7	18.8	14.7	0.8
Mercury	EPA 7471B	0.3	10	0.02	0.18	0.05	0.08	0.04	0.12	0.10	0.06	0.07	0.13	0.04
Lead	EPA 3050B/6010B	85	530	0.5	19.6	6.5	11.1	2.6	0.5	<0.5	16.8	21.9	5.0	3.1
Molybdenum	EPA 3050B/6010B	3	200	0.5	1.8	3.5	1.2	0.9	<0.5	<0.5	1.0	0.9	1.5	1.4
Nickel	EPA 3050B/6010B	35	210	0.5	3.1	1.2	2.1	1.2	<0.5	<0.5	2.5	3.2	2.3	1.5
Zinc	EPA 3050B/6010B	140	720	0.5	55.0	6.6	84.4	7.0	3.6	0.8	40.0	113	22.4	4.9
Antimony	EPA 3050B/6010B	3	15	0.5	2.6	3.3	3.2	3.2	<0.5	<0.5	1.6	1.7	4.0	3.8
Inorganic Compds, mg/kg														
Total Cyanide	EPA 9010	1	0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aromatic Compds, mg/kg														
Benzene	EPA 5035/8260C	0.01	1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	EPA 5035/8260C	0.03	50	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenol	EPA 8270D	0.05	40	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cresoles	EPA 8270D	0.05	5	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Toluene	EPA 5035/8260C	0.01	130	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Xylenes total	EPA 5035/8260C	0.1	25	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Styrene (vinylbenzene)	EPA 5035/8260C	0.3	100	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Catechol	EPA 8270D	0.05	20	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Resorcinol	EPA 8270D	0.05	10	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hydrochinon	EPA 8270D	0.05	10	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

RESULTS : On analysis, the following results were obtained :-

Test Parameter	Test Methods	Dutch Std-Soil		Level of Reporting	SAMPLE MARKINGS / RESULTS									
		Target Value	Inter-vention Value		SS06-0.3m	SS06-1.9m	SS07-0.3m	SS07-2.4m	SS08-0.3m	SS08-1.2m	SS09-0.3m	SS09-2.2m	SS10-0.4m	SS10-3m
Metals on dry basis, mg/kg														
Arsenic	EPA 3050B/6010B	29	55	0.5	98.5	56.9	43.8	32.2	21.1	23.9	10.8	12.0	2.3	83.0
Barium	EPA 3050B/6010B	160	625	0.5	1.1	2.3	15.6	2.1	1.2	1.3	6.5	2.1	<0.5	2.2
Cadmium	EPA 3050B/6010B	0.8	12	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium Total	EPA 3050B/6010B	100	380	0.5	8.9	11.5	11.8	10.2	7.9	9.5	10.4	9.1	0.6	11.1
Cobalt	EPA 3050B/6010B	9	240	0.5	<0.5	<0.5	1.0	0.5	<0.5	<0.5	0.5	0.6	<0.5	0.8
Copper	EPA 3050B/6010B	36	190	0.5	2.5	3.0	3.6	1.4	1.7	1.2	9.2	1.2	<0.5	0.6
Mercury	EPA 7471B	0.3	10	0.02	0.08	0.06	0.13	0.11	0.10	<0.02	0.08	0.02	0.12	0.07
Lead	EPA 3050B/6010B	85	530	0.5	5.1	5.3	12.9	5.0	2.8	1.6	5.3	5.7	<0.2	2.8
Molybdenum	EPA 3050B/6010B	3	200	0.5	1.3	1.2	1.0	1.6	2.7	3.0	1.0	0.7	<0.5	1.2
Nickel	EPA 3050B/6010B	35	210	0.5	1.3	2.3	1.8	1.2	1.0	1.0	11.6	1.2	<0.5	1.3
Zinc	EPA 3050B/6010B	140	720	0.5	8.2	8.3	16.1	6.0	5.8	5.9	9.6	8.5	0.9	9.8
Antimony	EPA 3050B/6010B	3	15	0.5	2.3	3.5	3.5	3.6	2.6	3.0	3.2	3.3	<0.5	4.3
Inorganic Compds, mg/kg														
Total Cyanide	EPA 9010	1	0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aromatic Compds, mg/kg														
Benzene	EPA 5035/8260C	0.01	1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	EPA 5035/8260C	0.03	50	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenol	EPA 8270D	0.05	40	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cresoles	EPA 8270D	0.05	5	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Toluene	EPA 5035/8260C	0.01	130	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Xylenes total	EPA 5035/8260C	0.1	25	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Styrene (vinylbenzene)	EPA 5035/8260C	0.3	100	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Catechol	EPA 8270D	0.05	20	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Resorcinol	EPA 8270D	0.05	10	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hydrochinon	EPA 8270D	0.05	10	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

RESULTS : On analysis, the following results were obtained :-

Test Parameter	Test Methods	Dutch Std-Soil		Level of Reporting	SAMPLE MARKINGS / RESULTS								
		Target Value	Inter-vention Value		SS11-0.3m	SS11-1.6m	SS12-0.3m	SS12-1.5m	SS13-0.3m	SS13-1.5m	SS14-0.4m	SS15-0.3m	SS15-2.0m
Metals on dry basis, mg/kg													
Arsenic	EPA 3050B/6010B	29	55	0.5	44.3	22.0	56.1	51.1	37.2	25.0	45.7	15.7	47.0
Barium	EPA 3050B/6010B	160	625	0.5	59.7	3.4	40.9	90.9	6.5	28.4	60.2	64.7	3.7
Cadmium	EPA 3050B/6010B	0.8	12	0.5	0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium Total	EPA 3050B/6010B	100	380	0.5	22.2	22.3	16.8	18.6	19.7	31.4	24.0	81.1	8.6
Cobalt	EPA 3050B/6010B	9	240	0.5	3.1	0.5	0.8	1.4	<0.5	1.5	3.9	12.7	0.6
Copper	EPA 3050B/6010B	36	190	0.5	44.6	1.9	12.0	21.6	13.3	17.7	26.2	39.9	6.3
Mercury	EPA 7471B	0.3	10	0.02	0.03	0.06	0.07	0.08	<0.02	0.11	0.05	0.06	0.09
Lead	EPA 3050B/6010B	85	530	0.5	30.3	1.6	24.1	81.6	3.8	15.0	25.9	16.4	11.7
Molybdenum	EPA 3050B/6010B	3	200	0.5	6.3	1.6	1.4	1.9	2.3	2.0	3.4	1.6	0.8
Nickel	EPA 3050B/6010B	35	210	0.5	7.1	1.5	2.4	6.5	1.5	5.1	7.0	17.1	5.2
Zinc	EPA 3050B/6010B	140	720	0.5	109	10.2	170	444	12.2	72.0	76.6	72.8	28.0
Antimony	EPA 3050B/6010B	3	15	0.5	7.8	3.1	3.8	4.3	7.2	3.7	2.0	3.4	2.0
Inorganic Compds, mg/kg													
Total Cyanide	EPA 9010	1	0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aromatic Compds, mg/kg													
Benzene	EPA 5035/8260C	0.01	1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	EPA 5035/8260C	0.03	50	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenol	EPA 8270D	0.05	40	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cresoles	EPA 8270D	0.05	5	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Toluene	EPA 5035/8260C	0.01	130	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Xylenes total	EPA 5035/8260C	0.1	25	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Styrene (vinylbenzene)	EPA 5035/8260C	0.3	100	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Catechol	EPA 8270D	0.5	20	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Resorcinol	EPA 8270D	0.5	10	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hydrochinon	EPA 8270D	0.5	10	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

RESULTS : On analysis, the following results were obtained :-

Test Parameter	Test Methods	Dutch Std- Soil		Level of Reporting	SAMPLE MARKINGS / RESULTS									
		Target Value	Inter-vention Value		SS01-0.3m	SS01-2.1m	SS02-0.3m	SS02-3m	SS03-0.3m	SS03-2.2m	SS04-0.3m	SS04-1.9m	SS05-0.3m	SS05-2.70m
PAHs, mg/kg														
Naphthalene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthrene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene	EPA 8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(g,h,i)perylene	EPA 8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(k)fluoranthrene	EPA 8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Indeno(1,2,3-cd)pyrene	EPA 8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sum PAH (soil with OM up to 10%)	-	1	40	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorinated HCs, mg/kg														
1,1-Dichloroethane	EPA8260C	0.02	15	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dichloroethane	EPA8260C	0.02	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1-dichloroethene	EPA8260C	0.1	0.3	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-dichloroethene(sum cis & trans)	EPA8260C	0.2	1	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
dichloropropanes	EPA8260C	0.002	2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1,1-trichloroethane	EPA8260C	0.07	15	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1,2-trichloroethane	EPA8260C	0.4	10	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trichloroethene(Tri)	EPA8260C	0.1	60	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
tetrachloroethene(per)	EPA8260C	0.002	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dichloromethane	EPA8260C	0.4	10	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Tetrachloromethane(Tetra)	EPA8260C	0.4	1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Trichloromethane	EPA8260C	0.02	10	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vinyl chloride	EPA8260C	0.01	0.1	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

RESULTS : On analysis, the following results were obtained :-

Test Parameter	Test Methods	Dutch Std- Soil		Level of Reporting	SAMPLE MARKINGS / RESULTS									
		Target Value	Inter-vention Value		SS06-0.3m	SS06-1.9m	SS07-0.3m	SS07-2.4m	SS08-0.3m	SS08-1.2m	SS09-0.3m	SS09-2.2m	SS10-0.4m	SS10-3m
PAHs, mg/kg														
Naphthalene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthrene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene	EPA 8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(g,h,i)perylene	EPA 8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(k)fluoranthrene	EPA 8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Indeno(1,2,3-cd)pyrene	EPA 8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sum PAH (soil with OM up to 10%)	-	1	40	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorinated HCs, mg/kg														
1,1-Dichloroethane	EPA8260C	0.02	15	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dichloroethane	EPA8260C	0.02	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1-dichloroethene	EPA8260C	0.1	0.3	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-dichloroethene(sum cis & trans)	EPA8260C	0.2	1	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
dichloropropanes	EPA8260C	0.002	2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1,1-trichloroethane	EPA8260C	0.07	15	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1,2-trichloroethane	EPA8260C	0.4	10	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trichloroethene(Tri)	EPA8260C	0.1	60	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
tetrachloroethene(per)	EPA8260C	0.002	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dichloromethane	EPA8260C	0.4	10	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Tetrachloromethane(Tetra)	EPA8260C	0.4	1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Trichloromethane	EPA8260C	0.02	10	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vinyl chloride	EPA8260C	0.01	0.1	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

RESULTS : On analysis, the following results were obtained :-

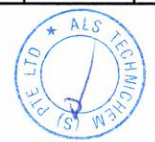
Test Parameter	Test Methods	Dutch Std- Soil		Level of Reporting	SAMPLE MARKINGS / RESULTS								
		Target Value	Inter-vention Value		SS11-0.3m	SS11-1.6m	SS12-0.3m	SS12-1.5m	SS13-0.3m	SS13-1.5m	SS14-0.4m	SS15-0.3m	SS15-2.0m
PAHs, mg/kg													
Naphthalene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthrene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.24	<0.1	<0.1	<0.1
Benzo(a)anthracene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.15	<0.1	<0.1	<0.1
Chrysene	EPA 8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.12	<0.1	<0.1	<0.1
Benzo(a)pyrene	EPA 8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(g,h,i)perylene	EPA 8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(k)fluoranthrene	EPA 8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Indeno(1,2,3-cd)pyrene	EPA 8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sum PAH (soil with OM up to 10%)	-	1	40	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.51	<0.2	<0.2	<0.2
Chlorinated HCs, mg/kg													
1,1-Dichloroethane	EPA8260C	0.02	15	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dichloroethane	EPA8260C	0.02	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1-dichloroethene	EPA8260C	0.1	0.3	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-dichloroethene(sum cis & trans)	EPA8260C	0.2	1	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
dichloropropanes	EPA8260C	0.002	2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1,1-trichloroethane	EPA8260C	0.07	15	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1,2-trichloroethane	EPA8260C	0.4	10	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trichloroethene(Tri)	EPA8260C	0.1	60	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
tetrachloroethene(per)	EPA8260C	0.002	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dichloromethane	EPA8260C	0.4	10	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Tetrachloromethane(Tetra)	EPA8260C	0.4	1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Trichloromethane	EPA8260C	0.02	10	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vinyl chloride	EPA8260C	0.01	0.1	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

RESULTS : On analysis, the following results were obtained :-

TEST PARAMETER	TEST METHODS	Dutch Std- Soil		Level of Reporting	SAMPLE MARKINGS / RESULTS									
		Target Value	Inter-vention Value		SS01-0.3m	SS01-2.1m	SS02-0.3m	SS02-3m	SS03-0.3m	SS03-2.2m	SS04-0.3m	SS04-1.9m	SS05-0.3m	SS05-2.70m
Chlorobenzenes(sum mono,di, tri,tetra,penta,hexa)	EPA 8270D	0.03	30	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Monochlorobenzene	EPA8260C	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dichlorobenzenes(sum)	EPA8260C	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Trichlorobenzenes(sum)	EPA8260C	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Tetrachlorobenzenes(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pentachlorobenzene(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexachlorobenzene(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorophenols (sum mono, di,tri,tetra,penta)	EPA8270D	0.01	10	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Monochlorophenol(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dichlorophenols(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Trichlorophenols(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Tetrachlorophenols(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pentachlorophenol	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chloronaphthalene	EPA8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
monochloroanilines	EPA8270D	0.005	50	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Polychlorobiphenyls (sum of PCB 28,52,101,118,138,153,180)	EPA8270D	0.02	1	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Pesticides, mg/kg														
Sum DDT/DDE/DDD	EPA 8270D	0.01	4	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum aldrin, dieldrin,endrin	EPA 8270D	0.01	4	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin	EPA 8270D	0.00006	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin	EPA 8270D	0.0005	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	EPA 8270D	0.00004	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sum HCH compounds	EPA 8270D	0.01	2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Alpha-HCH	EPA 8270D	0.003	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
beta-HCH	EPA 8270D	0.009	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-HCH	EPA 8270D	0.00005	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

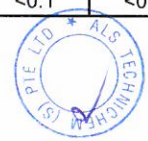
RESULTS : On analysis, the following results were obtained :-

TEST PARAMETER	TEST METHODS	Dutch Std- Soil		Level of Reporting	SAMPLE MARKINGS / RESULTS									
		Target Value	Inter-vention Value		SS06-0.3m	SS06-1.9m	SS07-0.3m	SS07-2.4m	SS08-0.3m	SS08-1.2m	SS09-0.3m	SS09-2.2m	SS10-0.4m	SS10-3m
Chlorobenzenes(sum mono,di, tri,tetra,penta,hexa)	EPA 8270D	0.03	30	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Monochlorobenzene	EPA8260C	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dichlorobenzenes(sum)	EPA8260C	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Trichlorobenzenes(sum)	EPA8260C	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Tetrachlorobenzenes(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pentachlorobenzene(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexachlorobenzene(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorophenols (sum mono, di,tri,tetra,penta)	EPA8270D	0.01	10	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Monochlorophenol(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dichlorophenols(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Trichlorophenols(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Tetrachlorophenols(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pentachlorophenol	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chloronaphthalene	EPA8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
monochloroanilines	EPA8270D	0.005	50	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Polychlorobiphenyls (sum of PCB 28,52,101,118,138,153,180)	EPA8270D	0.02	1	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Pesticides, mg/kg														
Sum DDT/DDE/DDD	EPA 8270D	0.01	4	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum aldrin, dieldrin,endrin	EPA 8270D	0.01	4	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin	EPA 8270D	0.00006	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin	EPA 8270D	0.0005	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	EPA 8270D	0.00004	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sum HCH compounds	EPA 8270D	0.01	2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Alpha-HCH	EPA 8270D	0.003	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
beta-HCH	EPA 8270D	0.009	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-HCH	EPA 8270D	0.00005	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1



RESULTS : On analysis, the following results were obtained :-

TEST PARAMETER	TEST METHODS	Dutch Std- Soil		Level of Reporting	SAMPLE MARKINGS / RESULTS									
		Target Value	Inter-vention Value		SS11-0.3m	SS11-1.6m	SS12-0.3m	SS12-1.5m	SS13-0.3m	SS13-1.5m	SS14-0.4m	SS15-0.3m	SS15-2.0m	
Chlorobenzenes(sum mono,di, tri,tetra,penta,hexa)	EPA 8270D	0.03	30	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Monochlorobenzene	EPA8260C	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dichlorobenzenes(sum)	EPA8260C	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Trichlorobenzenes(sum)	EPA8260C	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Tetrachlorobenzenes(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pentachlorobenzene(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexachlorobenzene(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorophenols (sum mono, di,tri,tetra,penta)	EPA8270D	0.01	10	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Monochlorophenol(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dichlorophenols(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Trichlorophenols(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Tetrachlorophenols(sum)	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pentachlorophenol	EPA8270D	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chloronaphthalene	EPA8270D	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
monochloroanilines	EPA8270D	0.005	50	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Polychlorobiphenyls (sum of PCB 28,52,101,118,138,153,180)	EPA8270D	0.02	1	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Pesticides, mg/kg														
Sum DDT/DDE/DDD	EPA 8270D	0.01	4	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum aldrin, dieldrin,endrin	EPA 8270D	0.01	4	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin	EPA 8270D	0.00006	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin	EPA 8270D	0.0005	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	EPA 8270D	0.00004	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sum HCH compounds	EPA 8270D	0.01	2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Alpha-HCH	EPA 8270D	0.003	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
beta-HCH	EPA 8270D	0.009	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-HCH	EPA 8270D	0.00005	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1



RESULTS : On analysis, the following results were obtained :-

TEST PARAMETER	TEST METHODS	Dutch Std- Soil		Level of Reporting	SAMPLE MARKINGS / RESULTS									
		Target Value	Inter-vention Value		SS01-0.3m	SS01-2.1m	SS02-0.3m	SS02-3m	SS03-0.3m	SS03-2.2m	SS04-0.3m	SS04-1.9m	SS05-0.3m	SS05-2.70m
Pesticides, mg/kg														
Chlordane	EPA 8270D	0.00003	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan	EPA 8270D	0.00001	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	EPA 8270D	0.0007	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
heptachlor epoxide	EPA 8270D	0.0000002	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Carbaryl	EPA 8270D	0.00003	5	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Carbofuran	EPA 8270D	0.00002	2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Maneb	EPA 8270D	0.002	35	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Atrazin	EPA 8270D	0.0002	6	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other Pollutants, mg/kg														
Cyclohexanone	EPA 5035/8260C	0.1	45	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phthalates (sum)	EPA 8270D	0.1	60	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mineral Oil	EPA 8015B Mod	50	5000	50	<50	<50	<50	<50	<50	<50	54	<50	<50	<50
Pyridine	EPA 8270D	0.1	0.5	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tribromomethane	EPA 5035/8260C	-	75	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tetrahydrofuran	EPA 8270D	0.1	2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tetrahydrothiophene	EPA 8270D	0.1	90	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

RESULTS : On analysis, the following results were obtained :-

TEST PARAMETER	TEST METHODS	Dutch Std- Soil		Level of Reporting	SAMPLE MARKINGS / RESULTS									
		Target Value	Inter-vention Value		SS06-0.3m	SS06-1.9m	SS07-0.3m	SS07-2.4m	SS08-0.3m	SS08-1.2m	SS09-0.3m	SS09-2.2m	SS10-0.4m	SS10-3m
Pesticides, mg/kg														
Chlordane	EPA 8270D	0.00003	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan	EPA 8270D	0.00001	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	EPA 8270D	0.0007	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
heptachlor epoxide	EPA 8270D	0.0000002	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Carbaryl	EPA 8270D	0.00003	5	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Carbofuran	EPA 8270D	0.00002	2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Maneb	EPA 8270D	0.002	35	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Atrazin	EPA 8270D	0.0002	6	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other Pollutants, mg/kg														
Cyclohexanone	EPA 5035/8260C	0.1	45	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phthalates (sum)	EPA 8270D	0.1	60	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mineral Oil	EPA 8015B Mod	50	5000	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Pyridine	EPA 8270D	0.1	0.5	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tribromomethane	EPA 5035/8260C	-	75	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tetrahydrofuran	EPA 8270D	0.1	2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tetrahydrothiophene	EPA 8270D	0.1	90	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

RESULTS : On analysis, the following results were obtained :-

TEST PARAMETER	TEST METHODS	Dutch Std- Soil		Level of Reporting	SAMPLE MARKINGS / RESULTS								
		Target Value	Inter-vention Value		SS11-0.3m	SS11-1.6m	SS12-0.3m	SS12-1.5m	SS13-0.3m	SS13-1.5m	SS14-0.4m	SS15-0.3m	SS15-2.0m
Pesticides, mg/kg													
Chlordane	EPA 8270D	0.00003	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan	EPA 8270D	0.00001	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	EPA 8270D	0.0007	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
heptachlor epoxide	EPA 8270D	0.0000002	4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Carbaryl	EPA 8270D	0.00003	5	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Carbofuran	EPA 8270D	0.00002	2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Maneb	EPA 8270D	0.002	35	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Atrazin	EPA 8270D	0.0002	6	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other Pollutants, mg/kg													
Cyclohexanone	EPA 5035/8260C	0.1	45	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phthalates (sum)	EPA 8270D	0.1	60	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mineral Oil	EPA 8015B Mod	50	5000	50	265	<50	<50	335	<50	65	65	<50	<50
Pyridine	EPA 8270D	0.1	0.5	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tribromomethane	EPA 5035/8260C	-	75	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tetrahydrofuran	EPA 8270D	0.1	2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tetrahydrothiophene	EPA 8270D	0.1	90	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

RESULTS : On analysis, the following results were obtained :-

TEST PARAMETER	TEST METHODS	Dutch Std- Soil		Level of Reporting	SAMPLE MARKINGS / RESULTS									
		Target Value	Inter-vention Value		SS01-0.3m	SS01-2.1m	SS02-0.3m	SS02-3m	SS03-0.3m	SS03-2.2m	SS04-0.3m	SS04-1.9m	SS05-0.3m	SS05-2.70m
Conventional :														
Organic matter, %	BS 1377	-	-	0.1	2.8	<0.1	1.2	1.7	2.3	0.4	1.8	1.0	1.1	0.1
Moisture, %	BS 1377	-	-	0.1	25.6	23.6	16.6	23.3	19.8	20.3	18.9	19.2	23.3	30.3
pH @25°C	EAP 9045D	-	-	0.1	6.2	5.6	5.2	5.2	5.2	4.7	7.4	6.2	5.4	4.7
TPH, mg/kg														
C_6-C_9	EPA 8015B	-	-	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
C_{10}-C_{14}	EPA 8015B	-	-	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
C_{15}-C_{28}	EPA 8015B	-	-	10	14	<10	<10	<10	<10	<10	19	<10	<10	<10
C_{29}-C_{36}	EPA 8015B	-	-	10	19	<10	<10	<10	<10	<10	35	26	12	<10
Others, mg/kg														
Phosphorus as P	EPA3050B/6010B	-	-	0.5	296	39.4	113	33.0	26.9	3.0	232	2,525	526	17.4
Potassium as K	EPA3050B/6010B	-	-	0.5	125	111	70.5	36.3	5.2	8.2	539	157	69.2	202
Calcium as Ca	EPA3050B/6010B	-	-	0.5	1,320	226	350	20.6	38.6	9.5	2,399	1,375	701	47.9
Magnesium as Mg	EPA3050B/6010B	-	-	0.5	164	104	58.8	16.5	8.3	3.9	246	158	108	15.9
Iron as Fe	EPA3050B/6010B	-	-	0.5	26,755	32,135	28,450	24,785	23,395	35,765	16,408	16,310	30,845	33,130
Boron as B	EPA3050B/6010B	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Manganease as Mn	EPA3050B/6010B	-	-	0.5	59.0	26.1	22.1	14.9	1.8	0.8	63.7	71.9	15.4	7.0
Dissolved Nitrogen as N, mg/kg	Water Extracted/FIA	-	-	0.5	11.1	3.67	5.80	4.65	5.95	3.65	7.05	9.88	6.47	8.49
Sulphur as S, mg/kg	Ion Chromatography	-	-	15	<15	<15	<15	<15	<15	38.9	52	19.4	43.0	39.7
Chlorine as Cl_2, mg/kg	Ion Chromatography	-	-	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Total Faecal Coliform Count, MPN/g sample	FDA-BAM Online Chap 4:Sep 2002	-	-	0.5	>1,100	<3	23	<3	240	<3	>1,100	>1,100	<3	<3
Volatile Organics (VOCs), mg/kg	Please see attachment.													
Semi-Volatile Organics (SVOCs), mg/kg	Please see attachment.													

RESULTS : On analysis, the following results were obtained :-

TEST PARAMETER	TEST METHODS	Dutch Std- Soil		Level of Reporting	SAMPLE MARKINGS / RESULTS									
		Target Value	Inter-vention Value		SS06-0.3m	SS06-1.9m	SS07-0.3m	SS07-2.4m	SS08-0.3m	SS08-1.2m	SS09-0.3m	SS09-2.2m	SS10-0.4m	SS10-3m
Conventional :														
Organic matter, %	BS 1377	-	-	0.1	0.8	0.8	0.1	1.2	1.9	0.9	0.7	0.2	2.2	0.2
Moisture, %	BS 1377	-	-	0.1	22.9	22.9	16.6	24.0	27.9	28.5	21.0	26.3	22.6	24.3
pH @25°C	EAP 9045D	-	-	0.1	4.4	4.8	8.0	6.0	46	4.8	6.2	5.0	5.5	4.7
TPH, mg/kg														
C_6-C_9	EPA 8015B	-	-	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
C_{10}-C_{14}	EPA 8015B	-	-	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
C_{15}-C_{28}	EPA 8015B	-	-	10	<10	10	<10	<10	<10	<10	12	<10	<10	<10
C_{29}-C_{36}	EPA 8015B	-	-	10	<10	13	<10	<10	<10	<10	14	<10	12	<10
Others, mg/kg														
Phosphorus as P	EPA3050B/6010B	-	-	0.5	52.9	28.4	36.0	30.7	39.7	20.8	55.1	64.5	6.2	39.2
Potassium as K	EPA3050B/6010B	-	-	0.5	20.6	53.0	265	99.5	72.5	69.3	16.1	88.3	6.2	212
Calcium as Ca	EPA3050B/6010B	-	-	0.5	353	598	4,234	589	308	212	1,019	175	64.1	224
Magnesium as Mg	EPA3050B/6010B	-	-	0.5	11.5	39.6	257	51.7	31.3	29.5	57.3	16.9	3.3	20.3
Iron as Fe	EPA3050B/6010B	-	-	0.5	20,685	26,760	26,790	34,870	23,225	28,990	31,105	26,775	20,435	59,430
Boron as B	EPA3050B/6010B	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Manganease as Mn	EPA3050B/6010B	-	-	0.5	5.1	8.2	68.5	7.0	6.7	6.8	10.5	8.4	0.8	9.6
Dissolved Nitrogen as N, mg/kg	Water Extracted/FIA	-	-	0.5	4.26	4.79	3.95	9.03	6.19	4.03	3.55	6.74	7.17	6.08
Sulphur as S, mg/kg	Ion Chromatography	-	-	15	33.5	45.1	44.6	<15	59.9	81.2	27.2	68.1	34.8	67.6
Chlorine as Cl_2, mg/kg	Ion Chromatography	-	-	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Total Faecal Coliform Count, MPN/g sample	FDA-BAM Online / Chap 4:Sep 2002	-	-	0.5	<3	>1,100	240	<3	<3	<3	240	23	>1,100	<3
Volatile Organics (VOCs), mg/kg	Please see attachment.													
Semi-Volatile Organics (SVOCs), mg/kg	Please see attachment.													

ALS TECHNICHEM (S) PTE LTD

RESULTS : On analysis, the following results were obtained :-

TEST PARAMETER	TEST METHODS	Dutch Std- Soil		Level of Reporting	SAMPLE MARKINGS / RESULTS								
		Target Value	Inter-vention Value		SS11-0.3m	SS11-1.6m	SS12-0.3m	SS12-1.5m	SS13-0.3m	SS13-1.5m	SS14-0.4m	SS15-0.3m	SS15-2.0m
Conventional :													
Organic matter, %	BS 1377	-	-	0.1	4.1	0.5	0.7	2.0	0.4	0.9	1.2	0.9	1.8
Moisture, %	BS 1377	-	-	0.1	14.3	18.5	16.3	16.1	18.9	18.2	13.0	17.4	18.5
pH @25°C	EAP 9045D	-	-	0.1	8.5	6.6	8.1	8.3	7.3	8.0	10.8	10.4	6.2
TPH, mg/kg													
C_6-C_9	EPA 8015B	-	-	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
C_{10}-C_{14}	EPA 8015B	-	-	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
C_{15}-C_{28}	EPA 8015B	-	-	10	79	<10	<10	62	<10	31	26	<10	<10
C_{29}-C_{36}	EPA 8015B	-	-	10	186	<10	<10	293	<10	34	39	28	<10
Others, mg/kg													
Phosphorus as P	EPA3050B/6010B			0.5	275	433	69.1	134	26.4	84.6	178	261	227
Potassium as K	EPA3050B/6010B			0.5	864	102	345	315	148	402	638	793	106
Calcium as Ca	EPA3050B/6010B			0.5	47,250	1,334	5,602	10,876	1,191	16,665	71,875	37,675	648
Magnesium as Mg	EPA3050B/6010B			0.5	1,815	85.9	186	562	50.9	462	1,980	1,664	53.0
Iron as Fe	EPA3050B/6010B			0.5	14,242	25,385	24,938	23,250	32,120	27,790	18,895	38,055	22,150
Boron as B	EPA3050B/6010B			0.5	0.9	<0.5	<0.5	<0.5	<0.5	<0.5	7.9	1.0	<0.5
Manganease as Mn	EPA3050B/6010B			0.5	273	25.7	25.9	108	9.6	61.8	174	269	19.2
Dissolved Nitrogen as N, mg/kg	Water Extracted/FIA			0.5	6.43	5.14	7.82	2.89	7.99	4.74	2.67	8.82	5.7
Sulphur as S, mg/kg	Ion Chromatography			15	83.4	71.2	26.3	212	24.3	85.1	160	126	21.3
Chlorine as Cl_2, mg/kg	Ion Chromatography			50	<50	<50	<50	74.6	<50	77	<50	69.7	56.1
Total Faecal Coliform Count, MPN/g sample	FDA-BAM Online Chap 4:Sep 2002	-	-	0.5	>1,100	>1,100	<3	>1,100	23	240	<3	<3	<3
Volatile Organics (VOCs), mg/kg	Please see attachment.												
Semi-Volatile Organics (SVOCs), mg/kg	Please see attachment.												

ALS TECHNICHEM (S) PTE LTD

RESULTS : On analysis, the following results were obtained :-

VOLATILE ORGANICS (EPA 5035/8260C)											
		SAMPLE MARKINGS / RESULTS									
TEST PARAMETER(mg/kg)	Level of Reporting	SS01-0.3m	SS01-2.1m	SS02-0.3m	SS02-3m	SS03-0.3m	SS03-2.2m	SS04-0.3m	SS04-1.9m	SS05-0.3m	SS05-2.70m
Halogenated aliphatics											
dichlorodifluoromethane	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Chloromethane	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
vinyl chloride	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
bromomethane	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
chloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trichlorofluoromethane	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
1,1-dichloroethylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
iodomethane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
methylene chloride	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
trans-1,2-dichloroethylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1-dichloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
cis-1,2-dichloroethylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1,1-trichloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1-dichloropropylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
carbon tetrachloride	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-dichloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trichloroethylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
dibromomethane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1,2-trichloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,3-dichloropropane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
tetrachloroethylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1,1,2-tetrachloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trans-1,4-dichloro-2-butene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
cis-1,4-dichloro-2-butene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1,2,2-tetrachloroethane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2,3-trichloropropane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
pentachloroethane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-dibromo-3-chloropropane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

RESULTS : On analysis, the following results were obtained :-

VOLATILE ORGANICS (EPA 5035/8260C)											
		SAMPLE MARKINGS / RESULTS									
TEST PARAMETER(mg/kg)	Level of Reporting	SS06-0.3m	SS06-1.9m	SS07-0.3m	SS07-2.4m	SS08-0.3m	SS08-1.2m	SS09-0.3m	SS09-2.2m	SS10-0.4m	SS10-3m
Halogenated aliphatics											
dichlorodifluoromethane	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Chloromethane	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
vinyl chloride	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
bromomethane	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
chloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trichlorofluoromethane	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
1,1-dichloroethylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
iodomethane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
methylene chloride	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
trans-1,2-dichloroethylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1-dichloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
cis-1,2-dichloroethylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1,1-trichloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1-dichloropropylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
carbon tetrachloride	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-dichloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trichloroethylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
dibromomethane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1,2-trichloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,3-dichloropropane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
tetrachloroethylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1,1,2-tetrachloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trans-1,4-dichloro-2-butene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
cis-1,4-dichloro-2-butene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1,2,2-tetrachloroethane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2,3-trichloropropane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
pentachloroethane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-dibromo-3-chloropropane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

RESULTS : On analysis, the following results were obtained :-

VOLATILE ORGANICS (EPA 5035/8260C)										
		SAMPLE MARKINGS / RESULTS								
TEST PARAMETER(mg/kg)	Level of Reporting	SS11-0.3m	SS11-1.6m	SS12-0.3m	SS12-1.5m	SS13-0.3m	SS13-1.5m	SS14-0.4m	SS15-0.3m	SS15-2.0m
Halogenated aliphatics										
dichlorodifluoromethane	2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Chloromethane	2	<2	<2	<2	<2	<2	<2	<2	<2	<2
vinyl chloride	2	<2	<2	<2	<2	<2	<2	<2	<2	<2
bromomethane	2	<2	<2	<2	<2	<2	<2	<2	<2	<2
chloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trichlorofluoromethane	2	<2	<2	<2	<2	<2	<2	<2	<2	<2
1,1-dichloroethylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
iodomethane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
methylene chloride	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
trans-1,2-dichloroethylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1-dichloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
cis-1,2-dichloroethylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1,1-trichloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1-dichloropropylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
carbon tetrachloride	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-dichloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trichloroethylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
dibromomethane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1,2-trichloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,3-dichloropropane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
tetrachloroethylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1,1,2-tetrachloroethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trans-1,4-dichloro-2-butene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
cis-1,4-dichloro-2-butene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1,2,2-tetrachloroethane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2,3-trichloropropane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
pentachloroethane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-dibromo-3-chloropropane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

RESULTS : On analysis, the following results were obtained :-

VOLATILE ORGANICS (EPA 5035/8260C)											
TEST PARAMETER(mg/kg)	Level of Reporting	SAMPLE MARKINGS / RESULTS									
		SS01-0.3m	SS01-2.1m	SS02-0.3m	SS02-3m	SS03-0.3m	SS03-2.2m	SS04-0.3m	SS04-1.9m	SS05-0.3m	SS05-2.70m
Halogenated aromatics											
chlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
bromobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2-chlorotoluene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-chlorotoluene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2,4-trichlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2,3-trichlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Trihalomethane											
chloroform	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
bromodichloromethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
dibromochloromethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
bromoform	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SEMI-VOLATILE ORGANICS (EPA 8270D)											
PHENOLS											
Phenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-Chlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-Methylphenol (o-Cresol)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
4-Methylphenol (p-Cresol)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dihydroxybenzene (Catechol)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,3-Dihydroxybenzene (Resorcinol)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,4-Dihydroxybenzene (Hydroquinone)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-Nitrophenol	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2,4-Dimethylphenol	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2,6- Dichlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2,4-Dichlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
4-Chloro-3-methylphenol	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2,4,6-Trichlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2,4,5-Trichlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pentachlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

RESULTS : On analysis, the following results were obtained :-

VOLATILE ORGANICS (EPA 5035/8260C)											
		SAMPLE MARKINGS / RESULTS									
TEST PARAMETER(mg/kg)	Level of Reporting	SS06-0.3m	SS06-1.9m	SS07-0.3m	SS07-2.4m	SS08-0.3m	SS08-1.2m	SS09-0.3m	SS09-2.2m	SS10-0.4m	SS10-3m
Halogenated aromatics											
chlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
bromobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2-chlorotoluene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-chlorotoluene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2,4-trichlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2,3-trichlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Trihalomethane											
chloroform	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
bromodichloromethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
dibromochloromethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
bromoform	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SEMI-VOLATILE ORGANICS (EPA 8270D)											
PHENOLS											
Phenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-Chlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-Methylphenol (o-Cresol)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
4-Methylphenol (p-Cresol)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dihydroxybenzene (Catechol)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,3-Dihydroxybenzene (Resorcinol)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,4-Dihydroxybenzene (Hydroquinone)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-Nitrophenol	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2,4-Dimethylphenol	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2,6- Dichlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2,4-Dichlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
4-Chloro-3-methylphenol	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2,4,6-Trichlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2,4,5-Trichlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pentachlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

RESULTS : On analysis, the following results were obtained :-

VOLATILE ORGANICS (EPA 5035/8260C)										
		SAMPLE MARKINGS / RESULTS								
TEST PARAMETER(mg/kg)	Level of Reporting	SS11-0.3m	SS11-1.6m	SS12-0.3m	SS12-1.5m	SS13-0.3m	SS13-1.5m	SS14-0.4m	SS15-0.3m	SS15-2.0m
Halogenated aromatics										
chlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
bromobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2-chlorotoluene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-chlorotoluene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2,4-trichlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2,3-trichlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Trihalomethane										
chloroform	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
bromodichloromethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
dibromochloromethane	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
bromoform	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SEMI-VOLATILE ORGANICS (EPA 8270D)										
PHENOLS										
Phenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-Chlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-Methylphenol (o-Cresol)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
4-Methylphenol (p-Cresol)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dihydroxybenzene (Catechol)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,3-Dihydroxybenzene (Resorcinol)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,4-Dihydroxybenzene (Hydroquinone)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-Nitrophenol	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2,4-Dimethylphenol	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2,6- Dichlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2,4-Dichlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
4-Chloro-3-methylphenol	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2,4,6-Trichlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2,4,5-Trichlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pentachlorophenol	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

RESULTS : On analysis, the following results were obtained :-

SEMI-VOLATILE ORGANICS (EPA 8270D)											
		SAMPLE MARKINGS / RESULTS									
TEST PARAMETER(mg/kg)	Level of Reporting	SS01-0.3m	SS01-2.1m	SS02-0.3m	SS02-3m	SS03-0.3m	SS03-2.2m	SS04-0.3m	SS04-1.9m	SS05-0.3m	SS05-2.70m
POLYNUCLEAR AROMATICS											
Naphthalene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-Methylnaphthalene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2-Chloronaphthalene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Acenaphthalene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Acenaphthene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Fluorene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Phenanthrene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-2-Fluorenylacetimide	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)anthracene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b)&(k)fluoranthene	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
7,12-Dimethyl benzo(a)anthracene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)pyrene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
3-Methylchloanthrene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Indeno(1,2,3-cd)pyrene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dibenzo(a,h)anthracene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(g,h,i)perylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
PHTHALATE ESTERS											
Dimethylphthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Diethylphthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Di-n-butylphthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzy butylphthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Bis(2-ethylhexyl)phthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Di-n-octylphthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

RESULTS : On analysis, the following results were obtained :-

SEMI-VOLATILE ORGANICS (EPA 8270D)											
		SAMPLE MARKINGS / RESULTS									
TEST PARAMETER(mg/kg)	Level of Reporting	SS06-0.3m	SS06-1.9m	SS07-0.3m	SS07-2.4m	SS08-0.3m	SS08-1.2m	SS09-0.3m	SS09-2.2m	SS10-0.4m	SS10-3m
POLYNUCLEAR AROMATICS											
Naphthalene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-Methylnaphthalene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2-Chloronaphthalene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Acenaphthalene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Acenaphthene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Fluorene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Phenanthrene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-2-Fluorenylacetimide	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)anthracene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b)&(k)fluoranthene	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
7,12-Dimethyl benzo(a)anthracene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)pyrene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
3-Methylchloanthrene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Indeno(1,2,3-cd)pyrene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dibenzo(a,h)anthracene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(g,h,i)perylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
PHTHALATE ESTERS											
Dimethylphthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Diethylphthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Di-n-butylphthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzy butylphthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Bis(2-ethylhexyl)phthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Di-n-octylphthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

RESULTS : On analysis, the following results were obtained :-

SEMI-VOLATILE ORGANICS (EPA 8270D)										
		SAMPLE MARKINGS / RESULTS								
TEST PARAMETER(mg/kg)	Level of Reporting	SS11-0.3m	SS11-1.6m	SS12-0.3m	SS12-1.5m	SS13-0.3m	SS13-1.5m	SS14-0.4m	SS15-0.3m	SS15-2.0m
POLYNUCLEAR AROMATICS										
Naphthalene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-Methylnaphthalene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2-Chloronaphthalene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Acenaphthalene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Acenaphthene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Fluorene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Phenanthrene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-2-Fluorenylacetimide	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)anthracene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b)&(k)fluoranthene	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
7,12-Dimethyl benzo(a)anthracene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)pyrene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
3-Methylchloanthrene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Indeno(1,2,3-cd)pyrene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dibenzo(a,h)anthracene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(g,h,i)perylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
PHTHALATE ESTERS										
Dimethylphthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Diethylphthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Di-n-butylphthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzy butylphthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Bis(2-ethylhexyl)phthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Di-n-octylphthalate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

RESULTS : On analysis, the following results were obtained :-

SEMI-VOLATILE ORGANICS (EPA 8270D)											
TEST PARAMETER(mg/kg)	Level of Reporting	SAMPLE MARKINGS / RESULTS									
		SS01-0.3m	SS01-2.1m	SS02-0.3m	SS02-3m	SS03-0.3m	SS03-2.2m	SS04-0.3m	SS04-1.9m	SS05-0.3m	SS05-2.70m
NITROSOAMINES											
N-Nitrosomethylethylamine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-Nitrosodiethylamine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-Nitrosopyrrolidine	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
N-Nitrosomorpholine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-Nitrosodi-n-propylamine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-Nitrosopiperidine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-Nitrosodibutylamine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Diphenylamine & N-nitrosodiphenylamine	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Methapyrilene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
NITROAROMATICS AND CYCLIC KETONES											
2-Picoline	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Acetophenone	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nitrobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Isophorone	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2,6-Dinitrotoluene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2,4-Dinitrotoluene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1-Naphthylamine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Nitroquinoline-N-oxide	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
5-Nitro-o-toluidine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Azobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,3,5-Trinitrobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Phenacetin	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Aminobiphenyl	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pentachloronitrobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dimethylaminoazobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorobenzilate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

RESULTS : On analysis, the following results were obtained :-

SEMI-VOLATILE ORGANICS (EPA 8270D)											
TEST PARAMETER(mg/kg)	Level of Reporting	SAMPLE MARKINGS / RESULTS									
		SS06-0.3m	SS06-1.9m	SS07-0.3m	SS07-2.4m	SS08-0.3m	SS08-1.2m	SS09-0.3m	SS09-2.2m	SS10-0.4m	SS10-3m
NITROSOAMINES											
N-Nitrosomethylethylamine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-Nitrosodiethylamine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-Nitrosopyrrolidine	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
N-Nitrosomorpholine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-Nitrosodi-n-propylamine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-Nitrosopiperidine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-Nitrosodibutylamine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Diphenylamine & N-nitrosodiphenylamine	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Methapyrilene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
NITROAROMATICS AND CYCLIC KETONES											
2-Picoline	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Acetophenone	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nitrobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Isophorone	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2,6-Dinitrotoluene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2,4-Dinitrotoluene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1-Naphthylamine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Nitroquinoline-N-oxide	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
5-Nitro-o-toluidine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Azobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,3,5-Trinitrobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Phenacetin	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Aminobiphenyl	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pentachloronitrobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dimethylaminoazobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorobenzilate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

RESULTS : On analysis, the following results were obtained :-

SEMI-VOLATILE ORGANICS (EPA 8270D)										
TEST PARAMETER(mg/kg)	Level of Reporting	SAMPLE MARKINGS / RESULTS								
		SS11-0.3m	SS11-1.6m	SS12-0.3m	SS12-1.5m	SS13-0.3m	SS13-1.5m	SS14-0.4m	SS15-0.3m	SS15-2.0m
NITROSOAMINES										
N-Nitrosomethylethylamine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-Nitrosodiethylamine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-Nitrosopyrrolidine	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
N-Nitrosomorpholine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-Nitrosodi-n-propylamine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-Nitrosopiperidine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
N-Nitrosodibutylamine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Diphenylamine & N-nitrosodiphenylamine	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Methapyrilene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
NITROAROMATICS AND CYCLIC KETONES										
2-Picoline	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Acetophenone	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nitrobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Isophorone	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2,6-Dinitrotoluene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2,4-Dinitrotoluene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1-Naphthylamine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Nitroquinoline-N-oxide	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
5-Nitro-o-toluidine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Azobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,3,5-Trinitrobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Phenacetin	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Aminobiphenyl	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pentachloronitrobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dimethylaminoazobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorobenzilate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

RESULTS : On analysis, the following results were obtained :-

SEMI-VOLATILE ORGANICS (EPA 8270D)											
		SAMPLE MARKINGS / RESULTS									
TEST PARAMETER(mg/kg)	Level of Reporting	SS01-0.3m	SS01-2.1m	SS02-0.3m	SS02-3m	SS03-0.3m	SS03-2.2m	SS04-0.3m	SS04-1.9m	SS05-0.3m	SS05-2.70m
HALOETHERS											
Bis(2-chloroethyl)ether	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Bis(2-chloroethoxy)methane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Chlorophenyl phenylether	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Bromophenyl phenylether	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
CHLORINATED HYDROCARBONS											
1,3-Dichlorobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,4-Dichlorobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-Dichlorobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexachloroethane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexachloropropylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexachlorobutadiene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexachlorocyclopentadiene	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Pentachlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hexachlorobenzene	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ANILINES AND BENZIDINES											
Aniline	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Chloroaniline	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2-Nitroaniline	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
3-Nitroaniline	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Dibenzofuran	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Nitroaniline	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Carbazole	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
3,3'-Dichlorobenzidine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
POLYCHORINATED BIPHENYLS											
Aroclor-1232	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Aroclor-1242	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Aroclor-1248	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Aroclor-1254	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

RESULTS : On analysis, the following results were obtained :-

SEMI-VOLATILE ORGANICS (EPA 8270D)											
		SAMPLE MARKINGS / RESULTS									
TEST PARAMETER(mg/kg)	Level of Reporting	SS06-0.3m	SS06-1.9m	SS07-0.3m	SS07-2.4m	SS08-0.3m	SS08-1.2m	SS09-0.3m	SS09-2.2m	SS10-0.4m	SS10-3m
HALOETHERS											
Bis(2-chloroethyl)ether	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Bis(2-chloroethoxy)methane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Chlorophenyl phenylether	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Bromophenyl phenylether	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
CHLORINATED HYDROCARBONS											
1,3-Dichlorobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,4-Dichlorobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-Dichlorobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexachloroethane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexachloropropylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexachlorobutadiene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexachlorocyclopentadiene	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Pentachlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hexachlorobenzene	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ANILINES AND BENZIDINES											
Aniline	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Chloroaniline	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2-Nitroaniline	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
3-Nitroaniline	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Dibenzofuran	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Nitroaniline	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Carbazole	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
3,3'-Dichlorobenzidine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
POLYCHORINATED BIPHENYLS											
Aroclor-1232	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Aroclor-1242	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Aroclor-1248	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Aroclor-1254	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

RESULTS : On analysis, the following results were obtained :-

SEMI-VOLATILE ORGANICS (EPA 8270D)										
		SAMPLE MARKINGS / RESULTS								
TEST PARAMETER(mg/kg)	Level of Reporting	SS11-0.3m	SS11-1.6m	SS12-0.3m	SS12-1.5m	SS13-0.3m	SS13-1.5m	SS14-0.4m	SS15-0.3m	SS15-2.0m
HALOETHERS										
Bis(2-chloroethyl)ether	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Bis(2-chloroethoxy)methane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Chlorophenyl phenylether	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Bromophenyl phenylether	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
CHLORINATED HYDROCARBONS										
1,3-Dichlorobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,4-Dichlorobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-Dichlorobenzene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexachloroethane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexachloropropylene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexachlorobutadiene	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexachlorocyclopentadiene	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Pentachlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hexachlorobenzene	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ANILINES AND BENZIDINES										
Aniline	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Chloroaniline	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2-Nitroaniline	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
3-Nitroaniline	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Dibenzofuran	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4-Nitroaniline	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Carbazole	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
3,3'-Dichlorobenzidine	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
POLYCHORINATED BIPHENYLS										
Aroclor-1232	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Aroclor-1242	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Aroclor-1248	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Aroclor-1254	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

RESULTS : On analysis, the following results were obtained :-

SEMI-VOLATILE ORGANICS (EPA 8270D)											
TEST PARAMETER(mg/kg)	Level of Reporting	SAMPLE MARKINGS / RESULTS									
		SS01-0.3m	SS01-2.1m	SS02-0.3m	SS02-3m	SS03-0.3m	SS03-2.2m	SS04-0.3m	SS04-1.9m	SS05-0.3m	SS05-2.70m
PESTICIDES											
Alpha-HCH	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta & Gamma-HCH	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Delta-HCH	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Aldrin	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor epoxide	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Gamma chlordane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Alpha chlordane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Endosulfan 1	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDE	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan 2	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDD	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan sulfate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDT	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Ketone	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Malathion	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dichlorvos	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dimethoate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Diazinon	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorpyrifos methyl	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Ethion	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Fenthion	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorpyrifos	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pirimipos ethyl	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Prothiofos	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Parathion	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Methyl parathion	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorfenvinphos-E	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorfenvinphos-Z	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

RESULTS : On analysis, the following results were obtained :-

SEMI-VOLATILE ORGANICS (EPA 8270D)											
		SAMPLE MARKINGS / RESULTS									
TEST PARAMETER(mg/kg)	Level of Reporting	SS06-0.3m	SS06-1.9m	SS07-0.3m	SS07-2.4m	SS08-0.3m	SS08-1.2m	SS09-0.3m	SS09-2.2m	SS10-0.4m	SS10-3m
PESTICIDES											
Alpha-HCH	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta & Gamma-HCH	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Delta-HCH	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Aldrin	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor epoxide	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Gamma chlordane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Alpha chlordane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Endosulfan 1	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDE	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan 2	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDD	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan sulfate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDT	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Ketone	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Malathion	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dichlorvos	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dimethoate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Diazinon	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorpyrifos methyl	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Ethion	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Fenthion	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorpyrifos	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pirimipos ethyl	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Prothiofos	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Parathion	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Methyl parathion	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorfenvinphos-E	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorfenvinphos-Z	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

RESULTS : On analysis, the following results were obtained :-

SEMI-VOLATILE ORGANICS (EPA 8270D)										
TEST PARAMETER(mg/kg)	Level of Reporting	SAMPLE MARKINGS / RESULTS								
		SS11-0.3m	SS11-1.6m	SS12-0.3m	SS12-1.5m	SS13-0.3m	SS13-1.5m	SS14-0.4m	SS15-0.3m	SS15-2.0m
PESTICIDES										
Alpha-HCH	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta & Gamma-HCH	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Delta-HCH	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Aldrin	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor epoxide	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Gamma chlordane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Alpha chlordane	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Endosulfan 1	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDE	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan 2	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDD	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan sulfate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDT	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Ketone	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Malathion	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dichlorvos	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dimethoate	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Diazinon	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorpyrifos methyl	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Ethion	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Fenthion	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorpyrifos	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pirimipos ethyl	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Prothiofos	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Parathion	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Methyl parathion	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorfenvinphos-E	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorfenvinphos-Z	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

RESULTS : On analysis, the following results were obtained :-

Remarks : QA/QC Results

a) All analyses were analyzed within their holding times.
b) Method blanks were run in each batch of analysis to check background interference, if any.
c) Surrogate spike recoveries were performed on each sample in the VOCs and SVOCs analysis. The results were summarized as below.
d) A summarized QC report on recoveries of Lab Control Samples(LCS) and Matrix Spike is attached. Upon reviewing the QA/QC datas the recoveries of laboratory control samples, matrix spikes and surrogate spikes (for vocs and svocs) were within the ALS labora acceptance criteria.

QA/QC Results :

% Surrogate Spike Recoveries

Volatile Organics (VOCs)

Surrogare Compound	Range for all samples
Dichloroethane-d_4	98 - 107
Toluene-d_8	96 - 106
4-Bromofluorobenzene	100 - 110

Semi-Volatile Organics (SVOCs)

Surrogate Compound	Range for all samples
2-Fluorophenol	40 - 80
Phenol-d_6	40 - 87
Nitrobenzene-d_5	43 - 72
2-Fluorobiphenyl	45 - 72
2,4,6-Tribromophenol	32 - 96
p-Terphenyl-d_{14}	47 - 92

RESULTS : On analysis, the following results were obtained :-

Test	LCS 1, % recovery	MS 1, % recovery	LCS 2, % recovery	MS 2, % recovery
TPH as diesel oil	113	83	98	83
SVOCs				
Phenol	82	101	118	106
2- Chlorophenol	97	83	90	88
4-Chloro-3-methyl phenol	88	86	88	85
Pentachlorophenol	104	99	100	87
Acenaphthalene	87	89	78	90
Pyrene	81	87	76	79
N-nitroso-di-n-propylamine	85	93	79	90
2,4-dinitrotolune	76	84	81	94
1,4-dichlorobenzene	79	78	84	78
1,2,4-trichlorobenzene	76	88	80	79
VOCs				
Benzene	81	86	88	99
Toluene	106	102	109	99
1,1-dichloroethene	104	81	106	84
Trichloroethene	91	90	92	86
Chlorobenzene	98	94	106	87
Metals				
Arsenic	97	100	96	99
Barium	101	107	101	106
Cadmium	94	109	91	110
Total chromium	98	106	96	97
Cobalt	96	103	94	102
Copper	93	104	91	105
Mercury	96	94	111	93
Lead	96	101	94	101
Molybdenum	99	109	97	109
Nickel	100	105	98	105
Zinc	93	105	89	103
Antimony	106	105	104	102
Boron	89	96	87	97
Calcium	96	86	94	77
Magnesium	106	109	102	96
Potassium	106	114	106	117
Manganese	97	102	94	95
Phosphorus	96	101	94	90

ALS TECHNICHEM (S) PTE LTD

PANSY TEO B.Y.
B.Sc., M.Sc., MSNIC.

Annex 9.2

Soil & Groundwater Sampling & Analysis

- Photographs of Sampling Locations
- Soil & Groundwater Borehole Logs
- Soil & Groundwater Analytical Results Summary
- Analytical Laboratory Report
- Groundwater Monitoring Well Level Report

Figure A9.2a: Photographs of Borehole/Monitoring Well Locations

BH/MW 1

BH/MW 2

BH/MW 3

BH/MW 4

BH/MW 6

BH/MW 7

BH/MW 8

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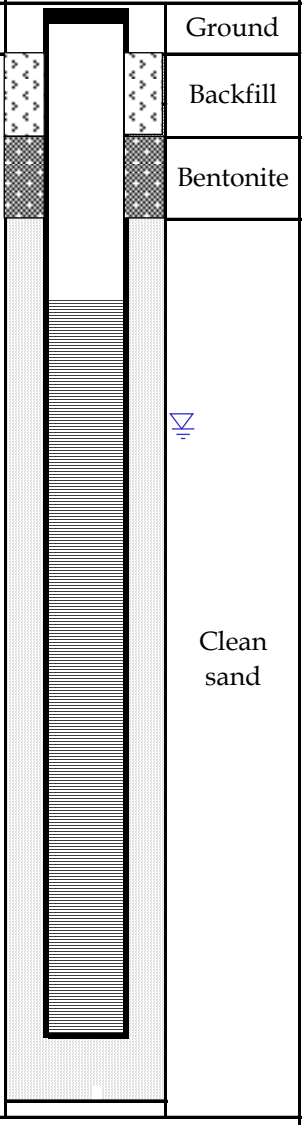
SOIL BORING LOG

Project No: 0292668
Project: Mandai Development EIA
Client: Mandai Park Holdings

Borehole/ Well No.	BH1/ MW1
Logged by:	LD
Reviewed by:	RF
Approved by:	CF
Page:	1/1

Depth (m)	Symbol	Description	Sample ID	PID (ppm)	Lab Analysis
		GRASS SURFACE			
0.0		CL-ML - [FILL] Silty CLAY, brown mottled red, (5,5,90), low plasticity, low dry strength, slow dilatancy, low toughness, trace fine to course sand, dry and soft. Construction debris observed. No chemical stains or odour noted.	BH1-0.5	0.1	Yes
0.5					
1.0		ML/CL - Clayey SILT, red brown, (5,15,80), low plasticity, slow dilatancy, no toughness, trace fine to medium sand, dry and soft. No chemical stains or odour noted.		0.0	No
2.0		ML - Sandy SILT, orange, (5,30,65), low plasticity, slow dilatancy, no toughness, fine to coarse sand, very moist and soft. No chemical stains or odour noted.		0.3	No
			BH1-2.3	0.1	Yes
3.0		ML - Sandy SILT, orange, (5,30,65), low plasticity, slow dilatancy, no toughness, fine to coarse sand, wet and very soft. No chemical stains or odour noted.		0.1	No
		Same as above.		0.2	No
4.0		OH - Organic CLAY with sand, black, (0,20,80), medium plasticity, no dilatancy, low toughness, fine to coarse sand, wet and very soft. Decomposed organic matters observed. No chemical stans or odour noted.			
5.0		SC - Clayey SAND, black, (0,60,40), fine to coarse, wet and very loose. No chemical stains or odour noted.		0.3	No
6.0		CL - Lean CLAY with sand, white, (0,25,75), medium plasticity, no dilatancy, low toughness, fine to coarse sand, wet and soft. No chemical stains or odour noted.	BH1-6.0	0.3	Yes



Hole Size:	100 mm	Screen Interval:	1 mm	Drilled By:	Ground Instrumentation & Engineering Pte. Ltd.
Casing Size:	50 mm	Initial Water Level:	0.8 m bgl	Drill Date:	16 Nov - 16 Nov 2015
End of Borehole:	6.0 m bgl	Static Water Level:	1.480 m btoc	Drill Method:	Trial Pit, Hand Auger, Rotary Drilling

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Organic CLAY, Sandy SILT, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Clayey SAND, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

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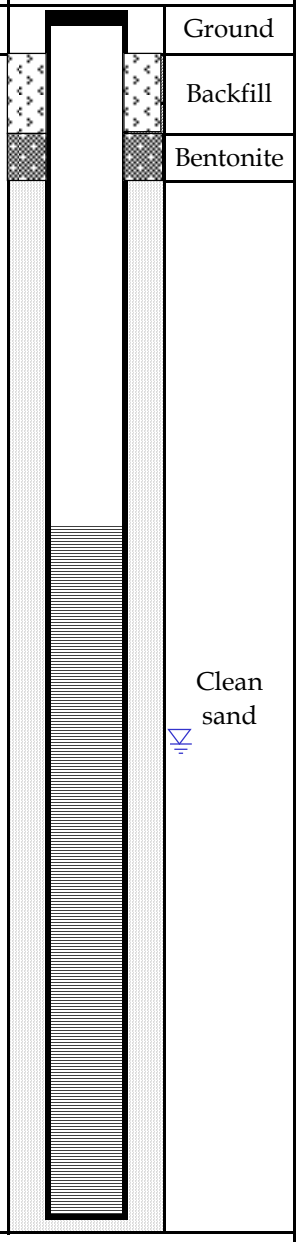
SOIL BORING LOG

Project No: 0292668
Project: Mandai Development EIA
Client: Mandai Park Holdings

Borehole/ Well No.	BH2/ MW2
Logged by:	LD
Reviewed by:	RF
Approved by:	CF
Page:	1/1

Depth (m)	Symbol	Description	Sample ID	PID (ppm)	Lab Analysis
		COMPACTED DIRT ROAD			
0.0 – 0.5		ML/CL - [FILL] Clayey SILT, red brown, (0,5,95), no plasticity, very high dry strength, no dilatancy, high toughness, trace fine to medium sand, dry and firm. No chemical stains or odour noted.	BH2-0.5	0.5	Yes
0.5 – 1.0				2.0	No
1.0 – 2.0		ML/SM - [FILL] Sandy SILT with gravel, brown, (20,30,50), no plasticity, low dry strength, no dilatancy, low toughness, fine to coarse sand with fine gravel, dry and soft. No chemical stains or odour noted.			
2.0 – 3.0		ML - SILT, green mottled red brown, (0,15,85), low plasticity, low dry strength, slow dilatancy, low toughness, trace fine to coarse sand, moist and soft. No chemical stains or odour noted.	BH2-2.0	3.0	Yes
3.0 – 4.0		ML/CL - Clayey SILT, yellow mottled green, (0,5,95), low plasticity, medium dry strength, slow dilatancy, low toughness, trace fine to course sand, moist and soft. No chemical stains or odour noted.		1.5	No
4.0 – 5.0		ML/CL - Clayey SILT, orange, (0,10,90), low plasticity, low dry strength, slow dilatancy, low toughness, trace fine to course sand, wet and soft. No chemical stains or odour noted.	BH2-4.4	1.2	No
				1.4	Yes
5.0 – 6.0				0.6	No
6.0 – 7.0				0.8	No
7.0 – 7.5				0.4	No



Hole Size:	100 mm	Screen Interval:	1 mm	Drilled By:	Ground Instrumentation & Engineering Pte. Ltd.
Casing Size:	50 mm	Initial Water Level:	4.4 m bgl	Drill Date:	11-12 Nov 2015
End of Borehole:	7.5 m bgl	Static Water Level:	5.565 m btoc	Drill Method:	Trial Pit, Hand Auger, Rotary Drilling

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Organic CLAY, Sandy SILT, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Clayey SAND, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

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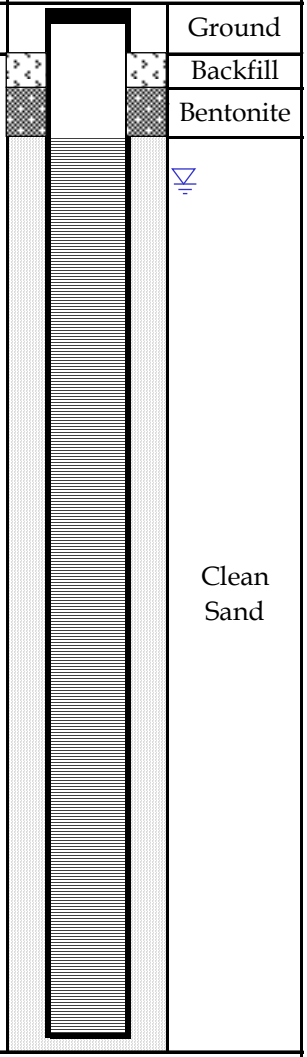
SOIL BORING LOG

Project No: 0292668
Project: Mandai Development EIA
Client: Mandai Park Holdings

Borehole/ Well No.	BH3/ MW3
Logged by:	LD
Reviewed by:	RF
Approved by:	CF
Page:	1/1

Depth (m)	Symbol	Description	Sample ID	PID (ppm)	Lab Analysis
		GRASS SURFACE			
0.0		ML/CL - Clayey SILT, brown, (0,5,95), low plasticity, slow dilatancy, low toughness, trace fine to course sand, moist and very soft. Decomposed roots observed. No chemical stains or odour noted.	BH3-0.5	0.1	Yes
0.5			BH3-0.8	0.2	Yes
1.0		ML/CL - Clayey SILT, light brown mottled black, (0,5,95), low plasticity, slow dilatancy, low toughness, trace fine to course sand, wet and very soft. Decomposed organic materials observed. No chemical stains or odour noted.			
2.0		ML/CL - Clayey SILT, light brown mottled black, (5,15,85), low plasticity, slow dilatancy, low toughness, with fine to course sand, wet and very soft. Decomposed organic materials observed. No chemical stains or odour noted.		0.1	No
3.0		OH - Organic CLAY, black mottled yellow, (0,10,90), medium plasticity, no dilatancy, low toughness, trace fine to coarse sand, wet and very soft. Decomposed organic matters observed. No chemical stans or odour noted.		0.1	No
4.0		OH/SC - Sandy Organic CLAY, black, (0,45,55), low plasticity, no dilatancy, low tougness, fine to course sand, wet and very soft. No chemical stains or odour noted.		0.0	No
5.0		CL - Lean CLAY with sand, white, (0,20,80), medium plasticity, no dilatancy, medium toughness, with fine to coarse sand, wet and soft. No chemical stains or odour noted.	BH3-5.0	0.1	Yes
6.0				0.1	No



Hole Size:	100 mm	Screen Interval:	1 mm	Drilled By:	Ground Instrumentation & Engineering Pte. Ltd.
Casing Size:	50 mm	Initial Water Level:	0.8 m bgl	Drill Date:	13 Nov - 13 Nov 2015
End of Borehole:	6.0 m bgl	Static Water Level:	1.132 m btoc	Drill Method:	Trial Pit, Hand Auger, Rotary Drilling

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Organic CLAY, Sandy GRAVEL, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Gravelly SILT, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Project No: 0292668
Project: Mandai Development EIA
Client: Mandai Park Holdings

Borehole/ Well No.	BH4/ MW4
Logged by:	DL
Reviewed by:	RF
Approved by:	CF
Page:	1/1

Depth (m)	Symbol	Description	Sample ID	PID (ppm)	Lab Analysis	Monitoring Well Completion Details
		GRASS SURFACE				Ground
0.0		SM - Silty SAND with gravel, brown, (25,60,15), fine to course grained sand and gravel, dry, low density. No chemical stains or odours noted.	BH4-0.3	0.5	Yes	Backfill
0.5				1.0	No	Bentonite
1.0		CH - Fat CLAY with gravel, yellow orange with mottled brown, (20,5,75), medium to high plasticity, low dry strength, no dilatancy, low toughness, fine to coarse grained gravel, slightly moist, soft, with backfill material. No chemical stains or odours noted.	BH4-1.0	0.6	Yes	
2.0		CH - Fat CLAY, yellow orange, (0,10,90), medium to high plasticity, low dry strength, no dilatancy, low toughness, fine to coarse grained sand, slightly moist, soft. No chemical stains or odours noted.		0.9	No	
3.0		CH - Fat CLAY with sand, yellow orange, (0,15,85), medium to high plasticity, low dry strength, no dilatancy, low toughness, fine to coarse grained sand, slightly moist, soft. No chemical stains or odours noted.	BH4-3.0	1.5	Yes	Clean Sand
4.0		CH - Fat CLAY with sand, yellow orange, (0,15,85), medium to high plasticity, low dry strength, no dilatancy, low toughness, fine to coarse grained sand, moist, soft. No chemical stains or odours noted.		0.9	No	
5.0		CH - Fat CLAY with sand, yellow orange, (0,15,85), medium to high plasticity, low dry strength, no dilatancy, low toughness, fine to coarse grained sand, wet, soft. No chemical stains or odours noted.		0.7	No	
6.0		CH - Fat CLAY, yellow orange, (0,5,95), high plasticity, low dry strength, no dilatancy, low toughness, fine grained sand, moist, soft. No chemical stains or odours noted.		0.5	No	

Hole Size:	100 mm	Screen Interval:	1 mm	Drilled By:	Ground Instrumentation & Engineering Pte. Ltd.
Casing Size:	50 mm	Initial Water Level:	3.0 m bgl	Drill Date:	23 Nov - 23 Nov 2015
End of Borehole:	6.0 m bgl	Static Water Level:	2.232 m btoc	Drill Method:	Trial Pit, Hand Auger, Rotary Drilling

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Organic CLAY, Sandy GRAVEL, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Gravelly SILT, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

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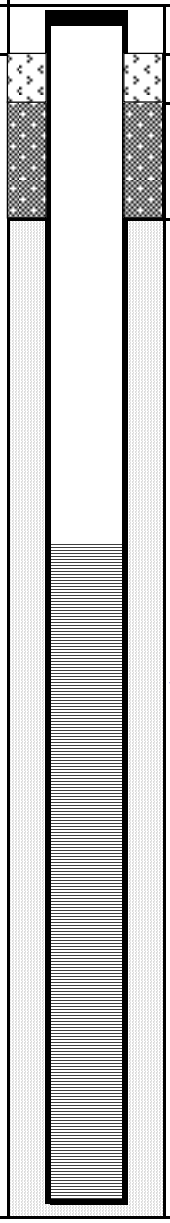
SOIL BORING LOG

Project No: 0292668
Project: Mandai Development EIA
Client: Mandai Park Holdings

Borehole/ Well No.	BH5/ MW5
Logged by:	DL
Reviewed by:	RF
Approved by:	CF
Page:	1/1

Depth (m)	Symbol	Description	Sample ID	PID (ppm)	Lab Analysis
		GRASS SURFACE			
0.0		MH - Elastic SILT, reddish brown, (5,5,90), medium plasticity, medium dry strength, no dilatancy, medium toughness, fine grained gravel and sand, dry, firm. No chemical stains or odours noted.	BH5-0.3	17.5	Yes
0.5				10.4	No
1.0		CH - Fat CLAY, brown, (0,5,95), medium plasticity, high dry strength, no dilatancy, medium toughness, fine grained sand, dry, firm. No chemical stains or odours noted.		7.4	No
2.0		CL - Lean CLAY with sand, greyish brown, (0,15,85), medium plasticity, medium dry strength, no dilatancy, low to medium toughness, fine to medium grained sand, slightly moist, soft. No chemical stains, but slight odours noted.		5.7	No
3.0		CL - Lean CLAY with sand, reddish brown, (0,15,85), medium plasticity, medium dry strength, no dilatancy, medium toughness, fine to medium grained sand, slightly moist, soft to firm. No chemical stains or odours noted.	BH5-3.0	9.8	Yes
4.0		OL - Organic CLAY with sand, grey, (0,15,85), low plasticity, low dry strength, no dilatancy, low toughness, fine to medium grained sand, moist, soft. No chemical stains, but slight odour noted.	BH5-4.0	4.6	Yes
5.0		MH - Elastic SILT with sand, yellow brown, (0,15,85), low plasticity, low dry strength, no dilatancy, low toughness, fine to medium grained sand, wet, soft. No chemical stains or odours noted.		10.5	No
6.0		ML-CL - Silty CLAY with sand, reddish brown, (0,15,85), low to medium plasticity, medium dry strength, no dilatancy, low to medium toughness, fine to medium grained sand, moist, soft. No chemical stains or odours noted.		8.1	No
7.0				5.1	No



Hole Size:	100 mm	Screen Interval:	1 mm	Drilled By:	Ground Instrumentation & Engineering Pte. Ltd.
Casing Size:	50 mm	Initial Water Level:	5.0 m bgl	Drill Date:	19 Nov - 19 Nov 2015
End of Borehole:	7.0 m bgl	Static Water Level:	6.990 m btoc	Drill Method:	Trial Pit, Hand Auger, Rotary Drilling

BENTONITE · GROUT · ASPHALT · SCREEN · Concrete Slab · Organic CLAY · Sandy GRAVEL · Gravelly SAND · GRAVEL · SAND · Silty SAND · Sandy CLAY · SILT · Clayey SILT · CLAY · Silty CLAY · Gravelly SILT · Boulders · FIRST APPEARANCE LEVEL · STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Project No: 0292668
Project: Mandai Development EIA
Client: Mandai Park Holdings

Borehole/ Well No.	BH6/ MW6
Logged by:	DL
Reviewed by:	RF
Approved by:	CF
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Depth (m)	Symbol	Description	Sample ID	PID (ppm)	Lab Analysis	Monitoring Well Completion Details
		GRASS SURFACE				Ground
0.0		MH - Elastic SILT with sand, reddish brown, (5,15,80), medium plasticity, low dry strength, no dilatancy, low toughness, fine grained sand, moist, soft to firm. No chemical stains or odours noted.	BH6-0.5	3.0	Yes	Backfill
0.5						Bentonite
1.0		ML - SILT with sand, yellow, (5,20,75), low to medium plasticity, low dry strength, no dilatancy, low toughness, fine grained sand, moist, soft to firm. No chemical stains or odours noted.		5.0	No	
2.0		MH - Elastic SILT with sand, yellow, (5,10,85), medium plasticity, low to medium dry strength, no dilatancy, low toughness, fine grained sand, moist, soft to firm. No chemical stains or odours noted.		4.9	No	
3.0		CH - Fat CLAY, pinkish brown with mottled brown and white, (0,10,90), medium to high plasticity, low to medium dry strength, no dilatancy, low toughness, fine grained sand, moist, firm. No chemical stains or odours noted.	BH6-1.0	4.3	Yes	
4.0		CH - Fat CLAY, pinkish brown with mottled brown and white, (0,10,90), medium plasticity, low dry strength, no dilatancy, low toughness, fine grained sand, wet, soft. No chemical stains or odours noted.		2.6	No	▽Clean Sand
5.0		CH - Fat CLAY, yellow with mottled white, (0,10,90), medium to high plasticity, high dry strength, no dilatancy, medium toughness, fine grained sand, moist, hard. No chemical stains or odours noted.		1.4	No	
6.0		CH - Fat CLAY, yellow with mottled white, (0,10,90), medium to high plasticity, medium dry strength, no dilatancy, low toughness, fine grained sand, moist, firm. No chemical stains or odours noted.	BH6-1.0	1.5	Yes	

Hole Size:	100 mm	Screen Interval:	1 mm	Drilled By:	Ground Instrumentation & Engineering Pte. Ltd.
Casing Size:	50 mm	Initial Water Level:	4.0 m bgl	Drill Date:	17 Nov - 17 Nov 2015
End of Borehole:	6.1 m bgl	Static Water Level:	4.640 m btoc	Drill Method:	Trial Pit, Hand Auger, Rotary Drilling

BENTONITE, Concrete Slab, GRAVEL, SILT, Gravelly SILT
GROUT, Organic CLAY, SAND, Clayey SILT, Boulders
ASPHALT, Sandy GRAVEL, Silty SAND, CLAY, FIRST APPEARANCE LEVEL
SCREEN, Gravelly SAND, Sandy CLAY, Silty CLAY, STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Project No: 0292668
Project: Mandai Development EIA
Client: Mandai Park Holdings

Borehole/ Well No.	BH7/ MW7
Logged by:	DL
Reviewed by:	RF
Approved by	CF
Page:	1/1

Depth (m)	Symbol	Description	Sample ID	PID (ppm)	Lab Analysis	Monitoring Well Completion Details
		Carpark tiles				Ground
0.0		ML - Gravelly SILT with sand, reddish brown, (20,15,65), low plasticity, medium dry strength, no dilatancy, medium toughness, coarse gravels, dry, firm. No chemical stains or odours noted.	BH7-0.3	4.2	Yes	Backfill
0.5				2.9	No	Bentonite
1.0		MH - Elastic SILT with sand, orange, (5,15,80), medium plasticity, medium dry strength, no dilatancy, medium toughness, coarse grained sand, dry, firm. No chemical stains or odours noted.	BH7-1.0	3.4	Yes	
2.0		ML - SILT, orange, (0,10,90), medium plasticity, medium dry strength, no dilatancy, medium toughness, dry to moist, firm. No chemical stains or odours noted.		1.5	No	
		ML - SILT with sand, yellow, (0,20,80), low plasticity, low dry strength, no dilatancy, low toughness, fine to coarse grained sand, dry to moist, soft to firm. No chemical stains or odours noted.				
3.0		CL - Lean CLAY with sand, pinkish brown with mottled yellow and white, (0,15,85), low plasticity to medium, low dry strength, no dilatancy, low toughness, fine to coarse grained sand, dry to moist, soft to firm. No chemical stains or odours noted.		2.1	No	
4.0		CL - Lean CLAY with trace of sand, pinkish brown with mottled yellow and white, (0,5,95), low to medium plasticity, low to medium dry strength, no dilatancy, low to medium toughness, fine grained sand, dry to moist, soft to firm. No chemical stains or odours noted.		3.0	No	
5.0		CL - Lean CLAY with trace of sand, pinkish brown with mottled yellow and white, (0,5,95), low to medium plasticity, low to medium dry strength, no dilatancy, low to medium toughness, fine grained sand, dry to moist, firm. No chemical stains or odours noted.		2.7	No	Clean Sand
6.0		CL - Lean CLAY with trace of sand, pinkish brown with mottled yellow and white, (0,5,95), low plasticity, medium dry strength, no dilatancy, medium toughness, fine grained sand, slightly moist, firm. No chemical stains or odours noted.	BH7-6.0	3.3	Yes	▽
7.0		CL - Lean CLAY with trace of sand, pinkish brown with mottled yellow and white, (0,5,95), low plasticity, medium dry strength, no dilatancy, medium toughness, fine grained sand, slightly moist, soft to firm. No chemical stains or odours noted.		2.6	No	
8.0		CL - Lean CLAY with trace of sand, pinkish brown with mottled yellow and white, (0,5,95), low plasticity, medium dry strength, no dilatancy, medium toughness, fine grained sand, wet, soft. No chemical stains or odours noted.		0.4	No	

Hole Size:	100 mm	Screen Interval:	1 mm	Drilled By:	Ground Instrumentation & Engineering Pte. Ltd.
Casing Size:	50 mm	Initial Water Level:	6.0 m bgl	Drill Date:	18 Nov - 18 Nov 2015
End of Borehole:	8.1 m bgl	Static Water Level:	6.170 m btoc	Drill Method:	Trial Pit, Hand Auger, Rotary Drilling

BENTONITE	Concrete Slab	GRAVEL	SILT	Gravelly SILT
GROUT	Organic CLAY	SAND	Clayey SILT	Boulders
ASPHALT	Sandy GRAVEL	Silty SAND	CLAY	FIRST APPEARANCE LEVEL
SCREEN	Gravelly SAND	Sandy CLAY	Silty CLAY	STATIC GROUNDWATER LEVEL

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SOIL BORING LOG

Project No: 0292668
Project: Mandai Development EIA
Client: Mandai Park Holdings

Borehole/ Well No.	BH8/ MW8
Logged by:	DL
Reviewed by:	RF
Approved by:	CF
Page:	1/1

Depth (m)	Symbol	Description	Sample ID	PID (ppm)	Lab Analysis	Monitoring Well Completion Details
		GRASS SURFACE				Ground
0.0		ML - Gravelly SILT, brown, (30,5,65), low plasticity, low dry strength, no dilatancy, low toughness, fine to coarse gravels, slightly moist, soft. No chemical stains or odours noted.	BH8-2.3	24.3	Yes	Backfill
0.5						Bentonite
1.0		ML - SILT with sand, orange, (0,20,80), low plasticity, low dry strength, no dilatancy, low toughness, fine to coarse grained sand, slightly moist, soft. No chemical stains or odours noted.	BH8-1.0	5.5	Yes	
2.0		MH - Elastic SILT with sand, orange, (0,15,85), medium plasticity, low to medium dry strength, no dilatancy, low toughness, fine to medium grained sand, slightly moist, soft to firm. No chemical stains or odours noted.		2.4	No	
3.0		ML - SILT with sand, yellow, (0,15,85), low plasticity, low dry strength, no dilatancy, low toughness, fine to medium grained sand, slightly moist, soft. No chemical stains or odours noted.		2.6	No	
4.0		MH - Elastic SILT, yellow, (0,10,90), medium plasticity, low dry strength, no dilatancy, low toughness, fine to medium grained sand, moist, soft. No chemical stains or odours noted.	BH8-4.0	2.7	Yes	Clean Sand
5.0		MH - Elastic SILT, yellow, (0,10,90), medium plasticity, low dry strength, no dilatancy, low toughness, fine to medium grained sand, wet, soft. No chemical stains or odours noted.		1.5	No	▽
6.0		MH - Elastic SILT, brown, (0,5,95), medium plasticity, medium dry strength, some dilatancy, low toughness, fine grained sand, wet, soft. No chemical stains or odours noted.		1.2	No	
6.5						

Hole Size:	100 mm	Screen Interval:	1 mm	Drilled By:	Ground Instrumentation & Engineering Pte. Ltd.
Casing Size:	50 mm	Initial Water Level:	5.0 m bgl	Drill Date:	20 Nov - 20 Nov 2015
End of Borehole:	6.5 m bgl	Static Water Level:	4.265 m btoc	Drill Method:	Trial Pit, Hand Auger, Rotary Drilling

BENTONITE, GROUT, ASPHALT, SCREEN, Concrete Slab, Organic CLAY, Sandy GRAVEL, Gravelly SAND, GRAVEL, SAND, Silty SAND, Sandy CLAY, SILT, Clayey SILT, CLAY, Silty CLAY, Gravelly SILT, Boulders, FIRST APPEARANCE LEVEL, STATIC GROUNDWATER LEVEL

Soil Samples Analysis Results

Soil Concentrations for Metals, Cyanide, Chlorinated Hydrocarbons, PAHs, Pesticides, VOC, SVOC, and TPH (mg/kg dry basis)

Test Parameter				Metals												Inorganic Compounds	Aromatic Compounds	Polynuclear Aromatic Hydrocarbons (PAHs)	Chlorinated Hydrocarbons	VOCs	SVOCs	Pesticides	Organochlorine Pesticides	Conventional		Total Petroleum Hydrocarbon (TPH)				Other Pollutants	
				Arsenic (As)	Barium (Ba)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Mercury (Hg)	Lead (Pb)	Molybdenum (Mo)	Nickel (Ni)	Zinc (Zn)	Antimony (Sb)	Cyanide	All Compounds	All Compounds	All Compounds	All Compounds	All Compounds	All Compounds	All Compounds	Organic Matter (%DW)	Moisture (%)	TPH (C_6–C_9)	TPH (C_{10}–C_{14})	TPH (C_{15}–C_{28})	TPH (C_{29}–C_{40})	Mineral Oils	All Other Compounds
LOR (ppm)				0.5	0.5	0.5	0.5	0.5	0.5	0.02	0.5	0.5	0.5	0.5	0.5	0.1	-	-	-	-	-	-	-	0.1	0.1	5	5	10	10	50	-
Soil Sample																															
Sample ID	***Coordinate***	***Sample Depth (m)***	***Sample Date***																												
BH 1	43582.82N, 21968.94E	0.5	16-Nov-15	**76.7**	**9.3**	**0.7**	**37.8**	**1.1**	**18.2**	**0.56**	**19.3**	**2.4**	**3.6**	**75.8**	**3.4**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**0.9**	**22.4**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
		2.3	16-Nov-15	**240**	**4.6**	**2.2**	**10.8**	**0.8**	**7.7**	**0.09**	**8.4**	**2.6**	**0.8**	**5.6**	**3.9**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**0.1**	**25**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
		6.0	16-Nov-15	**9.5**	**9.9**	<LOR	**1.1**	<LOR	**1.8**	**0.09**	**5.4**	<LOR	<LOR	**8.2**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**0.2**	**19.7**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
BH 2	43180.88N, 22058.75E	0.5	11-Nov-15	**0.6**	**18.3**	<LOR	**22.5**	**2.3**	**14.9**	**0.02**	**8.4**	**3.3**	**4.9**	**20.3**	**2.4**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**11.7**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
		2.0	12-Nov-15	**19.8**	**3.4**	<LOR	**13.5**	**0.8**	**3.7**	**0.13**	**1.6**	**2.1**	**1.1**	**8**	**3.5**	**0.11**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**0.6**	**23.4**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
		4.4	12-Nov-15	**31.9**	**2.2**	<LOR	**15.8**	**0.8**	**3.8**	**0.21**	**5.3**	**2**	**1**	**6.4**	**5.4**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**0.2**	**24**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
BH 3	43280.51N, 22272.29E	0.5	13-Nov-15	**20.7**	**9**	<LOR	**10**	**0.7**	**3.3**	**0.13**	**17.9**	**1.8**	**1.2**	**18.1**	**2.8**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**1.8**	**29.2**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
		0.8	13-Nov-15	**27.3**	**9.2**	<LOR	**11.4**	**0.8**	**4.4**	**0.14**	**12**	**1.8**	**1.2**	**16.7**	**3.3**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**1.3**	**26.4**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
		5.0	13-Nov-15	**3.6**	**9.6**	<LOR	**1.3**	<LOR	**1.8**	<LOR	**5.9**	<LOR	<LOR	**1.2**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**17.6**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
BH 4	43194.40N, 22479.81E	0.3	23-Nov-15	**23.1**	**68**	**0.5**	**21.4**	**4.8**	**44.8**	**0.08**	**29.3**	**7.8**	**9**	**152**	**2.1**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**2.7**	**13.4**	<LOR	<LOR	**26**	**37**	**63**	<LOR
		1.0	23-Nov-15	**37.1**	**3.1**	<LOR	**30.1**	**0.7**	**2.4**	**0.18**	**1.5**	**2.4**	**1.4**	**12.6**	**5**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**1**	**27**	<LOR	<LOR	<LOR	**21**	<LOR	<LOR
		3.0	23-Nov-15	**29.1**	**2**	<LOR	**16**	<LOR	**1.5**	**0.21**	**2.8**	**2.1**	**0.9**	**12.1**	**3.5**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**0.2**	**21.4**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
BH 5	43085.92N, 22964.76E	0.3	19-Nov-15	**49**	**10.1**	<LOR	**11.6**	**1**	**3.7**	**0.16**	**23.6**	**1.5**	**1.2**	**13**	**4**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**0.3**	**18.1**	<LOR	<LOR	<LOR	**14**	<LOR	<LOR
		4.0	19-Nov-15	**28.8**	**15.8**	<LOR	**13.6**	**2.4**	**7.9**	**0.14**	**17.6**	**3.1**	**4.4**	**39.2**	**3**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**0.8**	**24.5**	<LOR	<LOR	**16**	**19**	<LOR	<LOR
		5.0	19-Nov-15	**36.2**	**3.6**	<LOR	**10.7**	**0.8**	**2.8**	**0.11**	**12.9**	**1.9**	**0.9**	**6**	**4.8**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**0.5**	**27**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
BH 6	43085.59N, 23213.39E	0.5	17-Nov-15	**62.6**	**4.2**	<LOR	**12.2**	**0.6**	**3.7**	**0.15**	**3.6**	**2.4**	**1.4**	**12.8**	**3.8**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**0.6**	**25.1**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
		3.0	17-Nov-15	**113**	**1.8**	**0.6**	**13.5**	**0.8**	**2.5**	**0.11**	**3.2**	**1.8**	**1**	**8.2**	**5.3**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**0.2**	**24.9**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
		6.0	17-Nov-15	**39.3**	**7.1**	<LOR	**3.6**	<LOR	**13.8**	<LOR	**10.1**	**2.6**	<LOR	**6.2**	**2.2**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**24.5**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
BH 7	42978.93N, 23158.18E	0.3	18-Nov-15	**76**	**17.7**	**0.5**	**15.6**	**3.6**	**9.9**	**0.04**	**9.8**	**4.7**	**4.7**	**22.8**	**4.4**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**0.5**	**17.8**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
		1.0	18-Nov-15	**24.4**	**1.4**	<LOR	**11.3**	**0.7**	**5.6**	**0.06**	**5.5**	**2.6**	**0.9**	**6.1**	**4.4**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**0.2**	**20.1**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
		6.0	18-Nov-15	**18.3**	**2.1**	<LOR	**7.3**	**0.6**	**3**	<LOR	**6.5**	**1.2**	**0.7**	**4.6**	**4**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**23.9**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
BH 8	42872.41N, 23161.87E	0.3	20-Nov-15	**31.5**	**15.6**	<LOR	**18**	**1.5**	**28.9**	**0.12**	**10**	**4.8**	**4.2**	**99.5**	**3.8**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**0.5**	**17**	<LOR	<LOR	**20**	<LOR	<LOR	<LOR
		1.0	20-Nov-15	**36.3**	**7.5**	<LOR	**12.4**	**0.8**	**9.9**	**0.12**	**5.1**	**3.1**	**1.6**	**28.9**	**3.9**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**1.3**	**17.7**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
		4.0	20-Nov-15	**56.7**	**1.2**	<LOR	**14.8**	**0.7**	**4**	**0.1**	**1.3**	**3.2**	**1.3**	**8.3**	**4.5**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**0.7**	**23**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Assessment Criteria																															
DUTCH (2000)	**Target Value**			29	160	0.8	100	9	36	0.3	85	3	35	140	3	1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	50	ns
	Intervention Value			55	625	12	380	240	190	10	530	200	210	720	15	20	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	5000	ns

Notes:
All units in mg/kg unless stated otherwise
LOR = Limit of Reporting
<LOR = below laboratory's Limit of Reporting
na = not analysed
ns = not specified
Target Value - Dutch (2000) Target Values
Intervention Value - Dutch (2000) Intervention Values

XX	Indicates concentration exceeds Dutch "T" Value
XX	Indicates concentration exceeds Dutch "I" Value

Test Parameter			Metals												Inorganic Compounds	Chlorinated Hydrocarbons		Aromatic Compounds	Polynuclear Aromatic Hydrocarbons	Sulfonated Compounds	Pesticides	VOC		SVOC	Other Pollutants	Total Petroleum Hydrocarbons		Conventional (mg/L)									
			Arsenic	Barium	Cadmium	Chromium Total	Cobalt	Copper	Mercury	Lead	Molybdenum	Nickel	Zinc	Antimony	Total Cyanide	Chloroform	All other compound	All Compounds	All Compounds	Carbon disulfide	All Compounds	All other compounds	Bromodichloromethane	All other compounds	All compounds	TPH (C_6-C_9)	All other compounds	pH (pH Unit)	BOD	COD	TOC	Fluoride	Chloride	Bromide	Sulphate	Phosphate	Total Ammoniacal N	Conductivity (µS/cm)
LOR			10	20	5	10	10	10	0.1	10	10	10	10	10	10	1	-	-	-	5	-	-	1	-	-	5	-	0.1	2	1	0.1	0.1	0.1	0.1	0.1	0.1	0.01	1.0
GW Samples																																						
Sample ID	***Coordinate***	***Sample Date***																																				
MW1	43582.82N, 21968.94E	25-Nov-15	**30.3**	**198.0**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**5.9**	<LOR	**38**	**0.92**	**0.1**	**4.07**	**0.18**	**12.3**	<LOR	**7.45**	**267**
MW2	43180.88N, 22058.75E	25-Nov-15	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**13.1**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**5.7**	<LOR	**27**	**0.9**	<LOR	**6.35**	<LOR	**20.4**	<LOR	<LOR	**110**
MW3	43280.51N, 22272.29E	25-Nov-15	<LOR	**88.4**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**6.8**	<LOR	**38**	**2.29**	**0.14**	**5.85**	**0.22**	**14.5**	<LOR	**2.56**	**293**
MW4	43194.40N, 22479.81E	25-Nov-15	<LOR	35.7	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**6.1**	<LOR	**28**	**1.39**	<LOR	**6.37**	**0.29**	**155**	<LOR	**0.33**	**467**
MW5	43085.92N, 22964.76E	25-Nov-15	<LOR	**84.3**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**6.7**	<LOR	**24**	**3.6**	<LOR	**15.4**	**0.59**	**60.9**	<LOR	**4.38**	**769**
MW6	43085.59N, 23213.39E	25-Nov-15	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**5.8**	<LOR	**16**	**1.51**	**0.11**	**4.18**	<LOR	**20.3**	<LOR	**0.05**	**124**
MW7	42978.93N, 23158.18E	25-Nov-15	<LOR	22.3	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**6.9**	<LOR	**7**	**2.84**	<LOR	**3.2**	**0.1**	**4.38**	<LOR	**0.08**	**74**
MW8	42872.41N, 23161.87E	25-Nov-15	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**9.1**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	1.67	<LOR	<LOR	**8**	<LOR	**7.3**	<LOR	**55**	**1.37**	<LOR	**17.2**	<LOR	**23.1**	<LOR	**0.02**	**164**
DUP01		25-Nov-15	**31.5**	**197.0**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**6.4**	<LOR	**37**	**0.98**	**0.1**	**4.44**	**0.17**	**11.7**	<LOR	**7.75**	**260**
MW1		25-Nov-15	**30.3**	**198.0**	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	**5.9**	<LOR	**38**	**0.92**	**0.1**	**4.07**	**0.18**	**12.3**	<LOR	**7.45**	**267**
RPD (%)			3.9	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.1	-	2.7	6.3	0.0	8.7	5.7	5.0	-	3.9	2.7
Trip Blank			na	na	na	na	na	na	na	na	na	na	na	na	na	<LOR	<LOR	<LOR	na	<LOR	na	na	na	na	<LOR	na	na	na	na	na	na	na	na	na	na	na	na	na
Assessment Criteria																																						
DUTCH (2000)	**Target Value**		10	50	0.4	1	20	15	0.05	15	5	15	65	ns	5	6		ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
	Intervention Value		60	625	6	30	100	75	0.3	75	300	75	800	20	1,500	400		ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Notes:
All units in µg/l, unless stated otherwise
LOR = Limit of Reporting
<LOR = below laboratory's Limit of Reporting
na = not analysed
ns = not specified
Target Value - Dutch (2000) Target Values
Intervention Value - Dutch (2000) Intervention Values

XX	Indicates concentration exceeds Dutch "I" Value
XX	Indicates concentration exceeds Dutch "I" Value

Well Survey & Gauging Data

Monitoring Well ID	Survey Elevation (m) (RL) (Top of Pipe)	Standing Water Level below top of pipe (m)	Ground Level next to pipe (m)	Reduced SWL (m)
MW1	114.694	1.862	114.253	112.832
MW2	125.725	4.09	125.24	121.635
MW3	119.301	1.535	118.798	117.766
MW4	127.854	1.955	127.643	125.899
MW5	134.112	6.53	133.92	127.582
MW6	131.8	2.97	131.619	128.83
MW7	134.277	6.145	134.305	128.132
MW8	132.238	3.903	132.097	128.335

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **SG1521141**	Page	: 1 of 43
Client	: **ENVIRONMENTAL RESOURCES MANAGEMENT**	Project	: 0292668
Contact	: Mr Desmond Leung	Order number	: ----
Address	: 120 Robinson Road #10-01 Singapore 068913	Quote number	: ----
E-mail	: Desmond.Leung@erm.com	Date Received	: 23-NOV-2015
Telephone	: ----	Date Analysed	: 23-NOV-2015
Facsimile	: 6226 1363	Date Issued	: 15-DEC-2015
No. of samples received	: 24	No. of samples analysed	: 24

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*
Pansy Teo	Senior Environmental Manager

General Comments

This report supersedes any previous report(s) with this reference. All pages of this report have been checked and approved for release. Results apply to the sample(s) as submitted. The laboratory declares that the test results relate only to the items tested and do not substitute any other documents. This report may not be reproduced except with prior written approval from the testing laboratory. This report may not be used for advertising purposes.

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, BS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : LOR = Limit of reporting

- **BS method is referenced to British Standard 1377: Part 3/1990**

Analytical Results

Dutch Standards 2000: Dutch Soil Standards

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH1-0.5	BH1-2.3	BH1-6.0	BH2-0.5	BH2-2.0
Client sample ID										
Sampling date/time						16-NOV-2015 15:00	16-NOV-2015 15:00	16-NOV-2015 15:00	11-NOV-2015 15:00	12-NOV-2015 15:00
						SG1521141-001	SG1521141-002	SG1521141-003	SG1521141-004	SG1521141-005
Metals										
Arsenic	EPA3050B/EPA6010B	0.5	mg/kg	29	55	**76.7**	**240**	**9.5**	**0.6**	**19.8**
Barium	EPA3050B/EPA6010B	0.5	mg/kg	160	625	**9.3**	**4.6**	**9.9**	**18.3**	**3.4**
Cadmium	EPA3050B/EPA6010B	0.5	mg/kg	0.8	12	**0.7**	**2.2**	<0.5	<0.5	<0.5
Chromium	EPA3050B/EPA6010B	0.5	mg/kg	100	380	**37.8**	**10.8**	**1.1**	**22.5**	**13.5**
Cobalt	EPA3050B/EPA6010B	0.5	mg/kg	9	240	**1.1**	**0.8**	<0.5	**2.3**	**0.8**
Copper	EPA3050B/EPA6010B	0.5	mg/kg	36	190	**18.2**	**7.7**	**1.8**	**14.9**	**3.7**
Mercury	EPA7471B	0.02	mg/kg	0.3	10	**0.56**	**0.09**	**0.09**	**0.02**	**0.13**
Lead	EPA3050B/EPA6010B	0.5	mg/kg	85	530	**19.3**	**8.4**	**5.4**	**8.4**	**1.6**
Molybdenum	EPA3050B/EPA6010B	0.5	mg/kg	3	200	**2.4**	**2.6**	<0.5	**3.3**	**2.1**
Nickel	EPA3050B/EPA6010B	0.5	mg/kg	35	210	**3.6**	**0.8**	<0.5	**4.9**	**1.1**
Zinc	EPA3050B/EPA6010B	0.5	mg/kg	140	720	**75.8**	**5.6**	**8.2**	**20.3**	**8.0**
Antimony	EPA3050B/EPA6010B	0.5	mg/kg	3	15	**3.4**	**3.9**	<0.5	**2.4**	**3.5**
Inorganic Compounds										
Cyanide	EPA9010/EPA 9014	0.1	mg/kg	1	20	<0.10	<0.10	<0.10	<0.10	**0.11**
Aromatic Compounds										
Benzene	EPA5035/EPA8260C	0.10	mg/kg	0.01	1	<0.10	<0.10	<0.10	<0.10	<0.10
Ethylbenzene	EPA5035/EPA8260C	0.10	mg/kg	0.03	50	<0.10	<0.10	<0.10	<0.10	<0.10
Phenol	EPA8270D	0.10	mg/kg	0.05	40	<0.10	<0.10	<0.10	<0.10	<0.10
Cresoles (Sum)	EPA8270D	0.10	mg/kg	0.05	5	<0.10	<0.10	<0.10	<0.10	<0.10
Toluene	EPA5035/EPA8260C	0.10	mg/kg	0.01	130	<0.10	<0.10	<0.10	<0.10	<0.10
Xylenes (Sum)	EPA5035/EPA8260C	0.20	mg/kg	0.1	25	<0.20	<0.20	<0.20	<0.20	<0.20
Styrene	EPA5035/EPA8260C	0.10	mg/kg	0.3	100	<0.10	<0.10	<0.10	<0.10	<0.10
Catechol	EPA8270D	0.10	mg/kg	0.05	20	<0.10	<0.10	<0.10	<0.10	<0.10
Resorcinol	EPA8270D	0.10	mg/kg	0.05	10	<0.10	<0.10	<0.10	<0.10	<0.10
Hydrochinon	EPA8270D	0.10	mg/kg	0.05	10	<0.10	<0.10	<0.10	<0.10	<0.10
Polynuclear Aromatic Hydrocarbons										
Naphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phenanthrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Fluoranthene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benz(a)anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chrysene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(a)pyrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(g.h.i)perylene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

Dutch Standards 2000: Dutch Soil Standards

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH1-0.5 (Client sample ID) 16-NOV-2015 15:00 (Sampling date/time) SG1521141-001	BH1-2.3 16-NOV-2015 15:00 SG1521141-002	BH1-6.0 16-NOV-2015 15:00 SG1521141-003	BH2-0.5 11-NOV-2015 15:00 SG1521141-004	BH2-2.0 12-NOV-2015 15:00 SG1521141-005
Polynuclear Aromatic Hydrocarbons - Continued										
Benzo(k)fluoranthene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Indeno(1.2.3.cd)pyrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Sum of PAHs	EPA8270D	0.20	mg/kg	1	40	<0.20	<0.20	<0.20	<0.20	<0.20
Chlorinated Hydrocarbons										
1.1-Dichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.02	15	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.02	4	<0.10	<0.10	<0.10	<0.10	<0.10
1.1-Dichloroethene	EPA5035/EPA8260C	0.10	mg/kg	0.1	0.3	<0.10	<0.10	<0.10	<0.10	<0.10
1,2-Dichloroethene (sum cis & trans)	EPA5035/EPA8260C	0.20	mg/kg	0.2	1	<0.20	<0.20	<0.20	<0.20	<0.20
Dichloropropanes (Sum)	EPA5035/EPA8260C	0.10	mg/kg	0.002	2	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.1-Trichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.07	15	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.2-Trichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.4	10	<0.10	<0.10	<0.10	<0.10	<0.10
Trichloroethene	EPA5035/EPA8260C	0.10	mg/kg	0.1	60	<0.10	<0.10	<0.10	<0.10	<0.10
Tetrachloroethene	EPA5035/EPA8260C	0.10	mg/kg	0.002	4	<0.10	<0.10	<0.10	<0.10	<0.10
Methylene chloride	EPA5035/EPA8260C	1.00	mg/kg	0.4	10	<1.00	<1.00	<1.00	<1.00	<1.00
Tetrachloromethane	EPA5035/EPA8260C	0.10	mg/kg	0.4	1	<0.10	<0.10	<0.10	<0.10	<0.10
Chloroform	EPA5035/EPA8260C	0.10	mg/kg	0.02	10	<0.10	<0.10	<0.10	<0.10	<0.10
Vinyl chloride	EPA5035/EPA8260C	0.01	mg/kg	0.01	0.1	<0.01	<0.01	<0.01	<0.01	<0.01
Chlorobenzenes (sum mono, di, tri, tetra, penta, hexa)	EPA8260C	0.20	mg/kg	0.03	30	<0.20	<0.20	<0.20	<0.20	<0.20
Monochlorobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dichlorobenzenes (Sum)	EPA5035/EPA8260C	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Trichlorobenzenes (Sum)	EPA5035/EPA8260C	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Tetrachlorobenzenes (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Pentachlorobenzenes (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Hexachlorobenzenes (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Chlorophenols (sum mono, di, tri, tetra, penta)	EPA8270D	0.20	mg/kg	0.01	10	<0.20	<0.20	<0.20	<0.20	<0.20
Monochlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Dichlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Trichlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Tetrachlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Pentachlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chloronaphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Monochloroanilines	EPA8270D	0.20	mg/kg	0.005	50	<0.20	<0.20	<0.20	<0.20	<0.20
Polychlorobiphenyls (Sum of PCB 28,52,101,118,138,153,180)	EPA8082	0.50	mg/kg	0.02	1	<0.50	<0.50	<0.50	<0.50	<0.50

Dutch Standards 2000: Dutch Soil Standards

Sub-Matrix: **SOIL**

				Client sample ID	Target Value	Intervention Value	**BH1-0.5**	**BH1-2.3**	**BH1-6.0**	**BH2-0.5**	**BH2-2.0**
				Sampling date/time			16-NOV-2015 15:00	16-NOV-2015 15:00	16-NOV-2015 15:00	11-NOV-2015 15:00	12-NOV-2015 15:00
Compound	*Method*	*LOR*	*Unit*				**SG1521141-001**	**SG1521141-002**	**SG1521141-003**	**SG1521141-004**	**SG1521141-005**
Pesticides											
DDD/DDE/DDT	EPA8270D	0.50	mg/kg		0.01	4	<0.50	<0.50	<0.50	<0.50	<0.50
Aldrin,Dieldrin,Endrin (Sum)	EPA8270D	0.50	mg/kg		0.01	4	<0.50	<0.50	<0.50	<0.50	<0.50
Aldrin	EPA8270D	0.10	mg/kg		0.00006	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dieldrin	EPA8270D	0.10	mg/kg		0.0005	----	<0.10	<0.10	<0.10	<0.10	<0.10
Endrin	EPA8270D	0.10	mg/kg		0.00004	----	<0.10	<0.10	<0.10	<0.10	<0.10
BHC Compounds (Sum)	EPA8270D	0.50	mg/kg		0.01	2	<0.50	<0.50	<0.50	<0.50	<0.50
alpha-BHC	EPA8270D	0.10	mg/kg		0.003	----	<0.10	<0.10	<0.10	<0.10	<0.10
beta-BHC	EPA8270D	0.10	mg/kg		0.009	----	<0.10	<0.10	<0.10	<0.10	<0.10
gamma-BHC	EPA8270D	0.10	mg/kg		0.00005	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlordane	EPA8270D	0.10	mg/kg		0.00003	4	<0.10	<0.10	<0.10	<0.10	<0.10
Endosulfan	EPA8270D	0.10	mg/kg		0.00001	4	<0.10	<0.10	<0.10	<0.10	<0.10
Heptachlor	EPA8270D	0.10	mg/kg		0.0007	4	<0.10	<0.10	<0.10	<0.10	<0.10
Heptachlor epoxide	EPA8270D	0.10	mg/kg		0.0000002	4	<0.10	<0.10	<0.10	<0.10	<0.10
Carbaryl	EPA8270D	0.10	mg/kg		0.00003	5	<0.10	<0.10	<0.10	<0.10	<0.10
Carbofuran	EPA8270D	0.01	mg/kg		0.00002	2	<0.01	<0.01	<0.01	<0.01	<0.01
Maneb	EPA8270D	0.50	mg/kg		0.002	35	<0.50	<0.50	<0.50	<0.50	<0.50
Atrazine	EPA8270D	0.10	mg/kg		0.0002	6	<0.10	<0.10	<0.10	<0.10	<0.10
Other Pollutants											
Cyclohexanone	EPA5035/EPA8260C	0.10	mg/kg		0.1	45	<0.10	<0.10	<0.10	<0.10	<0.10
Phthalates (Sum)	EPA8270D	0.20	mg/kg		0.1	60	<0.20	<0.20	<0.20	<0.20	<0.20
Mineral oils	EPA8015B	50	mg/kg		50	5000	<50	<50	<50	<50	<50
Pyridine	EPA5035/EPA8260C	0.10	mg/kg		0.1	0.5	<0.10	<0.10	<0.10	<0.10	<0.10
Bromoform	EPA5035/EPA8260C	0.10	mg/kg		----	75	<0.10	<0.10	<0.10	<0.10	<0.10
Tetrahydrofuran	EPA8270D	0.10	mg/kg		0.1	2	<0.10	<0.10	<0.10	<0.10	<0.10
Tetrahydrothiophene	EPA8270D	0.10	mg/kg		0.1	90	<0.10	<0.10	<0.10	<0.10	<0.10
Conventional											
Organic Matter	BS1377	0.1	% DW		----	----	**0.9**	**0.1**	**0.2**	<0.1	**0.6**
Moisture Content (dried @ 103°C)	BS1377	0.10	%		----	----	**22.4**	**25.0**	**19.7**	**11.7**	**23.4**
Total Petroleum Hydrocarbon											
C6 - C9 Fraction	EPA5035/EPA8015B	5	mg/kg		----	----	<5	<5	<5	<5	<5
C10 - C14 Fraction	EPA8015B	5	mg/kg		----	----	<5	<5	<5	<5	<5
C15 - C28 Fraction	EPA8015B	10	mg/kg		----	----	<10	<10	<10	<10	<10
C29 - C36 Fraction	EPA8015B	10	mg/kg		----	----	<10	<10	<10	<10	<10

Dutch Standards 2000: Dutch Soil Standards

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH2-4.4 (Client sample ID) / 12-NOV-2015 15:00 (Sampling date/time) / SG1521141-006	BH3-0.5 / 13-NOV-2015 15:00 / SG1521141-007	BH3-0.8 / 13-NOV-2015 15:00 / SG1521141-008	BH3-5.0 / 13-NOV-2015 15:00 / SG1521141-009	BH4-0.3 / 23-NOV-2015 / SG1521141-010
Metals										
Arsenic	EPA3050B/EPA6010B	0.5	mg/kg	29	55	**31.9**	**20.7**	**27.3**	**3.6**	**23.1**
Barium	EPA3050B/EPA6010B	0.5	mg/kg	160	625	**2.2**	**9.0**	**9.2**	**9.6**	**68.0**
Cadmium	EPA3050B/EPA6010B	0.5	mg/kg	0.8	12	<0.5	<0.5	<0.5	<0.5	**0.5**
Chromium	EPA3050B/EPA6010B	0.5	mg/kg	100	380	**15.8**	**10.0**	**11.4**	**1.3**	**21.4**
Cobalt	EPA3050B/EPA6010B	0.5	mg/kg	9	240	**0.8**	**0.7**	**0.8**	<0.5	**4.8**
Copper	EPA3050B/EPA6010B	0.5	mg/kg	36	190	**3.8**	**3.3**	**4.4**	**1.8**	**44.8**
Mercury	EPA7471B	0.02	mg/kg	0.3	10	**0.21**	**0.13**	**0.14**	<0.02	**0.08**
Lead	EPA3050B/EPA6010B	0.5	mg/kg	85	530	**5.3**	**17.9**	**12.0**	**5.9**	**29.3**
Molybdenum	EPA3050B/EPA6010B	0.5	mg/kg	3	200	**2.0**	**1.8**	**1.8**	<0.5	**7.8**
Nickel	EPA3050B/EPA6010B	0.5	mg/kg	35	210	**1.0**	**1.2**	**1.2**	<0.5	**9.0**
Zinc	EPA3050B/EPA6010B	0.5	mg/kg	140	720	**6.4**	**18.1**	**16.7**	**1.2**	**152**
Antimony	EPA3050B/EPA6010B	0.5	mg/kg	3	15	**5.4**	**2.8**	**3.3**	<0.5	**2.1**
Inorganic Compounds										
Cyanide	EPA9010/EPA 9014	0.1	mg/kg	1	20	<0.10	<0.10	<0.10	<0.10	<0.10
Aromatic Compounds										
Benzene	EPA5035/EPA8260C	0.10	mg/kg	0.01	1	<0.10	<0.10	<0.10	<0.10	<0.10
Ethylbenzene	EPA5035/EPA8260C	0.10	mg/kg	0.03	50	<0.10	<0.10	<0.10	<0.10	<0.10
Phenol	EPA8270D	0.10	mg/kg	0.05	40	<0.10	<0.10	<0.10	<0.10	<0.10
Cresoles (Sum)	EPA8270D	0.10	mg/kg	0.05	5	<0.10	<0.10	<0.10	<0.10	<0.10
Toluene	EPA5035/EPA8260C	0.10	mg/kg	0.01	130	<0.10	<0.10	<0.10	<0.10	<0.10
Xylenes (Sum)	EPA5035/EPA8260C	0.20	mg/kg	0.1	25	<0.20	<0.20	<0.20	<0.20	<0.20
Styrene	EPA5035/EPA8260C	0.10	mg/kg	0.3	100	<0.10	<0.10	<0.10	<0.10	<0.10
Catechol	EPA8270D	0.10	mg/kg	0.05	20	<0.10	<0.10	<0.10	<0.10	<0.10
Resorcinol	EPA8270D	0.10	mg/kg	0.05	10	<0.10	<0.10	<0.10	<0.10	<0.10
Hydrochinon	EPA8270D	0.10	mg/kg	0.05	10	<0.10	<0.10	<0.10	<0.10	<0.10
Polynuclear Aromatic Hydrocarbons										
Naphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phenanthrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Fluoranthene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benz(a)anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chrysene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(a)pyrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(g.h.i)perylene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(k)fluoranthene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Indeno(1.2.3.cd)pyrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

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Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH2-4.4 (Client sample ID) 12-NOV-2015 15:00 (Sampling date/time) SG1521141-006	BH3-0.5 13-NOV-2015 15:00 SG1521141-007	BH3-0.8 13-NOV-2015 15:00 SG1521141-008	BH3-5.0 13-NOV-2015 15:00 SG1521141-009	BH4-0.3 23-NOV-2015 SG1521141-010
Polynuclear Aromatic Hydrocarbons - Continued										
Sum of PAHs	EPA8270D	0.20	mg/kg	1	40	<0.20	<0.20	<0.20	<0.20	<0.20
Chlorinated Hydrocarbons										
1.1-Dichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.02	15	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.02	4	<0.10	<0.10	<0.10	<0.10	<0.10
1.1-Dichloroethene	EPA5035/EPA8260C	0.10	mg/kg	0.1	0.3	<0.10	<0.10	<0.10	<0.10	<0.10
1,2-Dichloroethene (sum cis & trans)	EPA5035/EPA8260C	0.20	mg/kg	0.2	1	<0.20	<0.20	<0.20	<0.20	<0.20
Dichloropropanes (Sum)	EPA5035/EPA8260C	0.10	mg/kg	0.002	2	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.1-Trichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.07	15	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.2-Trichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.4	10	<0.10	<0.10	<0.10	<0.10	<0.10
Trichloroethene	EPA5035/EPA8260C	0.10	mg/kg	0.1	60	<0.10	<0.10	<0.10	<0.10	<0.10
Tetrachloroethene	EPA5035/EPA8260C	0.10	mg/kg	0.002	4	<0.10	<0.10	<0.10	<0.10	<0.10
Methylene chloride	EPA5035/EPA8260C	1.00	mg/kg	0.4	10	<1.00	<1.00	<1.00	<1.00	<1.00
Tetrachloromethane	EPA5035/EPA8260C	0.10	mg/kg	0.4	1	<0.10	<0.10	<0.10	<0.10	<0.10
Chloroform	EPA5035/EPA8260C	0.10	mg/kg	0.02	10	<0.10	<0.10	<0.10	<0.10	<0.10
Vinyl chloride	EPA5035/EPA8260C	0.01	mg/kg	0.01	0.1	<0.01	<0.01	<0.01	<0.01	<0.01
Chlorobenzenes (sum mono, di, tri, tetra, penta, hexa)	EPA8260C	0.20	mg/kg	0.03	30	<0.20	<0.20	<0.20	<0.20	<0.20
Monochlorobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dichlorobenzenes (Sum)	EPA5035/EPA8260C	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Trichlorobenzenes (Sum)	EPA5035/EPA8260C	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Tetrachlorobenzenes (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Pentachlorobenzenes (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Hexachlorobenzenes (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Chlorophenols (sum mono, di, tri, tetra, penta)	EPA8270D	0.20	mg/kg	0.01	10	<0.20	<0.20	<0.20	<0.20	<0.20
Monochlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Dichlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Trichlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Tetrachlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Pentachlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chloronaphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Monochloroanilines	EPA8270D	0.20	mg/kg	0.005	50	<0.20	<0.20	<0.20	<0.20	<0.20
Polychlorobiphenyls (Sum of PCB 28,52,101,118,138,153,180)	EPA8082	0.50	mg/kg	0.02	1	<0.50	<0.50	<0.50	<0.50	<0.50
Pesticides										
DDD/DDE/DDT	EPA8270D	0.50	mg/kg	0.01	4	<0.50	<0.50	<0.50	<0.50	<0.50

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Sub-Matrix: **SOIL**

Compound	*Method*	*LOR*	*Unit*	Target Value	Intervention Value	**BH2-4.4** 12-NOV-2015 15:00 **SG1521141-006**	**BH3-0.5** 13-NOV-2015 15:00 **SG1521141-007**	**BH3-0.8** 13-NOV-2015 15:00 **SG1521141-008**	**BH3-5.0** 13-NOV-2015 15:00 **SG1521141-009**	**BH4-0.3** 23-NOV-2015 **SG1521141-010**
Pesticides - Continued										
Aldrin,Dieldrin,Endrin (Sum)	EPA8270D	0.50	mg/kg	0.01	4	<0.50	<0.50	<0.50	<0.50	<0.50
Aldrin	EPA8270D	0.10	mg/kg	0.00006	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dieldrin	EPA8270D	0.10	mg/kg	0.0005	----	<0.10	<0.10	<0.10	<0.10	<0.10
Endrin	EPA8270D	0.10	mg/kg	0.00004	----	<0.10	<0.10	<0.10	<0.10	<0.10
BHC Compounds (Sum)	EPA8270D	0.50	mg/kg	0.01	2	<0.50	<0.50	<0.50	<0.50	<0.50
alpha-BHC	EPA8270D	0.10	mg/kg	0.003	----	<0.10	<0.10	<0.10	<0.10	<0.10
beta-BHC	EPA8270D	0.10	mg/kg	0.009	----	<0.10	<0.10	<0.10	<0.10	<0.10
gamma-BHC	EPA8270D	0.10	mg/kg	0.00005	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlordane	EPA8270D	0.10	mg/kg	0.00003	4	<0.10	<0.10	<0.10	<0.10	<0.10
Endosulfan	EPA8270D	0.10	mg/kg	0.00001	4	<0.10	<0.10	<0.10	<0.10	<0.10
Heptachlor	EPA8270D	0.10	mg/kg	0.0007	4	<0.10	<0.10	<0.10	<0.10	<0.10
Heptachlor epoxide	EPA8270D	0.10	mg/kg	0.0000002	4	<0.10	<0.10	<0.10	<0.10	<0.10
Carbaryl	EPA8270D	0.10	mg/kg	0.00003	5	<0.10	<0.10	<0.10	<0.10	<0.10
Carbofuran	EPA8270D	0.01	mg/kg	0.00002	2	<0.01	<0.01	<0.01	<0.01	<0.01
Maneb	EPA8270D	0.50	mg/kg	0.002	35	<0.50	<0.50	<0.50	<0.50	<0.50
Atrazine	EPA8270D	0.10	mg/kg	0.0002	6	<0.10	<0.10	<0.10	<0.10	<0.10
Other Pollutants										
Cyclohexanone	EPA5035/EPA8260C	0.10	mg/kg	0.1	45	<0.10	<0.10	<0.10	<0.10	<0.10
Phthalates (Sum)	EPA8270D	0.20	mg/kg	0.1	60	<0.20	<0.20	<0.20	<0.20	<0.20
Mineral oils	EPA8015B	50	mg/kg	50	5000	<50	<50	<50	<50	**63**
Pyridine	EPA5035/EPA8260C	0.10	mg/kg	0.1	0.5	<0.10	<0.10	<0.10	<0.10	<0.10
Bromoform	EPA5035/EPA8260C	0.10	mg/kg	----	75	<0.10	<0.10	<0.10	<0.10	<0.10
Tetrahydrofuran	EPA8270D	0.10	mg/kg	0.1	2	<0.10	<0.10	<0.10	<0.10	<0.10
Tetrahydrothiophene	EPA8270D	0.10	mg/kg	0.1	90	<0.10	<0.10	<0.10	<0.10	<0.10
Conventional										
Organic Matter	BS1377	0.1	% DW	----	----	**0.2**	**1.8**	**1.3**	<0.1	**2.7**
Moisture Content (dried @ 103°C)	BS1377	0.10	%	----	----	**24.0**	**29.2**	**26.4**	**17.6**	**13.4**
Total Petroleum Hydrocarbon										
C6 - C9 Fraction	EPA5035/EPA8015B	5	mg/kg	----	----	<5	<5	<5	<5	<5
C10 - C14 Fraction	EPA8015B	5	mg/kg	----	----	<5	<5	<5	<5	<5
C15 - C28 Fraction	EPA8015B	10	mg/kg	----	----	<10	<10	<10	<10	**26**
C29 - C36 Fraction	EPA8015B	10	mg/kg	----	----	<10	<10	<10	<10	**37**

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Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH4-1.0 (Client sample ID) / 23-NOV-2015 (Sampling date/time) / SG1521141-011	BH4-3.0 / 23-NOV-2015 / SG1521141-012	BH5-0.3 / 19-NOV-2015 15:00 / SG1521141-013	BH5-4.0 / 19-NOV-2015 15:00 / SG1521141-014	BH5-5.0 / 19-NOV-2015 15:00 / SG1521141-015
Metals										
Arsenic	EPA3050B/EPA6010B	0.5	mg/kg	29	55	**37.1**	**29.1**	**49.0**	**28.8**	**36.2**
Barium	EPA3050B/EPA6010B	0.5	mg/kg	160	625	**3.1**	**2.0**	**10.1**	**15.8**	**3.6**
Cadmium	EPA3050B/EPA6010B	0.5	mg/kg	0.8	12	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	EPA3050B/EPA6010B	0.5	mg/kg	100	380	**30.1**	**16.0**	**11.6**	**13.6**	**10.7**
Cobalt	EPA3050B/EPA6010B	0.5	mg/kg	9	240	**0.7**	<0.5	**1.0**	**2.4**	**0.8**
Copper	EPA3050B/EPA6010B	0.5	mg/kg	36	190	**2.4**	**1.5**	**3.7**	**7.9**	**2.8**
Mercury	EPA7471B	0.02	mg/kg	0.3	10	**0.18**	**0.21**	**0.16**	**0.14**	**0.11**
Lead	EPA3050B/EPA6010B	0.5	mg/kg	85	530	**1.5**	**2.8**	**23.6**	**17.6**	**12.9**
Molybdenum	EPA3050B/EPA6010B	0.5	mg/kg	3	200	**2.4**	**2.1**	**1.5**	**3.1**	**1.9**
Nickel	EPA3050B/EPA6010B	0.5	mg/kg	35	210	**1.4**	**0.9**	**1.2**	**4.4**	**0.9**
Zinc	EPA3050B/EPA6010B	0.5	mg/kg	140	720	**12.6**	**12.1**	**13.0**	**39.2**	**6.0**
Antimony	EPA3050B/EPA6010B	0.5	mg/kg	3	15	**5.0**	**3.5**	**4.0**	**3.0**	**4.8**
Inorganic Compounds										
Cyanide	EPA9010/EPA 9014	0.1	mg/kg	1	20	<0.10	<0.10	<0.10	<0.10	<0.10
Aromatic Compounds										
Benzene	EPA5035/EPA8260C	0.10	mg/kg	0.01	1	<0.10	<0.10	<0.10	<0.10	<0.10
Ethylbenzene	EPA5035/EPA8260C	0.10	mg/kg	0.03	50	<0.10	<0.10	<0.10	<0.10	<0.10
Phenol	EPA8270D	0.10	mg/kg	0.05	40	<0.10	<0.10	<0.10	<0.10	<0.10
Cresoles (Sum)	EPA8270D	0.10	mg/kg	0.05	5	<0.10	<0.10	<0.10	<0.10	<0.10
Toluene	EPA5035/EPA8260C	0.10	mg/kg	0.01	130	<0.10	<0.10	<0.10	<0.10	<0.10
Xylenes (Sum)	EPA5035/EPA8260C	0.20	mg/kg	0.1	25	<0.20	<0.20	<0.20	<0.20	<0.20
Styrene	EPA5035/EPA8260C	0.10	mg/kg	0.3	100	<0.10	<0.10	<0.10	<0.10	<0.10
Catechol	EPA8270D	0.10	mg/kg	0.05	20	<0.10	<0.10	<0.10	<0.10	<0.10
Resorcinol	EPA8270D	0.10	mg/kg	0.05	10	<0.10	<0.10	<0.10	<0.10	<0.10
Hydrochinon	EPA8270D	0.10	mg/kg	0.05	10	<0.10	<0.10	<0.10	<0.10	<0.10
Polynuclear Aromatic Hydrocarbons										
Naphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phenanthrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Fluoranthene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benz(a)anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chrysene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(a)pyrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(g.h.i)perylene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(k)fluoranthene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Indeno(1.2.3.cd)pyrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

Dutch Standards 2000: Dutch Soil Standards

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH4-1.0 (Client sample ID) / 23-NOV-2015 (Sampling date/time) / SG1521141-011	BH4-3.0 / 23-NOV-2015 / SG1521141-012	BH5-0.3 / 19-NOV-2015 15:00 / SG1521141-013	BH5-4.0 / 19-NOV-2015 15:00 / SG1521141-014	BH5-5.0 / 19-NOV-2015 15:00 / SG1521141-015
Polynuclear Aromatic Hydrocarbons - Continued										
Sum of PAHs	EPA8270D	0.20	mg/kg	1	40	<0.20	<0.20	<0.20	<0.20	<0.20
Chlorinated Hydrocarbons										
1.1-Dichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.02	15	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.02	4	<0.10	<0.10	<0.10	<0.10	<0.10
1.1-Dichloroethene	EPA5035/EPA8260C	0.10	mg/kg	0.1	0.3	<0.10	<0.10	<0.10	<0.10	<0.10
1,2-Dichloroethene (sum cis & trans)	EPA5035/EPA8260C	0.20	mg/kg	0.2	1	<0.20	<0.20	<0.20	<0.20	<0.20
Dichloropropanes (Sum)	EPA5035/EPA8260C	0.10	mg/kg	0.002	2	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.1-Trichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.07	15	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.2-Trichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.4	10	<0.10	<0.10	<0.10	<0.10	<0.10
Trichloroethene	EPA5035/EPA8260C	0.10	mg/kg	0.1	60	<0.10	<0.10	<0.10	<0.10	<0.10
Tetrachloroethene	EPA5035/EPA8260C	0.10	mg/kg	0.002	4	<0.10	<0.10	<0.10	<0.10	<0.10
Methylene chloride	EPA5035/EPA8260C	1.00	mg/kg	0.4	10	<1.00	<1.00	<1.00	<1.00	<1.00
Tetrachloromethane	EPA5035/EPA8260C	0.10	mg/kg	0.4	1	<0.10	<0.10	<0.10	<0.10	<0.10
Chloroform	EPA5035/EPA8260C	0.10	mg/kg	0.02	10	<0.10	<0.10	<0.10	<0.10	<0.10
Vinyl chloride	EPA5035/EPA8260C	0.01	mg/kg	0.01	0.1	<0.01	<0.01	<0.01	<0.01	<0.01
Chlorobenzenes (sum mono, di, tri, tetra, penta, hexa)	EPA8260C	0.20	mg/kg	0.03	30	<0.20	<0.20	<0.20	<0.20	<0.20
Monochlorobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dichlorobenzenes (Sum)	EPA5035/EPA8260C	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Trichlorobenzenes (Sum)	EPA5035/EPA8260C	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Tetrachlorobenzenes (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Pentachlorobenzenes (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Hexachlorobenzenes (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Chlorophenols (sum mono, di, tri, tetra, penta)	EPA8270D	0.20	mg/kg	0.01	10	<0.20	<0.20	<0.20	<0.20	<0.20
Monochlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Dichlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Trichlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Tetrachlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Pentachlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chloronaphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Monochloroanilines	EPA8270D	0.20	mg/kg	0.005	50	<0.20	<0.20	<0.20	<0.20	<0.20
Polychlorobiphenyls (Sum of PCB 28,52,101,118,138,153,180)	EPA8082	0.50	mg/kg	0.02	1	<0.50	<0.50	<0.50	<0.50	<0.50
Pesticides										
DDD/DDE/DDT	EPA8270D	0.50	mg/kg	0.01	4	<0.50	<0.50	<0.50	<0.50	<0.50

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Sub-Matrix: **SOIL**

Compound	*Method*	*LOR*	*Unit*	Target Value	Intervention Value	**BH4-1.0** 23-NOV-2015 **SG1521141-011**	**BH4-3.0** 23-NOV-2015 **SG1521141-012**	**BH5-0.3** 19-NOV-2015 15:00 **SG1521141-013**	**BH5-4.0** 19-NOV-2015 15:00 **SG1521141-014**	**BH5-5.0** 19-NOV-2015 15:00 **SG1521141-015**
Client sample ID										
Sampling date/time										
Pesticides - Continued										
Aldrin,Dieldrin,Endrin (Sum)	EPA8270D	0.50	mg/kg	0.01	4	<0.50	<0.50	<0.50	<0.50	<0.50
Aldrin	EPA8270D	0.10	mg/kg	0.00006	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dieldrin	EPA8270D	0.10	mg/kg	0.0005	----	<0.10	<0.10	<0.10	<0.10	<0.10
Endrin	EPA8270D	0.10	mg/kg	0.00004	----	<0.10	<0.10	<0.10	<0.10	<0.10
BHC Compounds (Sum)	EPA8270D	0.50	mg/kg	0.01	2	<0.50	<0.50	<0.50	<0.50	<0.50
alpha-BHC	EPA8270D	0.10	mg/kg	0.003	----	<0.10	<0.10	<0.10	<0.10	<0.10
beta-BHC	EPA8270D	0.10	mg/kg	0.009	----	<0.10	<0.10	<0.10	<0.10	<0.10
gamma-BHC	EPA8270D	0.10	mg/kg	0.00005	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlordane	EPA8270D	0.10	mg/kg	0.00003	4	<0.10	<0.10	<0.10	<0.10	<0.10
Endosulfan	EPA8270D	0.10	mg/kg	0.00001	4	<0.10	<0.10	<0.10	<0.10	<0.10
Heptachlor	EPA8270D	0.10	mg/kg	0.0007	4	<0.10	<0.10	<0.10	<0.10	<0.10
Heptachlor epoxide	EPA8270D	0.10	mg/kg	0.0000002	4	<0.10	<0.10	<0.10	<0.10	<0.10
Carbaryl	EPA8270D	0.10	mg/kg	0.00003	5	<0.10	<0.10	<0.10	<0.10	<0.10
Carbofuran	EPA8270D	0.01	mg/kg	0.00002	2	<0.01	<0.01	<0.01	<0.01	<0.01
Maneb	EPA8270D	0.50	mg/kg	0.002	35	<0.50	<0.50	<0.50	<0.50	<0.50
Atrazine	EPA8270D	0.10	mg/kg	0.0002	6	<0.10	<0.10	<0.10	<0.10	<0.10
Other Pollutants										
Cyclohexanone	EPA5035/EPA8260C	0.10	mg/kg	0.1	45	<0.10	<0.10	<0.10	<0.10	<0.10
Phthalates (Sum)	EPA8270D	0.20	mg/kg	0.1	60	<0.20	<0.20	<0.20	<0.20	<0.20
Mineral oils	EPA8015B	50	mg/kg	50	5000	<50	<50	<50	<50	<50
Pyridine	EPA5035/EPA8260C	0.10	mg/kg	0.1	0.5	<0.10	<0.10	<0.10	<0.10	<0.10
Bromoform	EPA5035/EPA8260C	0.10	mg/kg	----	75	<0.10	<0.10	<0.10	<0.10	<0.10
Tetrahydrofuran	EPA8270D	0.10	mg/kg	0.1	2	<0.10	<0.10	<0.10	<0.10	<0.10
Tetrahydrothiophene	EPA8270D	0.10	mg/kg	0.1	90	<0.10	<0.10	<0.10	<0.10	<0.10
Conventional										
Organic Matter	BS1377	0.1	% DW	----	----	**1.0**	**0.2**	**0.3**	**0.8**	**0.5**
Moisture Content (dried @ 103°C)	BS1377	0.10	%	----	----	**27.0**	**21.4**	**18.1**	**24.5**	**27.0**
Total Petroleum Hydrocarbon										
C6 - C9 Fraction	EPA5035/EPA8015B	5	mg/kg	----	----	<5	<5	<5	<5	<5
C10 - C14 Fraction	EPA8015B	5	mg/kg	----	----	<5	<5	<5	<5	<5
C15 - C28 Fraction	EPA8015B	10	mg/kg	----	----	<10	<10	<10	**16**	<10
C29 - C36 Fraction	EPA8015B	10	mg/kg	----	----	**21**	<10	**14**	**19**	<10

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Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH6-0.5 (Client sample ID) / 17-NOV-2015 15:00 (Sampling date/time) / SG1521141-016	BH6-3.0 / 17-NOV-2015 15:00 / SG1521141-017	BH6-6.0 / 17-NOV-2015 15:00 / SG1521141-018	BH7-0.3 / 18-NOV-2015 15:00 / SG1521141-019	BH7-1.0 / 18-NOV-2015 15:00 / SG1521141-020
Metals										
Arsenic	EPA3050B/EPA6010B	0.5	mg/kg	29	55	**62.6**	**113**	**39.3**	**76.0**	**24.4**
Barium	EPA3050B/EPA6010B	0.5	mg/kg	160	625	**4.2**	**1.8**	**7.1**	**17.7**	**1.4**
Cadmium	EPA3050B/EPA6010B	0.5	mg/kg	0.8	12	<0.5	**0.6**	<0.5	**0.5**	<0.5
Chromium	EPA3050B/EPA6010B	0.5	mg/kg	100	380	**12.2**	**13.5**	**3.6**	**15.6**	**11.3**
Cobalt	EPA3050B/EPA6010B	0.5	mg/kg	9	240	**0.6**	**0.8**	<0.5	**3.6**	**0.7**
Copper	EPA3050B/EPA6010B	0.5	mg/kg	36	190	**3.7**	**2.5**	**13.8**	**9.9**	**5.6**
Mercury	EPA7471B	0.02	mg/kg	0.3	10	**0.15**	**0.11**	<0.02	**0.04**	**0.06**
Lead	EPA3050B/EPA6010B	0.5	mg/kg	85	530	**3.6**	**3.2**	**10.1**	**9.8**	**5.5**
Molybdenum	EPA3050B/EPA6010B	0.5	mg/kg	3	200	**2.4**	**1.8**	**2.6**	**4.7**	**2.6**
Nickel	EPA3050B/EPA6010B	0.5	mg/kg	35	210	**1.4**	**1.0**	<0.5	**4.7**	**0.9**
Zinc	EPA3050B/EPA6010B	0.5	mg/kg	140	720	**12.8**	**8.2**	**6.2**	**22.8**	**6.1**
Antimony	EPA3050B/EPA6010B	0.5	mg/kg	3	15	**3.8**	**5.3**	**2.2**	**4.4**	**4.4**
Inorganic Compounds										
Cyanide	EPA9010/EPA 9014	0.1	mg/kg	1	20	<0.10	<0.10	<0.10	<0.10	<0.10
Aromatic Compounds										
Benzene	EPA5035/EPA8260C	0.10	mg/kg	0.01	1	<0.10	<0.10	<0.10	<0.10	<0.10
Ethylbenzene	EPA5035/EPA8260C	0.10	mg/kg	0.03	50	<0.10	<0.10	<0.10	<0.10	<0.10
Phenol	EPA8270D	0.10	mg/kg	0.05	40	<0.10	<0.10	<0.10	<0.10	<0.10
Cresoles (Sum)	EPA8270D	0.10	mg/kg	0.05	5	<0.10	<0.10	<0.10	<0.10	<0.10
Toluene	EPA5035/EPA8260C	0.10	mg/kg	0.01	130	<0.10	<0.10	<0.10	<0.10	<0.10
Xylenes (Sum)	EPA5035/EPA8260C	0.20	mg/kg	0.1	25	<0.20	<0.20	<0.20	<0.20	<0.20
Styrene	EPA5035/EPA8260C	0.10	mg/kg	0.3	100	<0.10	<0.10	<0.10	<0.10	<0.10
Catechol	EPA8270D	0.10	mg/kg	0.05	20	<0.10	<0.10	<0.10	<0.10	<0.10
Resorcinol	EPA8270D	0.10	mg/kg	0.05	10	<0.10	<0.10	<0.10	<0.10	<0.10
Hydrochinon	EPA8270D	0.10	mg/kg	0.05	10	<0.10	<0.10	<0.10	<0.10	<0.10
Polynuclear Aromatic Hydrocarbons										
Naphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phenanthrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Fluoranthene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benz(a)anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chrysene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(a)pyrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(g.h.i)perylene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(k)fluoranthene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Indeno(1.2.3.cd)pyrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

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Sub-Matrix: **SOIL**

			Client sample ID	Target Value	Intervention Value	**BH6-0.5**	**BH6-3.0**	**BH6-6.0**	**BH7-0.3**	**BH7-1.0**
			Sampling date/time			17-NOV-2015 15:00	17-NOV-2015 15:00	17-NOV-2015 15:00	18-NOV-2015 15:00	18-NOV-2015 15:00
Compound	*Method*	*LOR*	*Unit*			**SG1521141-016**	**SG1521141-017**	**SG1521141-018**	**SG1521141-019**	**SG1521141-020**
Polynuclear Aromatic Hydrocarbons - Continued										
Sum of PAHs	EPA8270D	0.20	mg/kg	1	40	<0.20	<0.20	<0.20	<0.20	<0.20
Chlorinated Hydrocarbons										
1.1-Dichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.02	15	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.02	4	<0.10	<0.10	<0.10	<0.10	<0.10
1.1-Dichloroethene	EPA5035/EPA8260C	0.10	mg/kg	0.1	0.3	<0.10	<0.10	<0.10	<0.10	<0.10
1,2-Dichloroethene (sum cis & trans)	EPA5035/EPA8260C	0.20	mg/kg	0.2	1	<0.20	<0.20	<0.20	<0.20	<0.20
Dichloropropanes (Sum)	EPA5035/EPA8260C	0.10	mg/kg	0.002	2	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.1-Trichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.07	15	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.2-Trichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.4	10	<0.10	<0.10	<0.10	<0.10	<0.10
Trichloroethene	EPA5035/EPA8260C	0.10	mg/kg	0.1	60	<0.10	<0.10	<0.10	<0.10	<0.10
Tetrachloroethene	EPA5035/EPA8260C	0.10	mg/kg	0.002	4	<0.10	<0.10	<0.10	<0.10	<0.10
Methylene chloride	EPA5035/EPA8260C	1.00	mg/kg	0.4	10	<1.00	<1.00	<1.00	<1.00	<1.00
Tetrachloromethane	EPA5035/EPA8260C	0.10	mg/kg	0.4	1	<0.10	<0.10	<0.10	<0.10	<0.10
Chloroform	EPA5035/EPA8260C	0.10	mg/kg	0.02	10	<0.10	<0.10	<0.10	<0.10	<0.10
Vinyl chloride	EPA5035/EPA8260C	0.01	mg/kg	0.01	0.1	<0.01	<0.01	<0.01	<0.01	<0.01
Chlorobenzenes (sum mono, di, tri, tetra, penta, hexa)	EPA8260C	0.20	mg/kg	0.03	30	<0.20	<0.20	<0.20	<0.20	<0.20
Monochlorobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dichlorobenzenes (Sum)	EPA5035/EPA8260C	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Trichlorobenzenes (Sum)	EPA5035/EPA8260C	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Tetrachlorobenzenes (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Pentachlorobenzenes (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Hexachlorobenzenes (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Chlorophenols (sum mono, di, tri, tetra, penta)	EPA8270D	0.20	mg/kg	0.01	10	<0.20	<0.20	<0.20	<0.20	<0.20
Monochlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Dichlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Trichlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Tetrachlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Pentachlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chloronaphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Monochloroanilines	EPA8270D	0.20	mg/kg	0.005	50	<0.20	<0.20	<0.20	<0.20	<0.20
Polychlorobiphenyls (Sum of PCB 28,52,101,118,138,153,180)	EPA8082	0.50	mg/kg	0.02	1	<0.50	<0.50	<0.50	<0.50	<0.50
Pesticides										
DDD/DDE/DDT	EPA8270D	0.50	mg/kg	0.01	4	<0.50	<0.50	<0.50	<0.50	<0.50

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Sub-Matrix: **SOIL**

Compound	*Method*	*LOR*	*Unit*	Target Value	Intervention Value	**BH6-0.5** 17-NOV-2015 15:00 **SG1521141-016**	**BH6-3.0** 17-NOV-2015 15:00 **SG1521141-017**	**BH6-6.0** 17-NOV-2015 15:00 **SG1521141-018**	**BH7-0.3** 18-NOV-2015 15:00 **SG1521141-019**	**BH7-1.0** 18-NOV-2015 15:00 **SG1521141-020**
Pesticides - Continued										
Aldrin,Dieldrin,Endrin (Sum)	EPA8270D	0.50	mg/kg	0.01	4	<0.50	<0.50	<0.50	<0.50	<0.50
Aldrin	EPA8270D	0.10	mg/kg	0.00006	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dieldrin	EPA8270D	0.10	mg/kg	0.0005	----	<0.10	<0.10	<0.10	<0.10	<0.10
Endrin	EPA8270D	0.10	mg/kg	0.00004	----	<0.10	<0.10	<0.10	<0.10	<0.10
BHC Compounds (Sum)	EPA8270D	0.50	mg/kg	0.01	2	<0.50	<0.50	<0.50	<0.50	<0.50
alpha-BHC	EPA8270D	0.10	mg/kg	0.003	----	<0.10	<0.10	<0.10	<0.10	<0.10
beta-BHC	EPA8270D	0.10	mg/kg	0.009	----	<0.10	<0.10	<0.10	<0.10	<0.10
gamma-BHC	EPA8270D	0.10	mg/kg	0.00005	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlordane	EPA8270D	0.10	mg/kg	0.00003	4	<0.10	<0.10	<0.10	<0.10	<0.10
Endosulfan	EPA8270D	0.10	mg/kg	0.00001	4	<0.10	<0.10	<0.10	<0.10	<0.10
Heptachlor	EPA8270D	0.10	mg/kg	0.0007	4	<0.10	<0.10	<0.10	<0.10	<0.10
Heptachlor epoxide	EPA8270D	0.10	mg/kg	0.0000002	4	<0.10	<0.10	<0.10	<0.10	<0.10
Carbaryl	EPA8270D	0.10	mg/kg	0.00003	5	<0.10	<0.10	<0.10	<0.10	<0.10
Carbofuran	EPA8270D	0.01	mg/kg	0.00002	2	<0.01	<0.01	<0.01	<0.01	<0.01
Maneb	EPA8270D	0.50	mg/kg	0.002	35	<0.50	<0.50	<0.50	<0.50	<0.50
Atrazine	EPA8270D	0.10	mg/kg	0.0002	6	<0.10	<0.10	<0.10	<0.10	<0.10
Other Pollutants										
Cyclohexanone	EPA5035/EPA8260C	0.10	mg/kg	0.1	45	<0.10	<0.10	<0.10	<0.10	<0.10
Phthalates (Sum)	EPA8270D	0.20	mg/kg	0.1	60	<0.20	<0.20	<0.20	<0.20	<0.20
Mineral oils	EPA8015B	50	mg/kg	50	5000	<50	<50	<50	<50	<50
Pyridine	EPA5035/EPA8260C	0.10	mg/kg	0.1	0.5	<0.10	<0.10	<0.10	<0.10	<0.10
Bromoform	EPA5035/EPA8260C	0.10	mg/kg	----	75	<0.10	<0.10	<0.10	<0.10	<0.10
Tetrahydrofuran	EPA8270D	0.10	mg/kg	0.1	2	<0.10	<0.10	<0.10	<0.10	<0.10
Tetrahydrothiophene	EPA8270D	0.10	mg/kg	0.1	90	<0.10	<0.10	<0.10	<0.10	<0.10
Conventional										
Organic Matter	BS1377	0.1	% DW	----	----	**0.6**	**0.2**	<0.1	**0.5**	**0.2**
Moisture Content (dried @ 103°C)	BS1377	0.10	%	----	----	**25.1**	**24.9**	**24.5**	**17.8**	**20.1**
Total Petroleum Hydrocarbon										
C6 - C9 Fraction	EPA5035/EPA8015B	5	mg/kg	----	----	<5	<5	<5	<5	<5
C10 - C14 Fraction	EPA8015B	5	mg/kg	----	----	<5	<5	<5	<5	<5
C15 - C28 Fraction	EPA8015B	10	mg/kg	----	----	<10	<10	<10	<10	<10
C29 - C36 Fraction	EPA8015B	10	mg/kg	----	----	<10	<10	<10	<10	<10

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Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	Client sample ID: **BH7-6.0** / Sampling date/time: 18-NOV-2015 15:00 / **SG1521141-021**	Client sample ID: **BH8-0.3** / Sampling date/time: 20-NOV-2015 15:00 / **SG1521141-022**	Client sample ID: **BH8-1.0** / Sampling date/time: 20-NOV-2015 15:00 / **SG1521141-023**	Client sample ID: **BH8-4.0** / Sampling date/time: 20-NOV-2015 15:00 / **SG1521141-024**	---- / ---- / **----**
Metals										
Arsenic	EPA3050B/EPA6010B	0.5	mg/kg	29	55	**18.3**	**31.5**	**36.3**	**56.7**	----
Barium	EPA3050B/EPA6010B	0.5	mg/kg	160	625	**2.1**	**15.6**	**7.5**	**1.2**	----
Cadmium	EPA3050B/EPA6010B	0.5	mg/kg	0.8	12	<0.5	<0.5	<0.5	<0.5	----
Chromium	EPA3050B/EPA6010B	0.5	mg/kg	100	380	**7.3**	**18.0**	**12.4**	**14.8**	----
Cobalt	EPA3050B/EPA6010B	0.5	mg/kg	9	240	**0.6**	**1.5**	**0.8**	**0.7**	----
Copper	EPA3050B/EPA6010B	0.5	mg/kg	36	190	**3.0**	**28.9**	**9.9**	**4.0**	----
Mercury	EPA7471B	0.02	mg/kg	0.3	10	<0.02	**0.12**	**0.12**	**0.10**	----
Lead	EPA3050B/EPA6010B	0.5	mg/kg	85	530	**6.5**	**10.0**	**5.1**	**1.3**	----
Molybdenum	EPA3050B/EPA6010B	0.5	mg/kg	3	200	**1.2**	**4.8**	**3.1**	**3.2**	----
Nickel	EPA3050B/EPA6010B	0.5	mg/kg	35	210	**0.7**	**4.2**	**1.6**	**1.3**	----
Zinc	EPA3050B/EPA6010B	0.5	mg/kg	140	720	**4.6**	**99.5**	**28.9**	**8.3**	----
Antimony	EPA3050B/EPA6010B	0.5	mg/kg	3	15	**4.0**	**3.8**	**3.9**	**4.5**	----
Inorganic Compounds										
Cyanide	EPA9010/EPA 9014	0.1	mg/kg	1	20	<0.10	<0.10	<0.10	<0.10	----
Aromatic Compounds										
Benzene	EPA5035/EPA8260C	0.10	mg/kg	0.01	1	<0.10	<0.10	<0.10	<0.10	----
Ethylbenzene	EPA5035/EPA8260C	0.10	mg/kg	0.03	50	<0.10	<0.10	<0.10	<0.10	----
Phenol	EPA8270D	0.10	mg/kg	0.05	40	<0.10	<0.10	<0.10	<0.10	----
Cresoles (Sum)	EPA8270D	0.10	mg/kg	0.05	5	<0.10	<0.10	<0.10	<0.10	----
Toluene	EPA5035/EPA8260C	0.10	mg/kg	0.01	130	<0.10	<0.10	<0.10	<0.10	----
Xylenes (Sum)	EPA5035/EPA8260C	0.20	mg/kg	0.1	25	<0.20	<0.20	<0.20	<0.20	----
Styrene	EPA5035/EPA8260C	0.10	mg/kg	0.3	100	<0.10	<0.10	<0.10	<0.10	----
Catechol	EPA8270D	0.10	mg/kg	0.05	20	<0.10	<0.10	<0.10	<0.10	----
Resorcinol	EPA8270D	0.10	mg/kg	0.05	10	<0.10	<0.10	<0.10	<0.10	----
Hydrochinon	EPA8270D	0.10	mg/kg	0.05	10	<0.10	<0.10	<0.10	<0.10	----
Polynuclear Aromatic Hydrocarbons										
Naphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Phenanthrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Fluoranthene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Benz(a)anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Chrysene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Benzo(a)pyrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Benzo(g.h.i)perylene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Benzo(k)fluoranthene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Indeno(1.2.3.cd)pyrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----

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Sub-Matrix: **SOIL**

				Client sample ID	Target Value	Intervention Value	**BH7-6.0**	**BH8-0.3**	**BH8-1.0**	**BH8-4.0**	----
				Sampling date/time			18-NOV-2015 15:00	20-NOV-2015 15:00	20-NOV-2015 15:00	20-NOV-2015 15:00	----
Compound	*Method*	*LOR*	*Unit*				**SG1521141-021**	**SG1521141-022**	**SG1521141-023**	**SG1521141-024**	**----**
Polynuclear Aromatic Hydrocarbons - Continued											
Sum of PAHs	EPA8270D	0.20	mg/kg	1	40	<0.20	<0.20	<0.20	<0.20	----
Chlorinated Hydrocarbons											
1.1-Dichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.02	15	<0.10	<0.10	<0.10	<0.10	----
1.2-Dichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.02	4	<0.10	<0.10	<0.10	<0.10	----
1.1-Dichloroethene	EPA5035/EPA8260C	0.10	mg/kg	0.1	0.3	<0.10	<0.10	<0.10	<0.10	----
1,2-Dichloroethene (sum cis & trans)	EPA5035/EPA8260C	0.20	mg/kg	0.2	1	<0.20	<0.20	<0.20	<0.20	----
Dichloropropanes (Sum)	EPA5035/EPA8260C	0.10	mg/kg	0.002	2	<0.10	<0.10	<0.10	<0.10	----
1.1.1-Trichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.07	15	<0.10	<0.10	<0.10	<0.10	----
1.1.2-Trichloroethane	EPA5035/EPA8260C	0.10	mg/kg	0.4	10	<0.10	<0.10	<0.10	<0.10	----
Trichloroethene	EPA5035/EPA8260C	0.10	mg/kg	0.1	60	<0.10	<0.10	<0.10	<0.10	----
Tetrachloroethene	EPA5035/EPA8260C	0.10	mg/kg	0.002	4	<0.10	<0.10	<0.10	<0.10	----
Methylene chloride	EPA5035/EPA8260C	1.00	mg/kg	0.4	10	<1.00	<1.00	<1.00	<1.00	----
Tetrachloromethane	EPA5035/EPA8260C	0.10	mg/kg	0.4	1	<0.10	<0.10	<0.10	<0.10	----
Chloroform	EPA5035/EPA8260C	0.10	mg/kg	0.02	10	<0.10	<0.10	<0.10	<0.10	----
Vinyl chloride	EPA5035/EPA8260C	0.01	mg/kg	0.01	0.1	<0.01	<0.01	<0.01	<0.01	----
Chlorobenzenes (sum mono, di, tri, tetra, penta, hexa)	EPA8260C	0.20	mg/kg	0.03	30	<0.20	<0.20	<0.20	<0.20	----
Monochlorobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Dichlorobenzenes (Sum)	EPA5035/EPA8260C	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----
Trichlorobenzenes (Sum)	EPA5035/EPA8260C	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----
Tetrachlorobenzenes (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----
Pentachlorobenzenes (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----
Hexachlorobenzenes (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----
Chlorophenols (sum mono, di, tri, tetra, penta)	EPA8270D	0.20	mg/kg	0.01	10	<0.20	<0.20	<0.20	<0.20	----
Monochlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----
Dichlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----
Trichlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----
Tetrachlorophenols (Sum)	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----
Pentachlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Chloronaphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Monochloroanilines	EPA8270D	0.20	mg/kg	0.005	50	<0.20	<0.20	<0.20	<0.20	----
Polychlorobiphenyls (Sum of PCB 28,52,101,118,138,153,180)	EPA8082	0.50	mg/kg	0.02	1	<0.50	<0.50	<0.50	<0.50	----
Pesticides											
DDD/DDE/DDT	EPA8270D	0.50	mg/kg	0.01	4	<0.50	<0.50	<0.50	<0.50	----

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Sub-Matrix: **SOIL**

				Client sample ID	Target Value	Intervention Value	**BH7-6.0**	**BH8-0.3**	**BH8-1.0**	**BH8-4.0**	----
				Sampling date/time			18-NOV-2015 15:00	20-NOV-2015 15:00	20-NOV-2015 15:00	20-NOV-2015 15:00	----
Compound	*Method*	*LOR*	*Unit*				**SG1521141-021**	**SG1521141-022**	**SG1521141-023**	**SG1521141-024**	**----**
Pesticides - Continued											
Aldrin,Dieldrin,Endrin (Sum)	EPA8270D	0.50	mg/kg		0.01	4	<0.50	<0.50	<0.50	<0.50	----
Aldrin	EPA8270D	0.10	mg/kg		0.00006	----	<0.10	<0.10	<0.10	<0.10	----
Dieldrin	EPA8270D	0.10	mg/kg		0.0005	----	<0.10	<0.10	<0.10	<0.10	----
Endrin	EPA8270D	0.10	mg/kg		0.00004	----	<0.10	<0.10	<0.10	<0.10	----
BHC Compounds (Sum)	EPA8270D	0.50	mg/kg		0.01	2	<0.50	<0.50	<0.50	<0.50	----
alpha-BHC	EPA8270D	0.10	mg/kg		0.003	----	<0.10	<0.10	<0.10	<0.10	----
beta-BHC	EPA8270D	0.10	mg/kg		0.009	----	<0.10	<0.10	<0.10	<0.10	----
gamma-BHC	EPA8270D	0.10	mg/kg		0.00005	----	<0.10	<0.10	<0.10	<0.10	----
Chlordane	EPA8270D	0.10	mg/kg		0.00003	4	<0.10	<0.10	<0.10	<0.10	----
Endosulfan	EPA8270D	0.10	mg/kg		0.00001	4	<0.10	<0.10	<0.10	<0.10	----
Heptachlor	EPA8270D	0.10	mg/kg		0.0007	4	<0.10	<0.10	<0.10	<0.10	----
Heptachlor epoxide	EPA8270D	0.10	mg/kg		0.0000002	4	<0.10	<0.10	<0.10	<0.10	----
Carbaryl	EPA8270D	0.10	mg/kg		0.00003	5	<0.10	<0.10	<0.10	<0.10	----
Carbofuran	EPA8270D	0.01	mg/kg		0.00002	2	<0.01	<0.01	<0.01	<0.01	----
Maneb	EPA8270D	0.50	mg/kg		0.002	35	<0.50	<0.50	<0.50	<0.50	----
Atrazine	EPA8270D	0.10	mg/kg		0.0002	6	<0.10	<0.10	<0.10	<0.10	----
Other Pollutants											
Cyclohexanone	EPA5035/EPA8260C	0.10	mg/kg		0.1	45	<0.10	<0.10	<0.10	<0.10	----
Phthalates (Sum)	EPA8270D	0.20	mg/kg		0.1	60	<0.20	<0.20	<0.20	<0.20	----
Mineral oils	EPA8015B	50	mg/kg		50	5000	<50	<50	<50	<50	----
Pyridine	EPA5035/EPA8260C	0.10	mg/kg		0.1	0.5	<0.10	<0.10	<0.10	<0.10	----
Bromoform	EPA5035/EPA8260C	0.10	mg/kg		----	75	<0.10	<0.10	<0.10	<0.10	----
Tetrahydrofuran	EPA8270D	0.10	mg/kg		0.1	2	<0.10	<0.10	<0.10	<0.10	----
Tetrahydrothiophene	EPA8270D	0.10	mg/kg		0.1	90	<0.10	<0.10	<0.10	<0.10	----
Conventional											
Organic Matter	BS1377	0.1	% DW		----	----	<0.1	**0.5**	**1.3**	**0.7**	----
Moisture Content (dried @ 103°C)	BS1377	0.10	%		----	----	**23.9**	**17.0**	**17.7**	**23.0**	----
Total Petroleum Hydrocarbon											
C6 - C9 Fraction	EPA5035/EPA8015B	5	mg/kg		----	----	<5	<5	<5	<5	----
C10 - C14 Fraction	EPA8015B	5	mg/kg		----	----	<5	<5	<5	<5	----
C15 - C28 Fraction	EPA8015B	10	mg/kg		----	----	<10	**20**	<10	<10	----
C29 - C36 Fraction	EPA8015B	10	mg/kg		----	----	<10	<10	<10	<10	----

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH1-0.5 (Client sample ID) 16-NOV-2015 15:00 (Sampling date/time) SG1521141-001	BH1-2.3 16-NOV-2015 15:00 SG1521141-002	BH1-6.0 16-NOV-2015 15:00 SG1521141-003	BH2-0.5 11-NOV-2015 15:00 SG1521141-004	BH2-2.0 12-NOV-2015 15:00 SG1521141-005
Monocyclic Aromatic Hydrocarbons										
Isopropylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
n-Propylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.3.5-Trimethylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
sec-Butylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.4-Trimethylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
tert-Butylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
p-Isopropyltoluene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
n-Butylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Oxygenated Compounds										
2-Propanone (Acetone)	EPA5035/EPA8260C	5.00	mg/kg	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
Vinyl Acetate	EPA5035/EPA8260C	5.00	mg/kg	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
2-Butanone (MEK)	EPA5035/EPA8260C	5.00	mg/kg	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
4-Methyl-2-pentanone (MIBK)	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
2-Hexanone (MBK)	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Sulfonated Compounds										
Carbon disulfide	EPA5035/EPA8260C	0.50	mg/kg	----	----	<0.50	<0.50	<0.50	<0.50	<0.50
Fumigants										
2.2-Dichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
cis-1.3-Dichloropropylene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-1.3-Dichloropropylene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dibromoethane (EDB)	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Halogenated Aliphatic Compounds										
Dichlorodifluoromethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Chloromethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Bromomethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Chloroethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Trichlorofluoromethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Iodomethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-1.2-Dichloroethene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
cis-1.2-Dichloroethene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.1-Dichloropropylene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dibromomethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.3-Dichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.1.2-Tetrachloroethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-1.4-Dichloro-2-butene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH1-0.5 16-NOV-2015 15:00 SG1521141-001	BH1-2.3 16-NOV-2015 15:00 SG1521141-002	BH1-6.0 16-NOV-2015 15:00 SG1521141-003	BH2-0.5 11-NOV-2015 15:00 SG1521141-004	BH2-2.0 12-NOV-2015 15:00 SG1521141-005
Halogenated Aliphatic Compounds - Continued										
cis-1.4-Dichloro-2-butene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.2.2-Tetrachloroethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.3-Trichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pentachloroethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dibromo-3-chloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Halogenated Aromatic Compounds										
Chlorobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Bromobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Chlorotoluene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Chlorotoluene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.3-Trichlorobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Trihalomethanes										
Bromodichloromethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dibromochloromethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phenolic Compounds										
2-Chlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Methylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Methylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Nitrophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4-Dimethylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.6-Dichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4-Dichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Chloro-3-methylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4.6-Trichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4.5-Trichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
PolyAromatic Hydrocarbons										
2-Methylnaphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Chloronaphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Acenaphthylene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Acenaphthene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Fluorene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pyrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
N-2-Fluorenyl Acetamide	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(b) & Benzo(k)fluoranthene	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
7.12-Dimethylbenz(a)anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

				Client sample ID	Target Value	Intervention Value	BH1-0.5	BH1-2.3	BH1-6.0	BH2-0.5	BH2-2.0
				Sampling date/time			16-NOV-2015 15:00	16-NOV-2015 15:00	16-NOV-2015 15:00	11-NOV-2015 15:00	12-NOV-2015 15:00
Compound	*Method*	*LOR*	*Unit*				**SG1521141-001**	**SG1521141-002**	**SG1521141-003**	**SG1521141-004**	**SG1521141-005**
PolyAromatic Hydrocarbons - Continued											
3-Methylcholanthrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dibenz(a.h)anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phthalate Esters											
Dimethyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Diethyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Di-n-butyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Butyl benzyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
bis(2-ethylhexyl) phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Di-n-octylphthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Nitrosamines											
N-Nitrosomethylethylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodiethylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosopyrrolidine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosomorpholine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodi-n-propylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosopiperidine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodibutylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodiphenyl & Diphenylamine	EPA8270D	0.50	mg/kg	----	----	<0.50	<0.50	<0.50	<0.50	<0.50
Methapyrilene	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Nitroaromatics and Cyclic Ketones											
2-Picoline	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Acetophenone	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Isophorone	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.6-Dinitrotoluene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4-Dinitrotoluene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1-Naphthylamine	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Nitroquinoline-N-oxide	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
5-Nitro-o-toluidine	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Azobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.3.5-Trinitrobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phenacetin	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Aminobiphenyl	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pentachloronitrobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dimethylaminoazobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorobenzilate	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH1-0.5 (Client sample ID) 16-NOV-2015 15:00 (Sampling date/time) SG1521141-001	BH1-2.3 16-NOV-2015 15:00 SG1521141-002	BH1-6.0 16-NOV-2015 15:00 SG1521141-003	BH2-0.5 11-NOV-2015 15:00 SG1521141-004	BH2-2.0 12-NOV-2015 15:00 SG1521141-005
Haloethers										
Bis(2-chloroethyl) ether	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Bis(2-chloroethoxy) methane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Chlorophenyl phenyl ether	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Bromophenyl phenyl ether	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorinated Hydrocarbon										
1.3-Dichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.4-Dichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachloroethane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.4-Trichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachloropropylene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachlorobutadiene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachlorocyclopentadiene	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Pentachlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachlorobenzene (HCB)	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Anilines and Benzidines										
Aniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
4-Chloroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
2-Nitroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
3-Nitroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Dibenzofuran	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
4-Nitroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Carbazole	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
3.3`-Dichlorobenzidine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Polychlorinated Biphenyls										
Aroclor 1232	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Aroclor 1242	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Aroclor 1248	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Aroclor 1254	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Organochlorine Pesticides										
delta-BHC	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-Chlordane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
cis-Chlordane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
alpha-Endosulfan	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4.4`-DDE	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
beta-Endosulfan	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	*Method*	*LOR*	*Unit*	*Client sample ID* / *Sampling date/time*	Target Value	Intervention Value	**BH1-0.5** 16-NOV-2015 15:00	**BH1-2.3** 16-NOV-2015 15:00	**BH1-6.0** 16-NOV-2015 15:00	**BH2-0.5** 11-NOV-2015 15:00	**BH2-2.0** 12-NOV-2015 15:00
							SG1521141-001	**SG1521141-002**	**SG1521141-003**	**SG1521141-004**	**SG1521141-005**
Organochlorine Pesticides - Continued											
4.4`-DDD	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Endosulfan sulfate	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4.4`-DDT	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Endrin ketone	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Organophosphorus Pesticides											
Malathion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dichlorvos	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dimethoate	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Diazinon	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorpyrifos-methyl	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Ethion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Fenthion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorpyrifos	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pirimphos-ethyl	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Prothiofos	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Parathion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Methyl Parathion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorfenvinphos (E)	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorfenvinphos (Z)	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
VOC Surrogates											
1.2-Dichloroethane-D4	EPA5035/EPA8260C	0.1	%		----	----	**90.0**	**88.1**	**89.0**	**89.7**	**88.6**
Toluene-D8	EPA5035/EPA8260C	0.1	%		----	----	**89.6**	**88.2**	**90.5**	**88.8**	**91.4**
4-Bromofluorobenzene	EPA5035/EPA8260C	0.1	%		----	----	**100**	**101**	**92.4**	**92.7**	**98.5**
Acid Extractable Surrogates											
2-Fluorophenol	EPA8270D	0.1	%		----	----	**51.1**	**52.3**	**55.6**	**46.1**	**52.7**
Phenol-d5	EPA8270D	0.1	%		----	----	**59.4**	**59.8**	**56.1**	**49.9**	**50.8**
2.4.6-Tribromophenol	EPA8270D	0.1	%		----	----	**65.3**	**70.7**	**79.7**	**54.7**	**72.4**
Base/Neutral Extractable Surrogates											
Nitrobenzene-D5	EPA8270D	0.1	%		----	----	**61.3**	**50.8**	**62.2**	**44.4**	**52.4**
2-Fluorobiphenyl	EPA8270D	0.1	%		----	----	**54.2**	**45.2**	**54.4**	**43.6**	**50.0**
4-Terphenyl-d14	EPA8270D	0.1	%		----	----	**58.8**	**78.2**	**62.4**	**59.0**	**60.9**

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH2-4.4 (Client sample ID) 12-NOV-2015 15:00 (Sampling date/time) SG1521141-006	BH3-0.5 13-NOV-2015 15:00 SG1521141-007	BH3-0.8 13-NOV-2015 15:00 SG1521141-008	BH3-5.0 13-NOV-2015 15:00 SG1521141-009	BH4-0.3 23-NOV-2015 SG1521141-010
Monocyclic Aromatic Hydrocarbons										
Isopropylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
n-Propylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.3.5-Trimethylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
sec-Butylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.4-Trimethylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
tert-Butylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
p-Isopropyltoluene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
n-Butylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Oxygenated Compounds										
2-Propanone (Acetone)	EPA5035/EPA8260C	5.00	mg/kg	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
Vinyl Acetate	EPA5035/EPA8260C	5.00	mg/kg	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
2-Butanone (MEK)	EPA5035/EPA8260C	5.00	mg/kg	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
4-Methyl-2-pentanone (MIBK)	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
2-Hexanone (MBK)	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Sulfonated Compounds										
Carbon disulfide	EPA5035/EPA8260C	0.50	mg/kg	----	----	<0.50	<0.50	<0.50	<0.50	<0.50
Fumigants										
2.2-Dichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
cis-1.3-Dichloropropylene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-1.3-Dichloropropylene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dibromoethane (EDB)	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Halogenated Aliphatic Compounds										
Dichlorodifluoromethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Chloromethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Bromomethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Chloroethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Trichlorofluoromethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Iodomethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-1.2-Dichloroethene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
cis-1.2-Dichloroethene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.1-Dichloropropylene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dibromomethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.3-Dichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.1.2-Tetrachloroethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-1.4-Dichloro-2-butene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH2-4.4 12-NOV-2015 15:00 SG1521141-006	BH3-0.5 13-NOV-2015 15:00 SG1521141-007	BH3-0.8 13-NOV-2015 15:00 SG1521141-008	BH3-5.0 13-NOV-2015 15:00 SG1521141-009	BH4-0.3 23-NOV-2015 SG1521141-010
Halogenated Aliphatic Compounds - Continued										
cis-1.4-Dichloro-2-butene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.2.2-Tetrachloroethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.3-Trichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pentachloroethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dibromo-3-chloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Halogenated Aromatic Compounds										
Chlorobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Bromobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Chlorotoluene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Chlorotoluene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.3-Trichlorobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Trihalomethanes										
Bromodichloromethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dibromochloromethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phenolic Compounds										
2-Chlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Methylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Methylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Nitrophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4-Dimethylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.6-Dichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4-Dichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Chloro-3-methylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4.6-Trichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4.5-Trichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
PolyAromatic Hydrocarbons										
2-Methylnaphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Chloronaphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Acenaphthylene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Acenaphthene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Fluorene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pyrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
N-2-Fluorenyl Acetamide	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(b) & Benzo(k)fluoranthene	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
7.12-Dimethylbenz(a)anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH2-4.4	BH3-0.5	BH3-0.8	BH3-5.0	BH4-0.3
Client sample ID										
Sampling date/time						12-NOV-2015 15:00	13-NOV-2015 15:00	13-NOV-2015 15:00	13-NOV-2015 15:00	23-NOV-2015
						SG1521141-006	SG1521141-007	SG1521141-008	SG1521141-009	SG1521141-010
PolyAromatic Hydrocarbons - Continued										
3-Methylcholanthrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dibenz(a.h)anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phthalate Esters										
Dimethyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Diethyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Di-n-butyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Butyl benzyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
bis(2-ethylhexyl) phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Di-n-octylphthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Nitrosamines										
N-Nitrosomethylethylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodiethylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosopyrrolidine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosomorpholine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodi-n-propylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosopiperidine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodibutylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodiphenyl & Diphenylamine	EPA8270D	0.50	mg/kg	----	----	<0.50	<0.50	<0.50	<0.50	<0.50
Methapyrilene	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Nitroaromatics and Cyclic Ketones										
2-Picoline	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Acetophenone	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Isophorone	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.6-Dinitrotoluene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4-Dinitrotoluene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1-Naphthylamine	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Nitroquinoline-N-oxide	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
5-Nitro-o-toluidine	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Azobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.3.5-Trinitrobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phenacetin	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Aminobiphenyl	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pentachloronitrobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dimethylaminoazobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorobenzilate	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH2-4.4	BH3-0.5	BH3-0.8	BH3-5.0	BH4-0.3
Client sample ID										
Sampling date/time						12-NOV-2015 15:00	13-NOV-2015 15:00	13-NOV-2015 15:00	13-NOV-2015 15:00	23-NOV-2015
						SG1521141-006	SG1521141-007	SG1521141-008	SG1521141-009	SG1521141-010
Haloethers										
Bis(2-chloroethyl) ether	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Bis(2-chloroethoxy) methane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Chlorophenyl phenyl ether	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Bromophenyl phenyl ether	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorinated Hydrocarbon										
1.3-Dichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.4-Dichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachloroethane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.4-Trichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachloropropylene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachlorobutadiene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachlorocyclopentadiene	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Pentachlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachlorobenzene (HCB)	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Anilines and Benzidines										
Aniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
4-Chloroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
2-Nitroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
3-Nitroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Dibenzofuran	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
4-Nitroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Carbazole	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
3.3`-Dichlorobenzidine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Polychlorinated Biphenyls										
Aroclor 1232	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Aroclor 1242	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Aroclor 1248	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Aroclor 1254	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Organochlorine Pesticides										
delta-BHC	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-Chlordane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
cis-Chlordane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
alpha-Endosulfan	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4.4`-DDE	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
beta-Endosulfan	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	*Method*	*LOR*	*Unit*	*Client sample ID* / *Sampling date/time*	Target Value	Intervention Value	**BH2-4.4** 12-NOV-2015 15:00	**BH3-0.5** 13-NOV-2015 15:00	**BH3-0.8** 13-NOV-2015 15:00	**BH3-5.0** 13-NOV-2015 15:00	**BH4-0.3** 23-NOV-2015
							SG1521141-006	**SG1521141-007**	**SG1521141-008**	**SG1521141-009**	**SG1521141-010**
Organochlorine Pesticides - Continued											
4.4`-DDD	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Endosulfan sulfate	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4.4`-DDT	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Endrin ketone	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Organophosphorus Pesticides											
Malathion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dichlorvos	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dimethoate	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Diazinon	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorpyrifos-methyl	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Ethion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Fenthion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorpyrifos	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pirimphos-ethyl	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Prothiofos	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Parathion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Methyl Parathion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorfenvinphos (E)	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorfenvinphos (Z)	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
VOC Surrogates											
1.2-Dichloroethane-D4	EPA5035/EPA8260C	0.1	%		----	----	**88.5**	**89.9**	**90.6**	**90.1**	**89.1**
Toluene-D8	EPA5035/EPA8260C	0.1	%		----	----	**88.7**	**90.6**	**89.8**	**88.2**	**88.6**
4-Bromofluorobenzene	EPA5035/EPA8260C	0.1	%		----	----	**98.6**	**98.6**	**100**	**99.1**	**100**
Acid Extractable Surrogates											
2-Fluorophenol	EPA8270D	0.1	%		----	----	**57.0**	**42.1**	**44.1**	**71.4**	**65.2**
Phenol-d5	EPA8270D	0.1	%		----	----	**57.9**	**50.3**	**60.9**	**102**	**83.3**
2.4.6-Tribromophenol	EPA8270D	0.1	%		----	----	**73.8**	**71.2**	**76.5**	**91.2**	**71.2**
Base/Neutral Extractable Surrogates											
Nitrobenzene-D5	EPA8270D	0.1	%		----	----	**60.7**	**83.4**	**78.8**	**105**	**61.9**
2-Fluorobiphenyl	EPA8270D	0.1	%		----	----	**50.3**	**48.1**	**52.8**	**51.5**	**70.3**
4-Terphenyl-d14	EPA8270D	0.1	%		----	----	**65.1**	**61.8**	**68.0**	**63.7**	**73.2**

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH4-1.0 (Client sample ID) / 23-NOV-2015 (Sampling date/time) / SG1521141-011	BH4-3.0 / 23-NOV-2015 / SG1521141-012	BH5-0.3 / 19-NOV-2015 15:00 / SG1521141-013	BH5-4.0 / 19-NOV-2015 15:00 / SG1521141-014	BH5-5.0 / 19-NOV-2015 15:00 / SG1521141-015
Monocyclic Aromatic Hydrocarbons										
Isopropylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
n-Propylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.3.5-Trimethylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
sec-Butylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.4-Trimethylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
tert-Butylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
p-Isopropyltoluene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
n-Butylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Oxygenated Compounds										
2-Propanone (Acetone)	EPA5035/EPA8260C	5.00	mg/kg	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
Vinyl Acetate	EPA5035/EPA8260C	5.00	mg/kg	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
2-Butanone (MEK)	EPA5035/EPA8260C	5.00	mg/kg	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
4-Methyl-2-pentanone (MIBK)	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
2-Hexanone (MBK)	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Sulfonated Compounds										
Carbon disulfide	EPA5035/EPA8260C	0.50	mg/kg	----	----	<0.50	<0.50	<0.50	<0.50	<0.50
Fumigants										
2.2-Dichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
cis-1.3-Dichloropropylene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-1.3-Dichloropropylene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dibromoethane (EDB)	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Halogenated Aliphatic Compounds										
Dichlorodifluoromethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Chloromethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Bromomethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Chloroethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Trichlorofluoromethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Iodomethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-1.2-Dichloroethene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
cis-1.2-Dichloroethene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.1-Dichloropropylene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dibromomethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.3-Dichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.1.2-Tetrachloroethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-1.4-Dichloro-2-butene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH4-1.0 (Client sample ID) / 23-NOV-2015 (Sampling date/time) / SG1521141-011	BH4-3.0 / 23-NOV-2015 / SG1521141-012	BH5-0.3 / 19-NOV-2015 15:00 / SG1521141-013	BH5-4.0 / 19-NOV-2015 15:00 / SG1521141-014	BH5-5.0 / 19-NOV-2015 15:00 / SG1521141-015
Halogenated Aliphatic Compounds - Continued										
cis-1.4-Dichloro-2-butene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.2.2-Tetrachloroethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.3-Trichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pentachloroethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dibromo-3-chloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Halogenated Aromatic Compounds										
Chlorobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Bromobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Chlorotoluene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Chlorotoluene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.3-Trichlorobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Trihalomethanes										
Bromodichloromethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dibromochloromethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phenolic Compounds										
2-Chlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Methylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Methylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Nitrophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4-Dimethylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.6-Dichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4-Dichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Chloro-3-methylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4.6-Trichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4.5-Trichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
PolyAromatic Hydrocarbons										
2-Methylnaphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Chloronaphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Acenaphthylene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Acenaphthene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Fluorene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pyrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
N-2-Fluorenyl Acetamide	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(b) & Benzo(k)fluoranthene	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
7.12-Dimethylbenz(a)anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

				Client sample ID	Target Value	Intervention Value	**BH4-1.0**	**BH4-3.0**	**BH5-0.3**	**BH5-4.0**	**BH5-5.0**
				Sampling date/time			23-NOV-2015	23-NOV-2015	19-NOV-2015 15:00	19-NOV-2015 15:00	19-NOV-2015 15:00
Compound	*Method*	*LOR*	*Unit*				**SG1521141-011**	**SG1521141-012**	**SG1521141-013**	**SG1521141-014**	**SG1521141-015**
PolyAromatic Hydrocarbons - Continued											
3-Methylcholanthrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dibenz(a.h)anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phthalate Esters											
Dimethyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Diethyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Di-n-butyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Butyl benzyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
bis(2-ethylhexyl) phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Di-n-octylphthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Nitrosamines											
N-Nitrosomethylethylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodiethylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosopyrrolidine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosomorpholine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodi-n-propylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosopiperidine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodibutylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodiphenyl & Diphenylamine	EPA8270D	0.50	mg/kg	----	----	<0.50	<0.50	<0.50	<0.50	<0.50
Methapyrilene	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Nitroaromatics and Cyclic Ketones											
2-Picoline	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Acetophenone	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Isophorone	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.6-Dinitrotoluene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4-Dinitrotoluene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1-Naphthylamine	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Nitroquinoline-N-oxide	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
5-Nitro-o-toluidine	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Azobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.3.5-Trinitrobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phenacetin	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Aminobiphenyl	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pentachloronitrobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dimethylaminoazobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorobenzilate	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH4-1.0 (Client sample ID) 23-NOV-2015 (Sampling date/time) SG1521141-011	BH4-3.0 23-NOV-2015 SG1521141-012	BH5-0.3 19-NOV-2015 15:00 SG1521141-013	BH5-4.0 19-NOV-2015 15:00 SG1521141-014	BH5-5.0 19-NOV-2015 15:00 SG1521141-015
Haloethers										
Bis(2-chloroethyl) ether	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Bis(2-chloroethoxy) methane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Chlorophenyl phenyl ether	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Bromophenyl phenyl ether	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorinated Hydrocarbon										
1.3-Dichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.4-Dichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachloroethane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.4-Trichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachloropropylene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachlorobutadiene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachlorocyclopentadiene	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Pentachlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachlorobenzene (HCB)	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Anilines and Benzidines										
Aniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
4-Chloroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
2-Nitroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
3-Nitroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Dibenzofuran	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
4-Nitroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Carbazole	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
3.3`-Dichlorobenzidine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Polychlorinated Biphenyls										
Aroclor 1232	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Aroclor 1242	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Aroclor 1248	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Aroclor 1254	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Organochlorine Pesticides										
delta-BHC	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-Chlordane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
cis-Chlordane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
alpha-Endosulfan	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4.4`-DDE	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
beta-Endosulfan	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	*Method*	*LOR*	*Unit*	*Client sample ID* / *Sampling date/time*	Target Value	Intervention Value	**BH4-1.0** 23-NOV-2015	**BH4-3.0** 23-NOV-2015	**BH5-0.3** 19-NOV-2015 15:00	**BH5-4.0** 19-NOV-2015 15:00	**BH5-5.0** 19-NOV-2015 15:00
							SG1521141-011	**SG1521141-012**	**SG1521141-013**	**SG1521141-014**	**SG1521141-015**
Organochlorine Pesticides - Continued											
4.4`-DDD	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Endosulfan sulfate	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4.4`-DDT	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Endrin ketone	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Organophosphorus Pesticides											
Malathion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dichlorvos	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dimethoate	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Diazinon	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorpyrifos-methyl	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Ethion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Fenthion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorpyrifos	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pirimphos-ethyl	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Prothiofos	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Parathion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Methyl Parathion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorfenvinphos (E)	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorfenvinphos (Z)	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
VOC Surrogates											
1.2-Dichloroethane-D4	EPA5035/EPA8260C	0.1	%		----	----	**89.4**	**92.4**	**91.3**	**90.7**	**90.4**
Toluene-D8	EPA5035/EPA8260C	0.1	%		----	----	**90.4**	**90.4**	**89.1**	**91.7**	**89.2**
4-Bromofluorobenzene	EPA5035/EPA8260C	0.1	%		----	----	**94.5**	**99.4**	**101**	**99.3**	**96.8**
Acid Extractable Surrogates											
2-Fluorophenol	EPA8270D	0.1	%		----	----	**49.4**	**46.3**	**50.9**	**44.3**	**42.6**
Phenol-d5	EPA8270D	0.1	%		----	----	**89.6**	**61.1**	**71.3**	**59.0**	**46.4**
2.4.6-Tribromophenol	EPA8270D	0.1	%		----	----	**76.7**	**69.2**	**88.3**	**98.4**	**66.0**
Base/Neutral Extractable Surrogates											
Nitrobenzene-D5	EPA8270D	0.1	%		----	----	**47.2**	**41.8**	**41.5**	**67.8**	**73.7**
2-Fluorobiphenyl	EPA8270D	0.1	%		----	----	**59.7**	**45.4**	**65.2**	**41.1**	**41.7**
4-Terphenyl-d14	EPA8270D	0.1	%		----	----	**74.2**	**55.5**	**80.0**	**90.8**	**61.0**

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

				Client sample ID	Target Value	Intervention Value	BH6-0.5	BH6-3.0	BH6-6.0	BH7-0.3	BH7-1.0
				Sampling date/time			17-NOV-2015 15:00	17-NOV-2015 15:00	17-NOV-2015 15:00	18-NOV-2015 15:00	18-NOV-2015 15:00
Compound	*Method*	*LOR*	*Unit*				**SG1521141-016**	**SG1521141-017**	**SG1521141-018**	**SG1521141-019**	**SG1521141-020**
Monocyclic Aromatic Hydrocarbons											
Isopropylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
n-Propylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.3.5-Trimethylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
sec-Butylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.4-Trimethylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
tert-Butylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
p-Isopropyltoluene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
n-Butylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Oxygenated Compounds											
2-Propanone (Acetone)	EPA5035/EPA8260C	5.00	mg/kg	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
Vinyl Acetate	EPA5035/EPA8260C	5.00	mg/kg	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
2-Butanone (MEK)	EPA5035/EPA8260C	5.00	mg/kg	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
4-Methyl-2-pentanone (MIBK)	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
2-Hexanone (MBK)	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Sulfonated Compounds											
Carbon disulfide	EPA5035/EPA8260C	0.50	mg/kg	----	----	<0.50	<0.50	<0.50	<0.50	<0.50
Fumigants											
2.2-Dichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
cis-1.3-Dichloropropylene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-1.3-Dichloropropylene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dibromoethane (EDB)	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Halogenated Aliphatic Compounds											
Dichlorodifluoromethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Chloromethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Bromomethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Chloroethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Trichlorofluoromethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Iodomethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-1.2-Dichloroethene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
cis-1.2-Dichloroethene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.1-Dichloropropylene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dibromomethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.3-Dichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.1.2-Tetrachloroethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-1.4-Dichloro-2-butene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH6-0.5 (Client sample ID) 17-NOV-2015 15:00 (Sampling date/time) SG1521141-016	BH6-3.0 17-NOV-2015 15:00 SG1521141-017	BH6-6.0 17-NOV-2015 15:00 SG1521141-018	BH7-0.3 18-NOV-2015 15:00 SG1521141-019	BH7-1.0 18-NOV-2015 15:00 SG1521141-020
Halogenated Aliphatic Compounds - Continued										
cis-1.4-Dichloro-2-butene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.1.2.2-Tetrachloroethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.3-Trichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pentachloroethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dibromo-3-chloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Halogenated Aromatic Compounds										
Chlorobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Bromobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Chlorotoluene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Chlorotoluene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.3-Trichlorobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Trihalomethanes										
Bromodichloromethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dibromochloromethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phenolic Compounds										
2-Chlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Methylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Methylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Nitrophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4-Dimethylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.6-Dichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4-Dichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Chloro-3-methylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4.6-Trichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4.5-Trichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
PolyAromatic Hydrocarbons										
2-Methylnaphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2-Chloronaphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Acenaphthylene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Acenaphthene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Fluorene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pyrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
N-2-Fluorenyl Acetamide	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(b) & Benzo(k)fluoranthene	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
7.12-Dimethylbenz(a)anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

				Client sample ID	Target Value	Intervention Value	BH6-0.5	BH6-3.0	BH6-6.0	BH7-0.3	BH7-1.0
				Sampling date/time			17-NOV-2015 15:00	17-NOV-2015 15:00	17-NOV-2015 15:00	18-NOV-2015 15:00	18-NOV-2015 15:00
Compound	*Method*	*LOR*	*Unit*				**SG1521141-016**	**SG1521141-017**	**SG1521141-018**	**SG1521141-019**	**SG1521141-020**
PolyAromatic Hydrocarbons - Continued											
3-Methylcholanthrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dibenz(a.h)anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phthalate Esters											
Dimethyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Diethyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Di-n-butyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Butyl benzyl phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
bis(2-ethylhexyl) phthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Di-n-octylphthalate	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Nitrosamines											
N-Nitrosomethylethylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodiethylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosopyrrolidine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosomorpholine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodi-n-propylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosopiperidine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodibutylamine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
N-Nitrosodiphenyl & Diphenylamine	EPA8270D	0.50	mg/kg	----	----	<0.50	<0.50	<0.50	<0.50	<0.50
Methapyrilene	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Nitroaromatics and Cyclic Ketones											
2-Picoline	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Acetophenone	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Isophorone	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.6-Dinitrotoluene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
2.4-Dinitrotoluene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1-Naphthylamine	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Nitroquinoline-N-oxide	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
5-Nitro-o-toluidine	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Azobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.3.5-Trinitrobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phenacetin	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Aminobiphenyl	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pentachloronitrobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dimethylaminoazobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorobenzilate	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH6-0.5 (Client sample ID) 17-NOV-2015 15:00 (Sampling date/time) SG1521141-016	BH6-3.0 17-NOV-2015 15:00 SG1521141-017	BH6-6.0 17-NOV-2015 15:00 SG1521141-018	BH7-0.3 18-NOV-2015 15:00 SG1521141-019	BH7-1.0 18-NOV-2015 15:00 SG1521141-020
Haloethers										
Bis(2-chloroethyl) ether	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Bis(2-chloroethoxy) methane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Chlorophenyl phenyl ether	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4-Bromophenyl phenyl ether	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorinated Hydrocarbon										
1.3-Dichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.4-Dichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2-Dichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachloroethane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
1.2.4-Trichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachloropropylene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachlorobutadiene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachlorocyclopentadiene	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Pentachlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Hexachlorobenzene (HCB)	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Anilines and Benzidines										
Aniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
4-Chloroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
2-Nitroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
3-Nitroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Dibenzofuran	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
4-Nitroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Carbazole	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
3.3`-Dichlorobenzidine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Polychlorinated Biphenyls										
Aroclor 1232	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Aroclor 1242	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Aroclor 1248	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Aroclor 1254	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
Organochlorine Pesticides										
delta-BHC	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
trans-Chlordane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
cis-Chlordane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
alpha-Endosulfan	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4.4`-DDE	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
beta-Endosulfan	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	<0.10

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	*Method*	*LOR*	*Unit*	*Client sample ID* / *Sampling date/time*	Target Value	Intervention Value	**BH6-0.5** 17-NOV-2015 15:00	**BH6-3.0** 17-NOV-2015 15:00	**BH6-6.0** 17-NOV-2015 15:00	**BH7-0.3** 18-NOV-2015 15:00	**BH7-1.0** 18-NOV-2015 15:00
							SG1521141-016	**SG1521141-017**	**SG1521141-018**	**SG1521141-019**	**SG1521141-020**
Organochlorine Pesticides - Continued											
4.4`-DDD	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Endosulfan sulfate	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
4.4`-DDT	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Endrin ketone	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Organophosphorus Pesticides											
Malathion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dichlorvos	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Dimethoate	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Diazinon	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorpyrifos-methyl	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Ethion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Fenthion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorpyrifos	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Pirimphos-ethyl	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Prothiofos	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Parathion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Methyl Parathion	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorfenvinphos (E)	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorfenvinphos (Z)	EPA8270D	0.10	mg/kg		----	----	<0.10	<0.10	<0.10	<0.10	<0.10
VOC Surrogates											
1.2-Dichloroethane-D4	EPA5035/EPA8260C	0.1	%		----	----	**92.2**	**91.1**	**91.3**	**91.4**	**89.8**
Toluene-D8	EPA5035/EPA8260C	0.1	%		----	----	**100**	**89.8**	**91.6**	**90.4**	**91.2**
4-Bromofluorobenzene	EPA5035/EPA8260C	0.1	%		----	----	**99.1**	**100**	**99.8**	**98.4**	**99.3**
Acid Extractable Surrogates											
2-Fluorophenol	EPA8270D	0.1	%		----	----	**47.4**	**53.9**	**59.7**	**54.6**	**38.4**
Phenol-d5	EPA8270D	0.1	%		----	----	**48.1**	**69.8**	**75.4**	**62.7**	**47.4**
2.4.6-Tribromophenol	EPA8270D	0.1	%		----	----	**50.6**	**72.0**	**73.9**	**62.0**	**48.9**
Base/Neutral Extractable Surrogates											
Nitrobenzene-D5	EPA8270D	0.1	%		----	----	**73.1**	**80.9**	**53.8**	**46.0**	**64.6**
2-Fluorobiphenyl	EPA8270D	0.1	%		----	----	**38.8**	**53.6**	**56.7**	**48.7**	**32.7**
4-Terphenyl-d14	EPA8270D	0.1	%		----	----	**49.0**	**66.3**	**76.5**	**62.1**	**50.2**

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

				Client sample ID	Target Value	Intervention Value	BH7-6.0	BH8-0.3	BH8-1.0	BH8-4.0	----
				Sampling date/time			18-NOV-2015 15:00	20-NOV-2015 15:00	20-NOV-2015 15:00	20-NOV-2015 15:00	----
Compound	*Method*	*LOR*	*Unit*				**SG1521141-021**	**SG1521141-022**	**SG1521141-023**	**SG1521141-024**	**----**
Monocyclic Aromatic Hydrocarbons											
Isopropylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
n-Propylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
1.3.5-Trimethylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
sec-Butylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
1.2.4-Trimethylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
tert-Butylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
p-Isopropyltoluene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
n-Butylbenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Oxygenated Compounds											
2-Propanone (Acetone)	EPA5035/EPA8260C	5.00	mg/kg	----	----	<5.00	<5.00	<5.00	<5.00	----
Vinyl Acetate	EPA5035/EPA8260C	5.00	mg/kg	----	----	<5.00	<5.00	<5.00	<5.00	----
2-Butanone (MEK)	EPA5035/EPA8260C	5.00	mg/kg	----	----	<5.00	<5.00	<5.00	<5.00	----
4-Methyl-2-pentanone (MIBK)	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	----
2-Hexanone (MBK)	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	----
Sulfonated Compounds											
Carbon disulfide	EPA5035/EPA8260C	0.50	mg/kg	----	----	<0.50	<0.50	<0.50	<0.50	----
Fumigants											
2.2-Dichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
1.2-Dichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
cis-1.3-Dichloropropylene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
trans-1.3-Dichloropropylene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
1.2-Dibromoethane (EDB)	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Halogenated Aliphatic Compounds											
Dichlorodifluoromethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	----
Chloromethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	----
Bromomethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	----
Chloroethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	----
Trichlorofluoromethane	EPA5035/EPA8260C	2.00	mg/kg	----	----	<2.00	<2.00	<2.00	<2.00	----
Iodomethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
trans-1.2-Dichloroethene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
cis-1.2-Dichloroethene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
1.1-Dichloropropylene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Dibromomethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
1.3-Dichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
1.1.1.2-Tetrachloroethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
trans-1.4-Dichloro-2-butene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

Compound	Method	LOR	Unit	Target Value	Intervention Value	BH7-6.0 18-NOV-2015 15:00 SG1521141-021	BH8-0.3 20-NOV-2015 15:00 SG1521141-022	BH8-1.0 20-NOV-2015 15:00 SG1521141-023	BH8-4.0 20-NOV-2015 15:00 SG1521141-024	---- ---- ----
Halogenated Aliphatic Compounds - Continued										
cis-1.4-Dichloro-2-butene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
1.1.2.2-Tetrachloroethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
1.2.3-Trichloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Pentachloroethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
1.2-Dibromo-3-chloropropane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Halogenated Aromatic Compounds										
Chlorobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Bromobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
2-Chlorotoluene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
4-Chlorotoluene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
1.2.3-Trichlorobenzene	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Trihalomethanes										
Bromodichloromethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Dibromochloromethane	EPA5035/EPA8260C	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Phenolic Compounds										
2-Chlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
2-Methylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
4-Methylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
2-Nitrophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
2.4-Dimethylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
2.6-Dichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
2.4-Dichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
4-Chloro-3-methylphenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
2.4.6-Trichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
2.4.5-Trichlorophenol	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
PolyAromatic Hydrocarbons										
2-Methylnaphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
2-Chloronaphthalene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Acenaphthylene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Acenaphthene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Fluorene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Pyrene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
N-2-Fluorenyl Acetamide	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Benzo(b) & Benzo(k)fluoranthene	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----
7.12-Dimethylbenz(a)anthracene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

				Client sample ID	Target Value	Intervention Value	BH7-6.0	BH8-0.3	BH8-1.0	BH8-4.0	----
				Sampling date/time			18-NOV-2015 15:00	20-NOV-2015 15:00	20-NOV-2015 15:00	20-NOV-2015 15:00	----
Compound	*Method*	*LOR*	*Unit*				**SG1521141-021**	**SG1521141-022**	**SG1521141-023**	**SG1521141-024**	**----**
PolyAromatic Hydrocarbons - Continued											
3-Methylcholanthrene	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
Dibenz(a.h)anthracene	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
Phthalate Esters											
Dimethyl phthalate	EPA8270D	0.20	mg/kg	----	----		<0.20	<0.20	<0.20	<0.20	----
Diethyl phthalate	EPA8270D	0.20	mg/kg	----	----		<0.20	<0.20	<0.20	<0.20	----
Di-n-butyl phthalate	EPA8270D	0.20	mg/kg	----	----		<0.20	<0.20	<0.20	<0.20	----
Butyl benzyl phthalate	EPA8270D	0.20	mg/kg	----	----		<0.20	<0.20	<0.20	<0.20	----
bis(2-ethylhexyl) phthalate	EPA8270D	0.20	mg/kg	----	----		<0.20	<0.20	<0.20	<0.20	----
Di-n-octylphthalate	EPA8270D	0.20	mg/kg	----	----		<0.20	<0.20	<0.20	<0.20	----
Nitrosamines											
N-Nitrosomethylethylamine	EPA8270D	0.20	mg/kg	----	----		<0.20	<0.20	<0.20	<0.20	----
N-Nitrosodiethylamine	EPA8270D	0.20	mg/kg	----	----		<0.20	<0.20	<0.20	<0.20	----
N-Nitrosopyrrolidine	EPA8270D	0.20	mg/kg	----	----		<0.20	<0.20	<0.20	<0.20	----
N-Nitrosomorpholine	EPA8270D	0.20	mg/kg	----	----		<0.20	<0.20	<0.20	<0.20	----
N-Nitrosodi-n-propylamine	EPA8270D	0.20	mg/kg	----	----		<0.20	<0.20	<0.20	<0.20	----
N-Nitrosopiperidine	EPA8270D	0.20	mg/kg	----	----		<0.20	<0.20	<0.20	<0.20	----
N-Nitrosodibutylamine	EPA8270D	0.20	mg/kg	----	----		<0.20	<0.20	<0.20	<0.20	----
N-Nitrosodiphenyl & Diphenylamine	EPA8270D	0.50	mg/kg	----	----		<0.50	<0.50	<0.50	<0.50	----
Methapyrilene	EPA8270D	0.20	mg/kg	----	----		<0.20	<0.20	<0.20	<0.20	----
Nitroaromatics and Cyclic Ketones											
2-Picoline	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
Acetophenone	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
Nitrobenzene	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
Isophorone	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
2.6-Dinitrotoluene	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
2.4-Dinitrotoluene	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
1-Naphthylamine	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
4-Nitroquinoline-N-oxide	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
5-Nitro-o-toluidine	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
Azobenzene	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
1.3.5-Trinitrobenzene	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
Phenacetin	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
4-Aminobiphenyl	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
Pentachloronitrobenzene	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
Dimethylaminoazobenzene	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----
Chlorobenzilate	EPA8270D	0.10	mg/kg	----	----		<0.10	<0.10	<0.10	<0.10	----

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

				Client sample ID	Target Value	Intervention Value	BH7-6.0	BH8-0.3	BH8-1.0	BH8-4.0	----
				Sampling date/time			18-NOV-2015 15:00	20-NOV-2015 15:00	20-NOV-2015 15:00	20-NOV-2015 15:00	----
Compound	*Method*	*LOR*	*Unit*				**SG1521141-021**	**SG1521141-022**	**SG1521141-023**	**SG1521141-024**	**----**
Haloethers											
Bis(2-chloroethyl) ether	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
Bis(2-chloroethoxy) methane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
4-Chlorophenyl phenyl ether	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
4-Bromophenyl phenyl ether	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
Chlorinated Hydrocarbon											
1.3-Dichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
1.4-Dichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
1.2-Dichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
Hexachloroethane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
1.2.4-Trichlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
Hexachloropropylene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
Hexachlorobutadiene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
Hexachlorocyclopentadiene	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----	
Pentachlorobenzene	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
Hexachlorobenzene (HCB)	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
Anilines and Benzidines											
Aniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----	
4-Chloroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----	
2-Nitroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----	
3-Nitroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----	
Dibenzofuran	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----	
4-Nitroaniline	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----	
Carbazole	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----	
3.3`-Dichlorobenzidine	EPA8270D	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----	
Polychlorinated Biphenyls											
Aroclor 1232	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----	
Aroclor 1242	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----	
Aroclor 1248	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----	
Aroclor 1254	EPA8082	0.20	mg/kg	----	----	<0.20	<0.20	<0.20	<0.20	----	
Organochlorine Pesticides											
delta-BHC	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
trans-Chlordane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
cis-Chlordane	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
alpha-Endosulfan	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
4.4`-DDE	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	
beta-Endosulfan	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----	

No Guideline Evaluation Required

Sub-Matrix: **SOIL**

				Client sample ID	Target Value	Intervention Value	**BH7-6.0**	**BH8-0.3**	**BH8-1.0**	**BH8-4.0**	----
				Sampling date/time			18-NOV-2015 15:00	20-NOV-2015 15:00	20-NOV-2015 15:00	20-NOV-2015 15:00	----
Compound	*Method*	*LOR*	*Unit*				**SG1521141-021**	**SG1521141-022**	**SG1521141-023**	**SG1521141-024**	**----**
Organochlorine Pesticides - Continued											
4.4`-DDD	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Endosulfan sulfate	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
4.4`-DDT	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Endrin ketone	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Organophosphorus Pesticides											
Malathion	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Dichlorvos	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Dimethoate	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Diazinon	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Chlorpyrifos-methyl	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Ethion	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Fenthion	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Chlorpyrifos	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Pirimphos-ethyl	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Prothiofos	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Parathion	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Methyl Parathion	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Chlorfenvinphos (E)	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
Chlorfenvinphos (Z)	EPA8270D	0.10	mg/kg	----	----	<0.10	<0.10	<0.10	<0.10	----
VOC Surrogates											
1.2-Dichloroethane-D4	EPA5035/EPA8260C	0.1	%	----	----	**91.1**	**91.3**	**89.8**	**90.7**	----
Toluene-D8	EPA5035/EPA8260C	0.1	%	----	----	**92.6**	**89.1**	**88.4**	**89.6**	----
4-Bromofluorobenzene	EPA5035/EPA8260C	0.1	%	----	----	**98.6**	**96.9**	**101**	**101**	----
Acid Extractable Surrogates											
2-Fluorophenol	EPA8270D	0.1	%	----	----	**49.4**	**82.1**	**58.4**	**49.9**	----
Phenol-d5	EPA8270D	0.1	%	----	----	**55.7**	**99.0**	**69.4**	**97.5**	----
2.4.6-Tribromophenol	EPA8270D	0.1	%	----	----	**38.0**	**55.2**	**51.9**	**60.8**	----
Base/Neutral Extractable Surrogates											
Nitrobenzene-D5	EPA8270D	0.1	%	----	----	**36.3**	**95.2**	**72.2**	**58.1**	----
2-Fluorobiphenyl	EPA8270D	0.1	%	----	----	**41.8**	**52.0**	**48.5**	**43.4**	----
4-Terphenyl-d14	EPA8270D	0.1	%	----	----	**49.8**	**64.7**	**58.4**	**66.6**	----

Surrogate Control Limits

Sub-Matrix: **SOIL**

Compound	Method	Acceptance Limits (%) Low	High
VOC Surrogates			
1.2-Dichloroethane-D4	EPA5035/EPA8260C	70	121
Toluene-D8	EPA5035/EPA8260C	84	138
4-Bromofluorobenzene	EPA5035/EPA8260C	59	113
Acid Extractable Surrogates			
2-Fluorophenol	EPA8270D	25	121
Phenol-d5	EPA8270D	24	113
2.4.6-Tribromophenol	EPA8270D	19	122
Base/Neutral Extractable Surrogates			
Nitrobenzene-D5	EPA8270D	23	120
2-Fluorobiphenyl	EPA8270D	30	115
4-Terphenyl-d14	EPA8270D	18	137

ALS TECHNICHEM (S) PTE LTD

OUR REF NO : SG 1521141
COMPANY : Environmental Resources Management

QA/QC REPORT

Remarks : QA/QC Results

a) All analyses were analyzed within their holding times.
b) Method blanks were run in each batch of analysis to check background interference, if any.
c) Surrogate spike recoveries were performed on each sample in the VOCs and SVOCs analysis. The results were summarized as below.
d) A summarized QC report on recoveries of Lab Control Samples(LCS) and Matrix Spike (MS) is attached. Upon review of the QA/QC datas, the recoveries of the laboratory control sample, matrix spikes and surrogate spikes (vocs & svocs) were within ALS laboratory acceptance criteria.

QA/QC Results :

% Surrogate Spike Recoveries

Volatile Organics (VOCs)

Surrogare Compound	Range for all samples
Dichloroethane-d_4	88-96
Toluene-d_8	86-100
4-Bromofluorobenzene	92-102

Semi-Volatile Organics (SVOCs)

Surrogate Compound	Range for all samples
2-Fluorophenol	42-92
Phenol-d_6	50-102
Nitrobenzene-d_5	36-105
2-Fluorobiphenyl	33-70
2,4,6-Tribromophenol	33-98
p-Terphenyl-d_{14}	49-96

ALS TECHNICHEM (S) PTE LTD

OUR REF NO : SG 1521141
COMPANY : Environmental Resources Management

Test	LCS % Recovery	MS, % recovery
TPH as diesel oil	104	88
SVOCs		
Phenol	102	87
2- Chlorophenol	97	90
4-Chloro-3-methyl phenol	82	83
Pentachlorophenol	96	109
Acenaphthene	78	78
Pyrene	79	79
N-nitroso-di-n-propylamine	88	79
2,4-dinitrotolune	77	82
1,4-dichlorobenzene	75	82
1,2,4-trichlorobenzene	82	76
VOCs		
Benzene	96	96
Toluene	97	101
1,1-Dichloroethene	101	97
Trichloroethene	91	96
Chlorobenzene	104	103
Metals		
Arsenic	101	99
Barium	91	90
Cadmium	99	110
Total chromium	103	106
Cobalt	102	101
Copper	101	105
Mercury	102	80
Lead	98	95
Molybdenum	106	110
Nickel	100	101
Zinc	96	94
Antimony	102	107

CHAIN OF CUSTODY DOCUMENTATION

ATS 7461

ALS TECHNICHEM

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CLIENT: ERM(S) Pte Ltd		LABORATORY BATCH NO.	
POSTAL ADDRESS: 120 Raffles Rd #10-01 S(068913)		SAMPLERS: Desmond	
SEND REPORT TO: Desmond	SEND INVOICE TO: Desmond	PHONE: 62795217	FAX:
DATA NEEDED BY: 7/12/15	REPORT NEEDED BY: 7/12/15	REPORT FORMAT: HARD ____	FAX: ____ DISK: email BULLETIN BOARD: ____
PROJECT ID: 0292668	QUOTE NO.: —	QC LEVEL: QCS1 ____	QCS2 ____ QCS3 ____ QCS4 ____
P.O. NO.: —	COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:	ANALYSIS REQUIRED	
FOR LAB USE ONLY	Page 1/2		
COOLER SEAL	TIC EBR Suite		
Yes ..... No	Soil Samples for now, gw to come soon		
Broken ..... Intact	Normal turnaround time: 4 days		
COOLER TEMP: deg.C			

SAMPLE DATA				*CONTAINER DATA			TIC EBR Suite	NOTES
SAMPLE ID	MATRIX	DATE	TIME	TYPE & PRESERVATIVE	NO.	pH		
BH1 - 0.5	Soil	16/11/15	—	—	1	—	✓	
BH1 - 2.3	"	16/11/15	—	—	1	—	✓	
BH1 - 6.0	"	16/11/15	—	—	1	—	✓	
BH2 - 0.5	"	11/11/15	—	—	1	—	✓	
BH2 - 2.0	"	12/11/15	—	—	1	—	✓	
BH2 - 11.5	"	12/11/15	—	—	1	—	✓	
BH3 - 0.5	"	13/11/15	—	—	1	—	✓	
BH3 - 0.8	"	13/11/15	—	—	1	—	✓	
BH3 - 5.0	"	13/11/15	—	—	1	—	✓	
BH4 - 0.3	"	23/11/15	—	—	1	—	✓	
BH4 - 1.0	"	23/11/15	—	—	1	—	✓	
BH4 - 3.0	"	23/11/15	—	—	1	—	✓	
BH5 - 0.3	"	19/11/15	—	—	1	—	✓	
BH5 - 4.0	"	19/11/15	—	—	1	—	✓	
BH5 - 5.0	"	19/11/15	—	—	1	—	✓	

ALS Technichem (S) Pte Ltd

Work Order

SG1521141

Telephone : +65 6589 0118

RELINQUISHED BY	RECEIVED BY	METHOD OF SHIPMENT
NAME: Desmond Leung OF: ERM DATE: 23/11/15 TIME: 16:00	NAME: OF: DATE: TIME:	CONSIGNMENT NOTE NO.
NAME: OF: DATE: TIME:	NAME: OF: DATE: TIME:	TRANSPORT CO. NAME.

*Container Type and Preservative Codes: P = Natural Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinsed Jar; S = Solvent Washed Acid Rinsed Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulphuric Acid Preserved Vial; BS = Sulphuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottle; S = Sterile Bottle. O = Other.

CHAIN OF CUSTODY DOCUMENTATION

ATS 6825

ALS TECHNICHEM

CLIENT: EGM	LABORATORY BATCH NO.:
POSTAL ADDRESS: 120 Robinson Rd #10-01 S(068913)	SAMPLERS: Desmond
SEND REPORT TO: Desmond	SEND INVOICE TO: Desmond
DATA NEEDED BY: 7/12/15	REPORT NEEDED BY: 7/12/15
PROJECT ID: 0292668	QUOTE NO.: —
P.O. NO.:	COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:
FOR LAB USE ONLY	Page 2/2
COOLER SEAL	JTC EGR Jurong
Yes ..... No	Soil samples for now, GW to come soon.
Broken ..... Intact	Normal turnaround time, asap.
COOLER TEMP deg.C	

PHONE: 97795027 FAX:

REPORT FORMAT: HARD ____ FAX: ____ DISK: excel BULLETIN BOARD: ____

QC LEVEL: QCS1 ____ QCS2 ____ QCS3 ____ QCS4 ____

1141

ANALYSIS REQUIRED

SAMPLE DATA				*CONTAINER DATA			JTC EGR Jurong		NOTES
SAMPLE ID	MATRIX	DATE	TIME	TYPE & PRESERVATIVE	NO.	pH			
BH6 - 0.5	Soil	17/11/15	—	—	1	—	✓		
BH6 - 6.0	"	"	—	—	1	—	✓		
BH 6 - 6.0	"	"	—	—	1	—	✓		
BH 4 - 0.3	"	18/11/15	—	—	1	—	✓		
BH 4 - 1.0	"	"	—	—	1	—	✓		
BH 4 - 6.0	"	"	—	—	1	—	✓		
BH8 - 0.3	"	20/11/15	—	—	1	—	✓		
BH8 - 1.0	"	"	—	—	1	—	✓		
BH8 - 6.0	"	"	—	—	1	—	✓		
Void							X	Void	
Void							X	Void	

RELINQUISHED BY

NAME: Desmond Leung
OF: EGM
DATE: 24/11/15
TIME: 16:00

NAME:
OF:
DATE:
TIME:

RECEIVED BY

NAME:
OF:
DATE:
TIME:

NAME:
OF:
DATE:
TIME:

METHOD OF SHIPMENT

CONSIGNMENT NOTE NO.

TRANSPORT CO. NAME.

*Container Type and Preservative Codes: **P** = Natural Plastic; **N** = Nitric Acid Preserved; **C** = Sodium Hydroxide Preserved; **J** = Solvent Washed Acid Rinsed Jar; **S** = Solvent Washed Acid Rinsed Glass Bottle; **VC** = Hydrochloric Acid Preserved Vial; **VS** = Sulphuric Acid Preserved Vial; **BS** = Sulphuric Acid Preserved Glass Bottle; **Z** = Zinc Acetate Preserved Bottle; **E** = EDTA Preserved Bottle; **S** = Sterile Bottle, **O** = Other.

ALS TECHNICHEM

sharon@23/11
check by: SH

ALS TECHNICHEM (S) PTE LTD

OUR REF NO : SG 1521141
COMPANY : Environmental Resources Management

QA/QC REPORT

Remarks : QA/QC Results

a) All analyses were analyzed within their holding times.
b) Method blanks were run in each batch of analysis to check background interference, if any.
c) Surrogate spike recoveries were performed on each sample in the VOCs and SVOCs analysis. The results were summarized as below.
d) A summarized QC report on recoveries of Lab Control Samples(LCS) and Matrix Spike (MS) is attached. Upon review of the QA/QC datas, the recoveries of the laboratory control sample, matrix spikes and surrogate spikes (vocs & svocs) were within ALS laboratory acceptance criteria.

QA/QC Results :

% Surrogate Spike Recoveries

Volatile Organics (VOCs)

Surrogare Compound	Range for all samples
Dichloroethane-d_4	88-96
Toluene-d_8	86-100
4-Bromofluorobenzene	92-102

Semi-Volatile Organics (SVOCs)

Surrogate Compound	Range for all samples
2-Fluorophenol	42-92
Phenol-d_6	50-102
Nitrobenzene-d_5	36-105
2-Fluorobiphenyl	33-70
2,4,6-Tribromophenol	33-98
p-Terphenyl-d_{14}	49-96

ALS TECHNICHEM (S) PTE LTD

OUR REF NO : SG 1521141
COMPANY : Environmental Resources Management

Test	LCS % Recovery	MS, % recovery
TPH as diesel oil	104	88
SVOCs		
Phenol	102	87
2- Chlorophenol	97	90
4-Chloro-3-methyl phenol	82	83
Pentachlorophenol	96	109
Acenaphthene	78	78
Pyrene	79	79
N-nitroso-di-n-propylamine	88	79
2,4-dinitrotolune	77	82
1,4-dichlorobenzene	75	82
1,2,4-trichlorobenzene	82	76
VOCs		
Benzene	96	96
Toluene	97	101
1,1-Dichloroethene	101	97
Trichloroethene	91	96
Chlorobenzene	104	103
Metals		
Arsenic	101	99
Barium	91	90
Cadmium	99	110
Total chromium	103	106
Cobalt	102	101
Copper	101	105
Mercury	102	80
Lead	98	95
Molybdenum	106	110
Nickel	100	101
Zinc	96	94
Antimony	102	107

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **SG1521324**	Page	: 1 of 21
Client	: **ENVIRONMENTAL RESOURCES MANAGEMENT**	Project	: DARWIN
Contact	: Mr Desmond Leung	Order number	: ----
Address	: 120 Robinson Road #10-01 Singapore 068913	Quote number	: ----
E-mail	: Desmond.Leung@erm.com	Date Received	: 25-NOV-2015
Telephone	: ----	Date Analysed	: 25-NOV-2015
Facsimile	: 6226 1363	Date Issued	: 15-DEC-2015
No. of samples received	: 10	No. of samples analysed	: 10

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*
Pansy Teo	Senior Environmental Manager
Yao Kaiwen	Technical Manager

General Comments

This report supersedes any previous report(s) with this reference. All pages of this report have been checked and approved for release. Results apply to the sample(s) as submitted. The laboratory declares that the test results relate only to the items tested and do not substitute any other documents. This report may not be reproduced except with prior written approval from the testing laboratory. This report may not be used for advertising purposes.

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, BS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : LOR = Limit of reporting

- **APHA method is referenced to APHA Standard Method, 22nd Ed, 2012**

Analytical Results

Dutch Standards 2000: Dutch Groundwater Standards

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Target Value	Intervention Value	DUP1	MW1	MW2	MW3	MW4
Client sample ID										
Sampling date/time						25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00
						SG1521324-009	SG1521324-001	SG1521324-002	SG1521324-003	SG1521324-004
Metals										
Arsenic	EPA3005/EPA6010B	10.0	µg/L	10	60	**31.5**	**30.3**	<10.0	<10.0	<10.0
Barium	EPA3005/EPA6010B	20.0	µg/L	50	625	**197**	**198**	<20.0	**88.4**	**35.7**
Cadmium	EPA3005/EPA6010B	5.0	µg/L	0.4	6	<5.0	<5.0	<5.0	<5.0	<5.0
Chromium	EPA3005/EPA6010B	10.0	µg/L	1	30	<10.0	<10.0	<10.0	<10.0	<10.0
Cobalt	EPA3005/EPA6010B	10.0	µg/L	20	100	<10.0	<10.0	<10.0	<10.0	<10.0
Copper	EPA3005/EPA6010B	10.0	µg/L	15	75	<10.0	<10.0	<10.0	<10.0	<10.0
Mercury	EPA7470	0.10	µg/L	0.05	0.3	<0.10	<0.10	<0.10	<0.10	<0.10
Lead	EPA3005/EPA6010B	10.0	µg/L	15	75	<10.0	<10.0	**13.1**	<10.0	<10.0
Molybdenum	EPA3005/EPA6010B	10.0	µg/L	5	300	<10.0	<10.0	<10.0	<10.0	<10.0
Nickel	EPA3005/EPA6010B	10.0	µg/L	15	75	<10.0	<10.0	<10.0	<10.0	<10.0
Zinc	EPA3005/EPA6010B	10.0	µg/L	65	800	<10.0	<10.0	<10.0	<10.0	<10.0
Antimony	EPA3005/EPA6010B	10.0	µg/L	----	20	<10.0	<10.0	<10.0	<10.0	<10.0
Inorganic Compounds										
Cyanide	EPA9010/EPA9014	10	µg/L	5	1500	<10	<10	<10	<10	<10
Aromatic Compounds										
Benzene	EPA5030B/EPA8260C	1.00	µg/L	0.2	30	<1.00	<1.00	<1.00	<1.00	<1.00
Ethylbenzene	EPA5030B/EPA8260C	1.00	µg/L	4	150	<1.00	<1.00	<1.00	<1.00	<1.00
Phenol	EPA3510C/EPA8270D	1.00	µg/L	0.2	2000	<1.00	<1.00	<1.00	<1.00	<1.00
Cresoles (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.2	200	<1.00	<1.00	<1.00	<1.00	<1.00
Toluene	EPA5030B/EPA8260C	1.00	µg/L	7	1000	<1.00	<1.00	<1.00	<1.00	<1.00
Xylenes (Sum)	EPA5030B/EPA8260C	2.00	µg/L	0.2	70	<2.00	<2.00	<2.00	<2.00	<2.00
Styrene	EPA5030B/EPA8260C	1.00	µg/L	0.6	300	<1.00	<1.00	<1.00	<1.00	<1.00
Catechol	EPA3510C/EPA8270D	1.00	µg/L	0.2	1250	<1.00	<1.00	<1.00	<1.00	<1.00
Resorcinol	EPA3510C/EPA8270D	1.00	µg/L	0.2	600	<1.00	<1.00	<1.00	<1.00	<1.00
Hydrochinon	EPA3510C/EPA8270D	1.00	µg/L	0.2	800	<1.00	<1.00	<1.00	<1.00	<1.00
Polynuclear Aromatic Hydrocarbons										
Naphthalene	EPA3510C/EPA8270D	0.10	µg/L	0.01	70	<0.10	<0.10	<0.10	<0.10	<0.10
Anthracene	EPA3510C/EPA8270D	0.10	µg/L	0.0007	5	<0.10	<0.10	<0.10	<0.10	<0.10
Phenanthrene	EPA3510C/EPA8270D	0.10	µg/L	0.003	5	<0.10	<0.10	<0.10	<0.10	<0.10
Fluoranthene	EPA3510C/EPA8270D	0.10	µg/L	0.003	1	<0.10	<0.10	<0.10	<0.10	<0.10
Benz(a)anthracene	EPA3510C/EPA8270D	0.10	µg/L	0.0001	0.5	<0.10	<0.10	<0.10	<0.10	<0.10
Chrysene	EPA3510C/EPA8270D	0.10	µg/L	0.003	0.2	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(a)pyrene	EPA3510C/EPA8270D	0.10	µg/L	0.001	0.05	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(g.h.i)perylene	EPA3510C/EPA8270D	0.10	µg/L	0.0003	0.05	<0.10	<0.10	<0.10	<0.10	<0.10

Dutch Standards 2000: Dutch Groundwater Standards

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Target Value	Intervention Value	DUP1	MW1	MW2	MW3	MW4
Client sample ID										
Sampling date/time						25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00
						SG1521324-009	SG1521324-001	SG1521324-002	SG1521324-003	SG1521324-004
Polynuclear Aromatic Hydrocarbons - Continued										
Benzo(k)fluoranthene	EPA3510C/EPA8270D	0.10	µg/L	0.0004	0.05	<0.10	<0.10	<0.10	<0.10	<0.10
Indeno(1.2.3.cd)pyrene	EPA3510C/EPA8270D	0.10	µg/L	0.0004	0.05	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorinated Hydrocarbons										
1.1-Dichloroethane	EPA5030B/EPA8260C	1.00	µg/L	7	900	<1.00	<1.00	<1.00	<1.00	<1.00
1.2-Dichloroethane	EPA5030B/EPA8260C	1.00	µg/L	7	400	<1.00	<1.00	<1.00	<1.00	<1.00
1.1-Dichloroethene	EPA5030B/EPA8260C	1.00	µg/L	0.01	10	<1.00	<1.00	<1.00	<1.00	<1.00
1,2-Dichloroethene (sum cis & trans)	EPA5030B/EPA8260C	1.00	µg/L	0.01	20	<1.00	<1.00	<1.00	<1.00	<1.00
Dichloropropanes (Sum)	EPA5030B/EPA8260C	1.00	µg/L	0.8	80	<1.00	<1.00	<1.00	<1.00	<1.00
1.1.1-Trichloroethane	EPA5030B/EPA8260C	1.00	µg/L	0.01	300	<1.00	<1.00	<1.00	<1.00	<1.00
1.1.2-Trichloroethane	EPA5030B/EPA8260C	1.00	µg/L	0.01	130	<1.00	<1.00	<1.00	<1.00	<1.00
Trichloroethene	EPA5030B/EPA8260C	1.00	µg/L	24	500	<1.00	<1.00	<1.00	<1.00	<1.00
Tetrachloroethene	EPA5030B/EPA8260C	1.00	µg/L	0.01	40	<1.00	<1.00	<1.00	<1.00	<1.00
Methylene chloride	EPA5030B/EPA8260C	10.0	µg/L	0.01	1000	<10.0	<10.0	<10.0	<10.0	<10.0
Tetrachloromethane	EPA5030B/EPA8260C	1.00	µg/L	0.01	10	<1.00	<1.00	<1.00	<1.00	<1.00
Chloroform	EPA5030B/EPA8260C	1.00	µg/L	6	400	<1.00	<1.00	<1.00	<1.00	<1.00
Vinyl chloride	EPA5030B/EPA8260C	2.00	µg/L	0.01	5	<2.00	<2.00	<2.00	<2.00	<2.00
Chlorobenzenes (sum mono, di, tri, tetra, penta, hexa)	EPA8260C	5.00	µg/L	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
Monochlorobenzene	EPA5030B/EPA8260C	1.00	µg/L	7	180	<1.00	<1.00	<1.00	<1.00	<1.00
Dichlorobenzenes (Sum)	EPA5030B/EPA8260C	1.00	µg/L	3	50	<1.00	<1.00	<1.00	<1.00	<1.00
Trichlorobenzenes (Sum)	EPA5030B/EPA8260C	1.00	µg/L	0.01	10	<1.00	<1.00	<1.00	<1.00	<1.00
Tetrachlorobenzenes (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.01	2.5	<1.00	<1.00	<1.00	<1.00	<1.00
Pentachlorobenzenes (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.003	1	<1.00	<1.00	<1.00	<1.00	<1.00
Hexachlorobenzenes (Sum)	EPA3510C/EPA8270D	0.50	µg/L	0.00009	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Chlorophenols (sum mono, di, tri, tetra, penta)	EPA3510C/EPA8270D	10.0	µg/L	----	----	<10.0	<10.0	<10.0	<10.0	<10.0
Monochlorophenols (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.3	100	<1.00	<1.00	<1.00	<1.00	<1.00
Dichlorophenols (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.2	30	<1.00	<1.00	<1.00	<1.00	<1.00
Trichlorophenols (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.03	10	<1.00	<1.00	<1.00	<1.00	<1.00
Tetrachlorophenols (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.01	10	<1.00	<1.00	<1.00	<1.00	<1.00
Pentachlorophenol	EPA3510C/EPA8270D	1.00	µg/L	0.04	3	<1.00	<1.00	<1.00	<1.00	<1.00
Chloronaphthalene	EPA3510C/EPA8270D	1.00	µg/L	----	6	<1.00	<1.00	<1.00	<1.00	<1.00
Monochloroanilines	EPA3510C/EPA8270D	2.00	µg/L	----	30	<2.00	<2.00	<2.00	<2.00	<2.00
Polychlorobiphenyls (Sum of PCB 28,52,101,118,138,153,180)	EPA3510C/EPA8082	1.00	µg/L	0.01	0.01	<1.00	<1.00	<1.00	<1.00	<1.00
Pesticides										

Dutch Standards 2000: Dutch Groundwater Standards

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Target Value	Intervention Value	DUP1	MW1	MW2	MW3	MW4
Client sample ID										
Sampling date/time						25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00
						SG1521324-009	SG1521324-001	SG1521324-002	SG1521324-003	SG1521324-004
Pesticides - Continued										
DDD/DDE/DDT	EPA3510C/EPA8270D	1.00	µg/L	0.004 ng/L	1000 ng/L	<1.00	<1.00	<1.00	<1.00	<1.00
Aldrin,Dieldrin,Endrin (Sum)	EPA3510C/EPA8270D	1.00	µg/L	----	0.1	<1.00	<1.00	<1.00	<1.00	<1.00
Aldrin	EPA3510C/EPA8270D	1.00	µg/L	0.009 ng/L	----	<1.00	<1.00	<1.00	<1.00	<1.00
Dieldrin	EPA3510C/EPA8270D	1.00	µg/L	0.1 ng/L	----	<1.00	<1.00	<1.00	<1.00	<1.00
Endrin	EPA3510C/EPA8270D	1.00	µg/L	0.04 ng/L	----	<1.00	<1.00	<1.00	<1.00	<1.00
BHC Compounds (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.05	1	<1.00	<1.00	<1.00	<1.00	<1.00
alpha-BHC	EPA3510C/EPA8270D	1.00	µg/L	33 ng/L	----	<1.00	<1.00	<1.00	<1.00	<1.00
beta-BHC	EPA3510C/EPA8270D	1.00	µg/L	8 ng/L	----	<1.00	<1.00	<1.00	<1.00	<1.00
gamma-BHC	EPA3510C/EPA8270D	1.00	µg/L	9 ng/L	----	<1.00	<1.00	<1.00	<1.00	<1.00
Atrazine	EPA3510C/EPA8270D	1.00	µg/L	29 ng/L	150000 ng/L	<1.00	<1.00	<1.00	<1.00	<1.00
Carbaryl	EPA3510C/EPA8270D	1.00	µg/L	2 ng/L	50000 ng/L	<1.00	<1.00	<1.00	<1.00	<1.00
Carbofuran	EPA3510C/EPA8270D	1.00	µg/L	9 ng/L	100000 ng/L	<1.00	<1.00	<1.00	<1.00	<1.00
Chlordane	EPA3510C/EPA8270D	1.00	µg/L	0.02 ng/L	200 ng/L	<1.00	<1.00	<1.00	<1.00	<1.00
Endosulfan	EPA3510C/EPA8270D	1.00	µg/L	0.2 ng/L	0.005 ng/L	<1.00	<1.00	<1.00	<1.00	<1.00
Heptachlor	EPA3510C/EPA8270D	1.00	µg/L	0.005 ng/L	300 ng/L	<1.00	<1.00	<1.00	<1.00	<1.00
Heptachlor epoxide	EPA3510C/EPA8270D	1.00	µg/L	0.005 ng/L	3000 ng/L	<1.00	<1.00	<1.00	<1.00	<1.00
Maneb	EPA3510C/EPA8270D	1.00	µg/L	0.05 ng/L	0.0001 ng/L	<1.00	<1.00	<1.00	<1.00	<1.00
Other Pollutants										
Cyclohexanone	EPA5030B/EPA8260C	1.00	µg/L	0.5	15000	<1.00	<1.00	<1.00	<1.00	<1.00
Phthalates (Sum)	EPA3510C/EPA8270D	2.00	µg/L	0.5	5	<2.00	<2.00	<2.00	<2.00	<2.00
Mineral oils	EPA8015B	115	µg/L	50	600	<115	<115	<115	<115	<115
Pyridine	EPA5030B/EPA8260C	1.00	µg/L	0.5	30	<1.00	<1.00	<1.00	<1.00	<1.00
Bromoform	EPA5030B/EPA8260C	1.00	µg/L	----	630	<1.00	<1.00	<1.00	<1.00	<1.00
Tetrahydrofuran	EPA3510C/EPA8270D	1.00	µg/L	0.5	300	<1.00	<1.00	<1.00	<1.00	<1.00
Tetrahydrothiophene	EPA3510C/EPA8270D	1.00	µg/L	0.5	5000	<1.00	<1.00	<1.00	<1.00	<1.00
Conventional										
pH @ 25 deg C	APHA4500 H+B	0.1	pH Unit	----	----	**6.4**	**5.9**	**5.7**	**6.8**	**6.1**
Biochemical Oxygen Demand (5 days @ 20 deg C)	APHA5210B	2	mg/L	----	----	<2	<2	<2	<2	<2
Chemical Oxygen Demand	APHA5220C	1	mg/L	----	----	**37**	**38**	**27**	**38**	**28**
Total Organic Carbon	APHA5310B	0.10	mg/L	----	----	**0.98**	**0.92**	**0.90**	**2.29**	**1.39**
Fluoride as F	APHA4110B	0.10	mg/L	----	----	**0.10**	**0.10**	<0.10	**0.14**	<0.10
Chloride as Cl	APHA4110B	0.10	mg/L	----	----	**4.44**	**4.07**	**6.35**	**5.85**	**6.37**
Bromide as Br	APHA4110B	0.10	mg/L	----	----	**0.17**	**0.18**	<0.10	**0.22**	**0.29**
Sulphate as SO4	APHA4110B	0.10	mg/L	----	----	**11.7**	**12.3**	**20.4**	**14.5**	**155**
Ammonia as N	APHA4500B/APHA4500H	0.01	mg/L	----	----	**7.75**	**7.45**	<0.01	**2.56**	**0.33**

Dutch Standards 2000: Dutch Groundwater Standards

Sub-Matrix: **WATER**

Compound	*Method*	*LOR*	*Unit*	*Client sample ID* / *Sampling date/time*	Target Value	Intervention Value	**DUP1** 25-NOV-2015 15:00	**MW1** 25-NOV-2015 15:00	**MW2** 25-NOV-2015 15:00	**MW3** 25-NOV-2015 15:00	**MW4** 25-NOV-2015 15:00
							SG1521324-009	**SG1521324-001**	**SG1521324-002**	**SG1521324-003**	**SG1521324-004**
Conventional - Continued											
Conductivity	APHA2510B	1.0	µS/cm		----	----	**260**	**267**	**110**	**293**	**467**
Total Petroleum Hydrocarbon											
C6 - C9 Fraction	EPA5030B/EPA8015B	5	µg/L		----	----	<5	<5	<5	<5	<5
C10 - C14 Fraction	EPA3510C/EPA8015B	10	µg/L		----	----	<10	<10	<10	<10	<10
C15 - C28 Fraction	EPA3510C/EPA8015B	50	µg/L		----	----	<50	<50	<50	<50	<50
C29 - C36 Fraction	EPA3510C/EPA8015B	50	µg/L		----	----	<50	<50	<50	<50	<50

Dutch Standards 2000: Dutch Groundwater Standards

Sub-Matrix: **WATER**

Compound	*Method*	*LOR*	*Unit*	Target Value	Intervention Value	**MW5** 25-NOV-2015 15:00 **SG1521324-005**	**MW6** 25-NOV-2015 15:00 **SG1521324-006**	**MW7** 25-NOV-2015 15:00 **SG1521324-007**	**MW8** 25-NOV-2015 15:00 **SG1521324-008**	**Trip Blank** 25-NOV-2015 15:00 **SG1521324-010**
Metals										
Arsenic	EPA3005/EPA6010B	10.0	µg/L	10	60	<10.0	<10.0	<10.0	<10.0	----
Barium	EPA3005/EPA6010B	20.0	µg/L	50	625	**84.3**	<20.0	**22.3**	<20.0	----
Cadmium	EPA3005/EPA6010B	5.0	µg/L	0.4	6	<5.0	<5.0	<5.0	<5.0	----
Chromium	EPA3005/EPA6010B	10.0	µg/L	1	30	<10.0	<10.0	<10.0	<10.0	----
Cobalt	EPA3005/EPA6010B	10.0	µg/L	20	100	<10.0	<10.0	<10.0	<10.0	----
Copper	EPA3005/EPA6010B	10.0	µg/L	15	75	<10.0	<10.0	<10.0	<10.0	----
Mercury	EPA7470	0.10	µg/L	0.05	0.3	<0.10	<0.10	<0.10	<0.10	----
Lead	EPA3005/EPA6010B	10.0	µg/L	15	75	<10.0	<10.0	<10.0	<10.0	----
Molybdenum	EPA3005/EPA6010B	10.0	µg/L	5	300	<10.0	<10.0	<10.0	<10.0	----
Nickel	EPA3005/EPA6010B	10.0	µg/L	15	75	<10.0	<10.0	<10.0	<10.0	----
Zinc	EPA3005/EPA6010B	10.0	µg/L	65	800	<10.0	<10.0	<10.0	<10.0	----
Antimony	EPA3005/EPA6010B	10.0	µg/L	----	20	<10.0	<10.0	<10.0	<10.0	----
Inorganic Compounds										
Cyanide	EPA9010/EPA9014	10	µg/L	5	1500	<10	<10	<10	<10	----
Aromatic Compounds										
Benzene	EPA5030B/EPA8260C	1.00	µg/L	0.2	30	<1.00	<1.00	<1.00	<1.00	<1.00
Ethylbenzene	EPA5030B/EPA8260C	1.00	µg/L	4	150	<1.00	<1.00	<1.00	<1.00	<1.00
Phenol	EPA3510C/EPA8270D	1.00	µg/L	0.2	2000	<1.00	<1.00	<1.00	<1.00	----
Cresoles (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.2	200	<1.00	<1.00	<1.00	<1.00	----
Toluene	EPA5030B/EPA8260C	1.00	µg/L	7	1000	<1.00	<1.00	<1.00	<1.00	<1.00
Xylenes (Sum)	EPA5030B/EPA8260C	2.00	µg/L	0.2	70	<2.00	<2.00	<2.00	<2.00	<2.00
Styrene	EPA5030B/EPA8260C	1.00	µg/L	0.6	300	<1.00	<1.00	<1.00	<1.00	<1.00
Catechol	EPA3510C/EPA8270D	1.00	µg/L	0.2	1250	<1.00	<1.00	<1.00	<1.00	----
Resorcinol	EPA3510C/EPA8270D	1.00	µg/L	0.2	600	<1.00	<1.00	<1.00	<1.00	----
Hydrochinon	EPA3510C/EPA8270D	1.00	µg/L	0.2	800	<1.00	<1.00	<1.00	<1.00	----
Polynuclear Aromatic Hydrocarbons										
Naphthalene	EPA3510C/EPA8270D	0.10	µg/L	0.01	70	<0.10	<0.10	<0.10	<0.10	----
Anthracene	EPA3510C/EPA8270D	0.10	µg/L	0.0007	5	<0.10	<0.10	<0.10	<0.10	----
Phenanthrene	EPA3510C/EPA8270D	0.10	µg/L	0.003	5	<0.10	<0.10	<0.10	<0.10	----
Fluoranthene	EPA3510C/EPA8270D	0.10	µg/L	0.003	1	<0.10	<0.10	<0.10	<0.10	----
Benz(a)anthracene	EPA3510C/EPA8270D	0.10	µg/L	0.0001	0.5	<0.10	<0.10	<0.10	<0.10	----
Chrysene	EPA3510C/EPA8270D	0.10	µg/L	0.003	0.2	<0.10	<0.10	<0.10	<0.10	----
Benzo(a)pyrene	EPA3510C/EPA8270D	0.10	µg/L	0.001	0.05	<0.10	<0.10	<0.10	<0.10	----
Benzo(g.h.i)perylene	EPA3510C/EPA8270D	0.10	µg/L	0.0003	0.05	<0.10	<0.10	<0.10	<0.10	----
Benzo(k)fluoranthene	EPA3510C/EPA8270D	0.10	µg/L	0.0004	0.05	<0.10	<0.10	<0.10	<0.10	----
Indeno(1.2.3.cd)pyrene	EPA3510C/EPA8270D	0.10	µg/L	0.0004	0.05	<0.10	<0.10	<0.10	<0.10	----

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Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Target Value	Intervention Value	MW5 (Client sample ID)	MW6	MW7	MW8	Trip Blank
						25-NOV-2015 15:00 (Sampling date/time)	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00
						SG1521324-005	SG1521324-006	SG1521324-007	SG1521324-008	SG1521324-010
Chlorinated Hydrocarbons										
1.1-Dichloroethane	EPA5030B/EPA8260C	1.00	µg/L	7	900	<1.00	<1.00	<1.00	<1.00	<1.00
1.2-Dichloroethane	EPA5030B/EPA8260C	1.00	µg/L	7	400	<1.00	<1.00	<1.00	<1.00	<1.00
1.1-Dichloroethene	EPA5030B/EPA8260C	1.00	µg/L	0.01	10	<1.00	<1.00	<1.00	<1.00	<1.00
1,2-Dichloroethene (sum cis & trans)	EPA5030B/EPA8260C	1.00	µg/L	0.01	20	<1.00	<1.00	<1.00	<1.00	<1.00
Dichloropropanes (Sum)	EPA5030B/EPA8260C	1.00	µg/L	0.8	80	<1.00	<1.00	<1.00	<1.00	<1.00
1.1.1-Trichloroethane	EPA5030B/EPA8260C	1.00	µg/L	0.01	300	<1.00	<1.00	<1.00	<1.00	<1.00
1.1.2-Trichloroethane	EPA5030B/EPA8260C	1.00	µg/L	0.01	130	<1.00	<1.00	<1.00	<1.00	<1.00
Trichloroethene	EPA5030B/EPA8260C	1.00	µg/L	24	500	<1.00	<1.00	<1.00	<1.00	<1.00
Tetrachloroethene	EPA5030B/EPA8260C	1.00	µg/L	0.01	40	<1.00	<1.00	<1.00	<1.00	<1.00
Methylene chloride	EPA5030B/EPA8260C	10.0	µg/L	0.01	1000	<10.0	<10.0	<10.0	<10.0	<10.0
Tetrachloromethane	EPA5030B/EPA8260C	1.00	µg/L	0.01	10	<1.00	<1.00	<1.00	<1.00	<1.00
Chloroform	EPA5030B/EPA8260C	1.00	µg/L	6	400	<1.00	<1.00	<1.00	**9.10**	<1.00
Vinyl chloride	EPA5030B/EPA8260C	2.00	µg/L	0.01	5	<2.00	<2.00	<2.00	<2.00	<2.00
Chlorobenzenes (sum mono, di, tri, tetra, penta, hexa)	EPA8260C	5.00	µg/L	----	----	<5.00	<5.00	<5.00	<5.00	----
Monochlorobenzene	EPA5030B/EPA8260C	1.00	µg/L	7	180	<1.00	<1.00	<1.00	<1.00	<1.00
Dichlorobenzenes (Sum)	EPA5030B/EPA8260C	1.00	µg/L	3	50	<1.00	<1.00	<1.00	<1.00	<1.00
Trichlorobenzenes (Sum)	EPA5030B/EPA8260C	1.00	µg/L	0.01	10	<1.00	<1.00	<1.00	<1.00	<1.00
Tetrachlorobenzenes (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.01	2.5	<1.00	<1.00	<1.00	<1.00	----
Pentachlorobenzenes (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.003	1	<1.00	<1.00	<1.00	<1.00	----
Hexachlorobenzenes (Sum)	EPA3510C/EPA8270D	0.50	µg/L	0.00009	0.5	<0.50	<0.50	<0.50	<0.50	----
Chlorophenols (sum mono, di, tri, tetra, penta)	EPA3510C/EPA8270D	10.0	µg/L	----	----	<10.0	<10.0	<10.0	<10.0	----
Monochlorophenols (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.3	100	<1.00	<1.00	<1.00	<1.00	----
Dichlorophenols (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.2	30	<1.00	<1.00	<1.00	<1.00	----
Trichlorophenols (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.03	10	<1.00	<1.00	<1.00	<1.00	----
Tetrachlorophenols (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.01	10	<1.00	<1.00	<1.00	<1.00	----
Pentachlorophenol	EPA3510C/EPA8270D	1.00	µg/L	0.04	3	<1.00	<1.00	<1.00	<1.00	----
Chloronaphthalene	EPA3510C/EPA8270D	1.00	µg/L	----	6	<1.00	<1.00	<1.00	<1.00	----
Monochloroanilines	EPA3510C/EPA8270D	2.00	µg/L	----	30	<2.00	<2.00	<2.00	<2.00	----
Polychlorobiphenyls (Sum of PCB 28,52,101,118,138,153,180)	EPA3510C/EPA8082	1.00	µg/L	0.01	0.01	<1.00	<1.00	<1.00	<1.00	----
Pesticides										
DDD/DDE/DDT	EPA3510C/EPA8270D	1.00	µg/L	0.004 ng/L	1000 ng/L	<1.00	<1.00	<1.00	<1.00	----
Aldrin,Dieldrin,Endrin (Sum)	EPA3510C/EPA8270D	1.00	µg/L	----	0.1	<1.00	<1.00	<1.00	<1.00	----
Aldrin	EPA3510C/EPA8270D	1.00	µg/L	0.009 ng/L	----	<1.00	<1.00	<1.00	<1.00	----

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Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Target Value	Intervention Value	MW5	MW6	MW7	MW8	Trip Blank
Client sample ID										
Sampling date/time						25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00
						SG1521324-005	**SG1521324-006**	**SG1521324-007**	**SG1521324-008**	**SG1521324-010**
Pesticides - Continued										
Dieldrin	EPA3510C/EPA8270D	1.00	µg/L	0.1 ng/L	----	<1.00	<1.00	<1.00	<1.00	----
Endrin	EPA3510C/EPA8270D	1.00	µg/L	0.04 ng/L	----	<1.00	<1.00	<1.00	<1.00	----
BHC Compounds (Sum)	EPA3510C/EPA8270D	1.00	µg/L	0.05	1	<1.00	<1.00	<1.00	<1.00	----
alpha-BHC	EPA3510C/EPA8270D	1.00	µg/L	33 ng/L	----	<1.00	<1.00	<1.00	<1.00	----
beta-BHC	EPA3510C/EPA8270D	1.00	µg/L	8 ng/L	----	<1.00	<1.00	<1.00	<1.00	----
gamma-BHC	EPA3510C/EPA8270D	1.00	µg/L	9 ng/L	----	<1.00	<1.00	<1.00	<1.00	----
Atrazine	EPA3510C/EPA8270D	1.00	µg/L	29 ng/L	150000 ng/L	<1.00	<1.00	<1.00	<1.00	----
Carbaryl	EPA3510C/EPA8270D	1.00	µg/L	2 ng/L	50000 ng/L	<1.00	<1.00	<1.00	<1.00	----
Carbofuran	EPA3510C/EPA8270D	1.00	µg/L	9 ng/L	100000 ng/L	<1.00	<1.00	<1.00	<1.00	----
Chlordane	EPA3510C/EPA8270D	1.00	µg/L	0.02 ng/L	200 ng/L	<1.00	<1.00	<1.00	<1.00	----
Endosulfan	EPA3510C/EPA8270D	1.00	µg/L	0.2 ng/L	0.005 ng/L	<1.00	<1.00	<1.00	<1.00	----
Heptachlor	EPA3510C/EPA8270D	1.00	µg/L	0.005 ng/L	300 ng/L	<1.00	<1.00	<1.00	<1.00	----
Heptachlor epoxide	EPA3510C/EPA8270D	1.00	µg/L	0.005 ng/L	3000 ng/L	<1.00	<1.00	<1.00	<1.00	----
Maneb	EPA3510C/EPA8270D	1.00	µg/L	0.05 ng/L	0.0001 ng/L	<1.00	<1.00	<1.00	<1.00	----
Other Pollutants										
Cyclohexanone	EPA5030B/EPA8260C	1.00	µg/L	0.5	15000	<1.00	<1.00	<1.00	<1.00	<1.00
Phthalates (Sum)	EPA3510C/EPA8270D	2.00	µg/L	0.5	5	<2.00	<2.00	<2.00	<2.00	----
Mineral oils	EPA8015B	115	µg/L	50	600	<115	<115	<115	<115	----
Pyridine	EPA5030B/EPA8260C	1.00	µg/L	0.5	30	<1.00	<1.00	<1.00	<1.00	<1.00
Bromoform	EPA5030B/EPA8260C	1.00	µg/L	----	630	<1.00	<1.00	<1.00	<1.00	<1.00
Tetrahydrofuran	EPA3510C/EPA8270D	1.00	µg/L	0.5	300	<1.00	<1.00	<1.00	<1.00	----
Tetrahydrothiophene	EPA3510C/EPA8270D	1.00	µg/L	0.5	5000	<1.00	<1.00	<1.00	<1.00	----
Conventional										
pH @ 25 deg C	APHA4500 H+B	0.1	pH Unit	----	----	**6.7**	**5.8**	**6.9**	**7.3**	----
Biochemical Oxygen Demand (5 days @ 20 deg C)	APHA5210B	2	mg/L	----	----	<2	<2	<2	<2	----
Chemical Oxygen Demand	APHA5220C	1	mg/L	----	----	**24**	**16**	**7**	**55**	----
Total Organic Carbon	APHA5310B	0.10	mg/L	----	----	**3.60**	**1.51**	**2.84**	**1.37**	----
Fluoride as F	APHA4110B	0.10	mg/L	----	----	<0.10	**0.11**	<0.10	<0.10	----
Chloride as Cl	APHA4110B	0.10	mg/L	----	----	**15.4**	**4.18**	**3.20**	**17.2**	----
Bromide as Br	APHA4110B	0.10	mg/L	----	----	**0.59**	<0.10	**0.10**	<0.10	----
Sulphate as SO4	APHA4110B	0.10	mg/L	----	----	**60.9**	**20.3**	**4.38**	**23.1**	----
Ammonia as N	APHA4500B/APHA4500H	0.01	mg/L	----	----	**4.38**	**0.05**	**0.08**	**0.02**	----
Conductivity	APHA2510B	1.0	µS/cm	----	----	**769**	**124**	**74.0**	**164**	----
Total Petroleum Hydrocarbon										
C6 - C9 Fraction	EPA5030B/EPA8015B	5	µg/L	----	----	<5	<5	<5	**8**	----

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Sub-Matrix: **WATER**

Compound	*Method*	*LOR*	*Unit*	*Client sample ID* / *Sampling date/time*	Target Value	Intervention Value	**MW5** 25-NOV-2015 15:00	**MW6** 25-NOV-2015 15:00	**MW7** 25-NOV-2015 15:00	**MW8** 25-NOV-2015 15:00	**Trip Blank** 25-NOV-2015 15:00
							SG1521324-005	**SG1521324-006**	**SG1521324-007**	**SG1521324-008**	**SG1521324-010**
Total Petroleum Hydrocarbon - Continued											
C10 - C14 Fraction	EPA3510C/EPA8015B	10	µg/L		----	----	<10	<10	<10	<10	----
C15 - C28 Fraction	EPA3510C/EPA8015B	50	µg/L		----	----	<50	<50	<50	<50	----
C29 - C36 Fraction	EPA3510C/EPA8015B	50	µg/L		----	----	<50	<50	<50	<50	----

No Guideline Evaluation Required

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Target Value	Intervention Value	DUP1	MW1	MW2	MW3	MW4
Client sample ID										
Sampling date/time						25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00
						SG1521324-009	SG1521324-001	SG1521324-002	SG1521324-003	SG1521324-004
Conventional										
Phosphate as PO4	APHA4110B	0.10	mg/L	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Monocyclic Aromatic Hydrocarbons										
Isopropylbenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
n-Propylbenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.3.5-Trimethylbenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
sec-Butylbenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.2.4-Trimethylbenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
tert-Butylbenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
p-Isopropyltoluene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
n-Butylbenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Oxygenated Compounds										
2-Propanone (Acetone)	EPA5030B/EPA8260C	50.0	µg/L	----	----	<50.0	<50.0	<50.0	<50.0	<50.0
Vinyl Acetate	EPA5030B/EPA8260C	50.0	µg/L	----	----	<50.0	<50.0	<50.0	<50.0	<50.0
2-Butanone (MEK)	EPA5030B/EPA8260C	50.0	µg/L	----	----	<50.0	<50.0	<50.0	<50.0	<50.0
4-Methyl-2-pentanone (MIBK)	EPA5030B/EPA8260C	10.0	µg/L	----	----	<10.0	<10.0	<10.0	<10.0	<10.0
2-Hexanone (MBK)	EPA5030B/EPA8260C	5.00	µg/L	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
Sulfonated Compounds										
Carbon disulfide	EPA5030B/EPA8260C	5.00	µg/L	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
Fumigants										
2.2-Dichloropropane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.2-Dichloropropane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
cis-1.3-Dichloropropylene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
trans-1.3-Dichloropropylene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.2-Dibromoethane (EDB)	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Halogenated Aliphatic Compounds										
Dichlorodifluoromethane	EPA5030B/EPA8260C	10.0	µg/L	----	----	<10.0	<10.0	<10.0	<10.0	<10.0
Chloromethane	EPA5030B/EPA8260C	10.0	µg/L	----	----	<10.0	<10.0	<10.0	<10.0	<10.0
Bromomethane	EPA5030B/EPA8260C	10.0	µg/L	----	----	<10.0	<10.0	<10.0	<10.0	<10.0
Chloroethane	EPA5030B/EPA8260C	10.0	µg/L	----	----	<10.0	<10.0	<10.0	<10.0	<10.0
Trichlorofluoromethane	EPA5030B/EPA8260C	10.0	µg/L	----	----	<10.0	<10.0	<10.0	<10.0	<10.0
Iodomethane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
trans-1.2-Dichloroethene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
cis-1.2-Dichloroethene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.1-Dichloropropylene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Carbon Tetrachloride	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00

No Guideline Evaluation Required

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Target Value	Intervention Value	DUP1	MW1	MW2	MW3	MW4
Client sample ID										
Sampling date/time						25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00
						SG1521324-009	SG1521324-001	SG1521324-002	SG1521324-003	SG1521324-004
Halogenated Aliphatic Compounds - Continued										
Dibromomethane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.3-Dichloropropane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.1.1.2-Tetrachloroethane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
trans-1.4-Dichloro-2-butene	EPA5030B/EPA8260C	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
cis-1.4-Dichloro-2-butene	EPA5030B/EPA8260C	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
1.1.2.2-Tetrachloroethane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.2.3-Trichloropropane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Pentachloroethane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.2-Dibromo-3-chloropropane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Halogenated Aromatic Compounds										
Chlorobenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Bromobenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
2-Chlorotoluene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
4-Chlorotoluene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.2.3-Trichlorobenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Trihalomethanes										
Bromodichloromethane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Dibromochloromethane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Phenolic Compounds										
2-Chlorophenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
2-Methylphenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
4-Methylphenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
2-Nitrophenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
2.4-Dimethylphenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
2.6-Dichlorophenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
2.4-Dichlorophenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
4-Chloro-3-methylphenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
2.4.6-Trichlorophenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
2.4.5-Trichlorophenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
PolyAromatic Hydrocarbons										
2-Methylnaphthalene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
2-Chloronaphthalene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Acenaphthylene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Acenaphthene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Fluorene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Pyrene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00

No Guideline Evaluation Required

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Target Value	Intervention Value	DUP1	MW1	MW2	MW3	MW4
Client sample ID										
Sampling date/time						25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00
						SG1521324-009	SG1521324-001	SG1521324-002	SG1521324-003	SG1521324-004
PolyAromatic Hydrocarbons - Continued										
N-2-Fluorenyl Acetamide	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Benzo(b) & Benzo(k)fluoranthene	EPA3510C/EPA8270D	0.20	µg/L	----	----	<0.20	<0.20	<0.20	<0.20	<0.20
3-Methylcholanthrene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Dibenz(a.h)anthracene	EPA3510C/EPA8270D	0.10	µg/L	----	----	<0.10	<0.10	<0.10	<0.10	<0.10
Phthalate Esters										
Dimethyl phthalate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Diethyl phthalate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Di-n-butyl phthalate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Butyl benzyl phthalate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
bis(2-ethylhexyl) phthalate	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Di-n-octylphthalate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Nitrosamines										
N-Nitrosomethylethylamine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
N-Nitrosodiethylamine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
N-Nitrosopyrrolidine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
N-Nitrosomorpholine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
N-Nitrosodi-n-propylamine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
N-Nitrosopiperidine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
N-Nitrosodibutylamine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
N-Nitrosodiphenyl & Diphenylamine	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Nitroaromatics and Cyclic Ketones										
2-Picoline	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Acetophenone	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Nitrobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Isophorone	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
2.6-Dinitrotoluene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
2.4-Dinitrotoluene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1-Naphthylamine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
4-Nitroquinoline-N-oxide	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
5-Nitro-o-toluidine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Azobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.3.5-Trinitrobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Phenacetin	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
4-Aminobiphenyl	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Pentachloronitrobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Dimethylaminoazobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00

No Guideline Evaluation Required

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Target Value	Intervention Value	DUP1	MW1	MW2	MW3	MW4
Client sample ID										
Sampling date/time						25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00
						SG1521324-009	SG1521324-001	SG1521324-002	SG1521324-003	SG1521324-004
Nitroaromatics and Cyclic Ketones - Continued										
Chlorobenzilate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Haloethers										
Bis(2-chloroethyl) ether	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Bis(2-chloroethoxy) methane	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
4-Chlorophenyl phenyl ether	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
4-Bromophenyl phenyl ether	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Chlorinated Hydrocarbon										
1.3-Dichlorobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.4-Dichlorobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.2-Dichlorobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Hexachloroethane	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.2.4-Trichlorobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Hexachloropropylene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Hexachlorobutadiene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Hexachlorocyclopentadiene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Pentachlorobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Hexachlorobenzene (HCB)	EPA3510C/EPA8270D	0.50	µg/L	----	----	<0.50	<0.50	<0.50	<0.50	<0.50
Anilines and Benzidines										
Aniline	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
4-Chloroaniline	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
2-Nitroaniline	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
3-Nitroaniline	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Dibenzofuran	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
4-Nitroaniline	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Carbazole	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
3.3`-Dichlorobenzidine	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
Polychlorinated Biphenyls										
Aroclor 1232	EPA3510C/EPA8082	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Aroclor 1242	EPA3510C/EPA8082	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Aroclor 1248	EPA3510C/EPA8082	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Aroclor 1254	EPA3510C/EPA8082	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Organochlorine Pesticides										
delta-BHC	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
trans-Chlordane	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
cis-Chlordane	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00

No Guideline Evaluation Required

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Target Value	Intervention Value	DUP1	MW1	MW2	MW3	MW4
Client sample ID										
Sampling date/time						25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00
						SG1521324-009	SG1521324-001	SG1521324-002	SG1521324-003	SG1521324-004
Organochlorine Pesticides - Continued										
alpha-Endosulfan	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
4.4`-DDE	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
beta-Endosulfan	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
4.4`-DDD	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Endosulfan sulfate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
4.4`-DDT	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Endrin ketone	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Organophosphorus Pesticides										
Malathion	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Dichlorvos	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Dimethoate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Diazinon	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Chlorpyrifos-methyl	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Ethion	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Fenthion	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Chlorpyrifos	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Pirimphos-ethyl	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Prothiofos	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Parathion	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Methyl Parathion	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Chlorfenvinphos (E)	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Chlorfenvinphos (Z)	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
VOC Surrogates										
1.2-Dichloroethane-D4	EPA5030B/EPA8260C	0.1	%	----	----	**88.0**	**89.2**	**89.2**	**90.8**	**88.3**
Toluene-D8	EPA5030B/EPA8260C	0.1	%	----	----	**95.2**	**88.2**	**91.2**	**91.1**	**88.5**
4-Bromofluorobenzene	EPA5030B/EPA8260C	0.1	%	----	----	**100**	**100**	**100**	**101**	**102**
Acid Extractable Surrogates										
2-Fluorophenol	EPA3510C/EPA8270D	0.1	%	----	----	**38.4**	**42.0**	**25.1**	**50.6**	**60.1**
Phenol-d5	EPA3510C/EPA8270D	0.1	%	----	----	**30.2**	**49.9**	**33.9**	**39.0**	**35.2**
2.4.6-Tribromophenol	EPA3510C/EPA8270D	0.1	%	----	----	**54.6**	**63.0**	**54.2**	**54.5**	**55.7**
Base/Neutral Extractable Surrogates										
Nitrobenzene-D5	EPA3510C/EPA8270D	0.1	%	----	----	**48.3**	**60.5**	**69.0**	**50.0**	**53.0**
2-Fluorobiphenyl	EPA3510C/EPA8270D	0.1	%	----	----	**49.9**	**58.1**	**60.2**	**49.3**	**54.2**
4-Terphenyl-d14	EPA3510C/EPA8270D	0.1	%	----	----	**52.9**	**61.0**	**53.2**	**54.6**	**59.3**

No Guideline Evaluation Required

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Target Value	Intervention Value	MW5	MW6	MW7	MW8	Trip Blank
Client sample ID										
Sampling date/time						25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00
						SG1521324-005	SG1521324-006	SG1521324-007	SG1521324-008	SG1521324-010
Conventional										
Phosphate as PO4	APHA4110B	0.10	mg/L	----	----	<0.10	<0.10	<0.10	<0.10	----
Monocyclic Aromatic Hydrocarbons										
Isopropylbenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
n-Propylbenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.3.5-Trimethylbenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
sec-Butylbenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.2.4-Trimethylbenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
tert-Butylbenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
p-Isopropyltoluene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
n-Butylbenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Oxygenated Compounds										
2-Propanone (Acetone)	EPA5030B/EPA8260C	50.0	µg/L	----	----	<50.0	<50.0	<50.0	<50.0	<50.0
Vinyl Acetate	EPA5030B/EPA8260C	50.0	µg/L	----	----	<50.0	<50.0	<50.0	<50.0	<50.0
2-Butanone (MEK)	EPA5030B/EPA8260C	50.0	µg/L	----	----	<50.0	<50.0	<50.0	<50.0	<50.0
4-Methyl-2-pentanone (MIBK)	EPA5030B/EPA8260C	10.0	µg/L	----	----	<10.0	<10.0	<10.0	<10.0	<10.0
2-Hexanone (MBK)	EPA5030B/EPA8260C	5.00	µg/L	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
Sulfonated Compounds										
Carbon disulfide	EPA5030B/EPA8260C	5.00	µg/L	----	----	<5.00	<5.00	<5.00	<5.00	<5.00
Fumigants										
2.2-Dichloropropane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.2-Dichloropropane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
cis-1.3-Dichloropropylene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
trans-1.3-Dichloropropylene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.2-Dibromoethane (EDB)	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Halogenated Aliphatic Compounds										
Dichlorodifluoromethane	EPA5030B/EPA8260C	10.0	µg/L	----	----	<10.0	<10.0	<10.0	<10.0	<10.0
Chloromethane	EPA5030B/EPA8260C	10.0	µg/L	----	----	<10.0	<10.0	<10.0	<10.0	<10.0
Bromomethane	EPA5030B/EPA8260C	10.0	µg/L	----	----	<10.0	<10.0	<10.0	<10.0	<10.0
Chloroethane	EPA5030B/EPA8260C	10.0	µg/L	----	----	<10.0	<10.0	<10.0	<10.0	<10.0
Trichlorofluoromethane	EPA5030B/EPA8260C	10.0	µg/L	----	----	<10.0	<10.0	<10.0	<10.0	<10.0
Iodomethane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
trans-1.2-Dichloroethene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
cis-1.2-Dichloroethene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.1-Dichloropropylene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Carbon Tetrachloride	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00

No Guideline Evaluation Required

Sub-Matrix: **WATER**

				Client sample ID	Target Value	Intervention Value	MW5	MW6	MW7	MW8	Trip Blank
				Sampling date/time			25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00
Compound	*Method*	*LOR*	*Unit*				**SG1521324-005**	**SG1521324-006**	**SG1521324-007**	**SG1521324-008**	**SG1521324-010**
Halogenated Aliphatic Compounds - Continued											
Dibromomethane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.3-Dichloropropane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.1.1.2-Tetrachloroethane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
trans-1.4-Dichloro-2-butene	EPA5030B/EPA8260C	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
cis-1.4-Dichloro-2-butene	EPA5030B/EPA8260C	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	<2.00
1.1.2.2-Tetrachloroethane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.2.3-Trichloropropane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Pentachloroethane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.2-Dibromo-3-chloropropane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Halogenated Aromatic Compounds											
Chlorobenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Bromobenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
2-Chlorotoluene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
4-Chlorotoluene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
1.2.3-Trichlorobenzene	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Trihalomethanes											
Bromodichloromethane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	**1.67**	<1.00
Dibromochloromethane	EPA5030B/EPA8260C	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	<1.00
Phenolic Compounds											
2-Chlorophenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
2-Methylphenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
4-Methylphenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
2-Nitrophenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
2.4-Dimethylphenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
2.6-Dichlorophenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
2.4-Dichlorophenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
4-Chloro-3-methylphenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
2.4.6-Trichlorophenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
2.4.5-Trichlorophenol	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
PolyAromatic Hydrocarbons											
2-Methylnaphthalene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
2-Chloronaphthalene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Acenaphthylene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Acenaphthene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Fluorene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Pyrene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----

No Guideline Evaluation Required

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Target Value	Intervention Value	MW5	MW6	MW7	MW8	Trip Blank
Client sample ID										
Sampling date/time						25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00
						SG1521324-005	SG1521324-006	SG1521324-007	SG1521324-008	SG1521324-010
PolyAromatic Hydrocarbons - Continued										
N-2-Fluorenyl Acetamide	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Benzo(b) & Benzo(k)fluoranthene	EPA3510C/EPA8270D	0.20	µg/L	----	----	<0.20	<0.20	<0.20	<0.20	----
3-Methylcholanthrene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Dibenz(a.h)anthracene	EPA3510C/EPA8270D	0.10	µg/L	----	----	<0.10	<0.10	<0.10	<0.10	----
Phthalate Esters										
Dimethyl phthalate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Diethyl phthalate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Di-n-butyl phthalate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Butyl benzyl phthalate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
bis(2-ethylhexyl) phthalate	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	----
Di-n-octylphthalate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Nitrosamines										
N-Nitrosomethylethylamine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
N-Nitrosodiethylamine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
N-Nitrosopyrrolidine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
N-Nitrosomorpholine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
N-Nitrosodi-n-propylamine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
N-Nitrosopiperidine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
N-Nitrosodibutylamine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
N-Nitrosodiphenyl & Diphenylamine	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	----
Nitroaromatics and Cyclic Ketones										
2-Picoline	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Acetophenone	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Nitrobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Isophorone	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
2.6-Dinitrotoluene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
2.4-Dinitrotoluene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
1-Naphthylamine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
4-Nitroquinoline-N-oxide	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
5-Nitro-o-toluidine	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Azobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
1.3.5-Trinitrobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Phenacetin	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
4-Aminobiphenyl	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Pentachloronitrobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Dimethylaminoazobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----

No Guideline Evaluation Required

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Target Value	Intervention Value	MW5	MW6	MW7	MW8	Trip Blank
Client sample ID										
Sampling date/time						25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00
						SG1521324-005	SG1521324-006	SG1521324-007	SG1521324-008	SG1521324-010
Nitroaromatics and Cyclic Ketones - Continued										
Chlorobenzilate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Haloethers										
Bis(2-chloroethyl) ether	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Bis(2-chloroethoxy) methane	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
4-Chlorophenyl phenyl ether	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
4-Bromophenyl phenyl ether	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Chlorinated Hydrocarbon										
1.3-Dichlorobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
1.4-Dichlorobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
1.2-Dichlorobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Hexachloroethane	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
1.2.4-Trichlorobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Hexachloropropylene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Hexachlorobutadiene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Hexachlorocyclopentadiene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Pentachlorobenzene	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Hexachlorobenzene (HCB)	EPA3510C/EPA8270D	0.50	µg/L	----	----	<0.50	<0.50	<0.50	<0.50	----
Anilines and Benzidines										
Aniline	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
4-Chloroaniline	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
2-Nitroaniline	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	----
3-Nitroaniline	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	----
Dibenzofuran	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	----
4-Nitroaniline	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	----
Carbazole	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	----
3.3`-Dichlorobenzidine	EPA3510C/EPA8270D	2.00	µg/L	----	----	<2.00	<2.00	<2.00	<2.00	----
Polychlorinated Biphenyls										
Aroclor 1232	EPA3510C/EPA8082	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Aroclor 1242	EPA3510C/EPA8082	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Aroclor 1248	EPA3510C/EPA8082	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Aroclor 1254	EPA3510C/EPA8082	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Organochlorine Pesticides										
delta-BHC	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
trans-Chlordane	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
cis-Chlordane	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----

No Guideline Evaluation Required

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Target Value	Intervention Value	MW5	MW6	MW7	MW8	Trip Blank
Client sample ID										
Sampling date/time						25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00	25-NOV-2015 15:00
						SG1521324-005	SG1521324-006	SG1521324-007	SG1521324-008	SG1521324-010
Organochlorine Pesticides - Continued										
alpha-Endosulfan	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
4.4`-DDE	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
beta-Endosulfan	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
4.4`-DDD	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Endosulfan sulfate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
4.4`-DDT	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Endrin ketone	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Organophosphorus Pesticides										
Malathion	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Dichlorvos	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Dimethoate	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Diazinon	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Chlorpyrifos-methyl	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Ethion	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Fenthion	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Chlorpyrifos	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Pirimphos-ethyl	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Prothiofos	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Parathion	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Methyl Parathion	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Chlorfenvinphos (E)	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
Chlorfenvinphos (Z)	EPA3510C/EPA8270D	1.00	µg/L	----	----	<1.00	<1.00	<1.00	<1.00	----
VOC Surrogates										
1.2-Dichloroethane-D4	EPA5030B/EPA8260C	0.1	%	----	----	**88.8**	**89.5**	**89.6**	**88.9**	**89.9**
Toluene-D8	EPA5030B/EPA8260C	0.1	%	----	----	**94.5**	**88.2**	**88.2**	**88.4**	**88.5**
4-Bromofluorobenzene	EPA5030B/EPA8260C	0.1	%	----	----	**102**	**101**	**99.6**	**97.8**	**101**
Acid Extractable Surrogates										
2-Fluorophenol	EPA3510C/EPA8270D	0.1	%	----	----	**36.9**	**53.3**	**36.6**	**32.9**	----
Phenol-d5	EPA3510C/EPA8270D	0.1	%	----	----	**39.2**	**43.0**	**42.2**	**33.4**	----
2.4.6-Tribromophenol	EPA3510C/EPA8270D	0.1	%	----	----	**60.0**	**58.8**	**55.8**	**57.0**	----
Base/Neutral Extractable Surrogates										
Nitrobenzene-D5	EPA3510C/EPA8270D	0.1	%	----	----	**53.7**	**47.2**	**50.1**	**52.3**	----
2-Fluorobiphenyl	EPA3510C/EPA8270D	0.1	%	----	----	**55.3**	**47.4**	**52.7**	**50.2**	----
4-Terphenyl-d14	EPA3510C/EPA8270D	0.1	%	----	----	**56.0**	**57.6**	**54.2**	**60.7**	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	Method	Acceptance Limits (%) Low	High
VOC Surrogates			
1.2-Dichloroethane-D4	EPA5030B/EPA8260C	76	114
Toluene-D8	EPA5030B/EPA8260C	88	110
4-Bromofluorobenzene	EPA5030B/EPA8260C	86	115
Acid Extractable Surrogates			
2-Fluorophenol	EPA3510C/EPA8270D	21	110
Phenol-d5	EPA3510C/EPA8270D	10	110
2.4.6-Tribromophenol	EPA3510C/EPA8270D	10	123
Base/Neutral Extractable Surrogates			
Nitrobenzene-D5	EPA3510C/EPA8270D	35	114
2-Fluorobiphenyl	EPA3510C/EPA8270D	43	116
4-Terphenyl-d14	EPA3510C/EPA8270D	33	141

CHAIN OF CUSTODY DOCUMENTATION

ATS 6960

ALS TECHNICHEM

1324

CLIENT: Environmental Resources Management (S) Pte Ltd
POSTAL ADDRESS: 120 Robinson Rd 068913
SEND REPORT TO: DESMOND LEUNG SEND INVOICE TO: DESMOND LEUNG
DATA NEEDED BY: 11/DEC/2015 REPORT NEEDED BY: 11/DEC 2015
PROJECT ID: DARWIN QUOTE NO.:
P.O. NO.: COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LABORATORY BATCH NO:
SAMPLERS:
PHONE: FAX:
REPORT FORMAT: HARD _____ FAX: _____ DISK: EMAIL BULLETIN BOARD: _____
QC LEVEL: QCS1 _____ QCS2 _____ QCS3 _____ QCS4 _____

FOR LAB USE ONLY
COOLER SEAL
Yes ..... No .....
Broken ..... Intact .....
COOLER TEMP: deg.C

SEND RESULTS TO
DESMOND.LEUNG@ERM.COM
LE.DUY@ERM.COM

ANALYSIS REQUIRED

SAMPLE DATA				*CONTAINER DATA			TTC FBS Suite	VOC suite	NOTES
SAMPLE ID	MATRIX	DATE	TIME	TYPE & PRESERVATIVE	NO.	pH			
MW1	Water	25/11/15	-	-	1	-	/		
MW2	"	"	-	-	1	-	/		
MW3	"	"	-	-	1	-	/		
MW4	"	"	-	-	1	-	/		
MW5	"	"	-	-	1	-	/		
MW6	"	"	-	-	1	-	/		
MW7	"	"	-	-	1	-	/		
MW8	"	"	-	-	1	-	/		
DUP 1	"	"	-	-	1	-	/		
TRIPBLANK	"	"	-	-	1	-		/	

ALS Technichem (S) Pte Ltd
Work Order
SG1521324
Telephone : +65 6589 0118

RELINQUISHED BY		RECEIVED BY	
NAME: Theodore Le Duy	DATE: 25/11/15	NAME:	DATE: 25/11/15
OF: ERM	TIME: 7:00pm	OF:	TIME: 7.01 pm
NAME:	DATE:	NAME:	DATE:
OF:	TIME:	OF:	TIME:

METHOD OF SHIPMENT
CONSIGNMENT NOTE NO.
TRANSPORT CO. NAME.

*Container Type and Preservative Codes: **P** = Natural Plastic; **N** = Nitric Acid Preserved; **C** = Sodium Hydroxide Preserved; **J** = Solvent Washed Acid Rinsed Jar; **S** = Solvent Washed Acid Rinsed Glass Bottle; **VC** = Hydrochloric Acid Preserved Vial; **VS** = Sulphuric Acid Preserved Vial; **BS** = Sulphuric Acid Preserved Glass Bottle; **Z** = Zinc Acetate Preserved Bottle; **E** = EDTA Preserved Bottle; **S** = Sterile Bottle.

ALS TECHNICHEM

Email @ 26/11
check by: YH

ALS TECHNICHEM (S) PTE LTD

OUR REF NO : SG 1521324
COMPANY : Environmental Resources Management

QA/QC REPORT

Remarks : QA/QC Results

a) All analyses were analyzed within their holding times.
b) Method blanks were run in each batch of analysis to check background interference, if any.
c) Surrogate spike recoveries were performed on each sample in the VOCs and SVOCs analysis. The results were summarized as below.
d) A summarized QC report on recoveries of Lab Control Samples(LCS) and Matrix Spike (MS) is attached. Upon review of the QA/QC datas, the recoveries of the laboratory control sample, matrix spikes and surrogate spikes (vocs & svocs) were within ALS laboratory acceptance criteria.

QA/QC Results :

% Surrogate Spike Recoveries

Volatile Organics (VOCs)

Surrogare Compound	Range for all samples
Dichloroethane-d_4	88-91
Toluene-d_8	88-95
4-Bromofluorobenzene	98-102

Semi-Volatile Organics (SVOCs)

Surrogate Compound	Range for all samples
2-Fluorophenol	25-60
Phenol-d_6	30-50
Nitrobenzene-d_5	47-69
2-Fluorobiphenyl	47-60
2,4,6-Tribromophenol	54-63
p-Terphenyl-d_{14}	53-61

ALS TECHNICHEM (S) PTE LTD

OUR REF NO : SG 1521324
COMPANY : Environmental Resources Management

Test	LCS % Recovery	MS, % recovery
TPH as diesel oil	102	97
SVOCs		
Phenol	95	96
2- Chlorophenol	88	95
4-Chloro-3-methyl phenol	92	104
Pentachlorophenol	81	78
Acenaphthene	85	80
Pyrene	82	81
N-nitroso-di-n-propylamine	84	86
2,4-dinitrotolune	92	89
1,4-dichlorobenzene	79	78
1,2,4-trichlorobenzene	83	92
VOCs		
Benzene	97	96
Toluene	103	92
1,1-Dichloroethene	95	101
Trichloroethene	100	102
Chlorobenzene	102	99
Metals		
Arsenic	106	109
Barium	85	83
Cadmium	102	100
Total chromium	99	97
Cobalt	100	98
Copper	97	95
Mercury	99	94
Lead	99	96
Molybdenum	99	100
Nickel	100	98
Zinc	99	99
Antimony	105	104

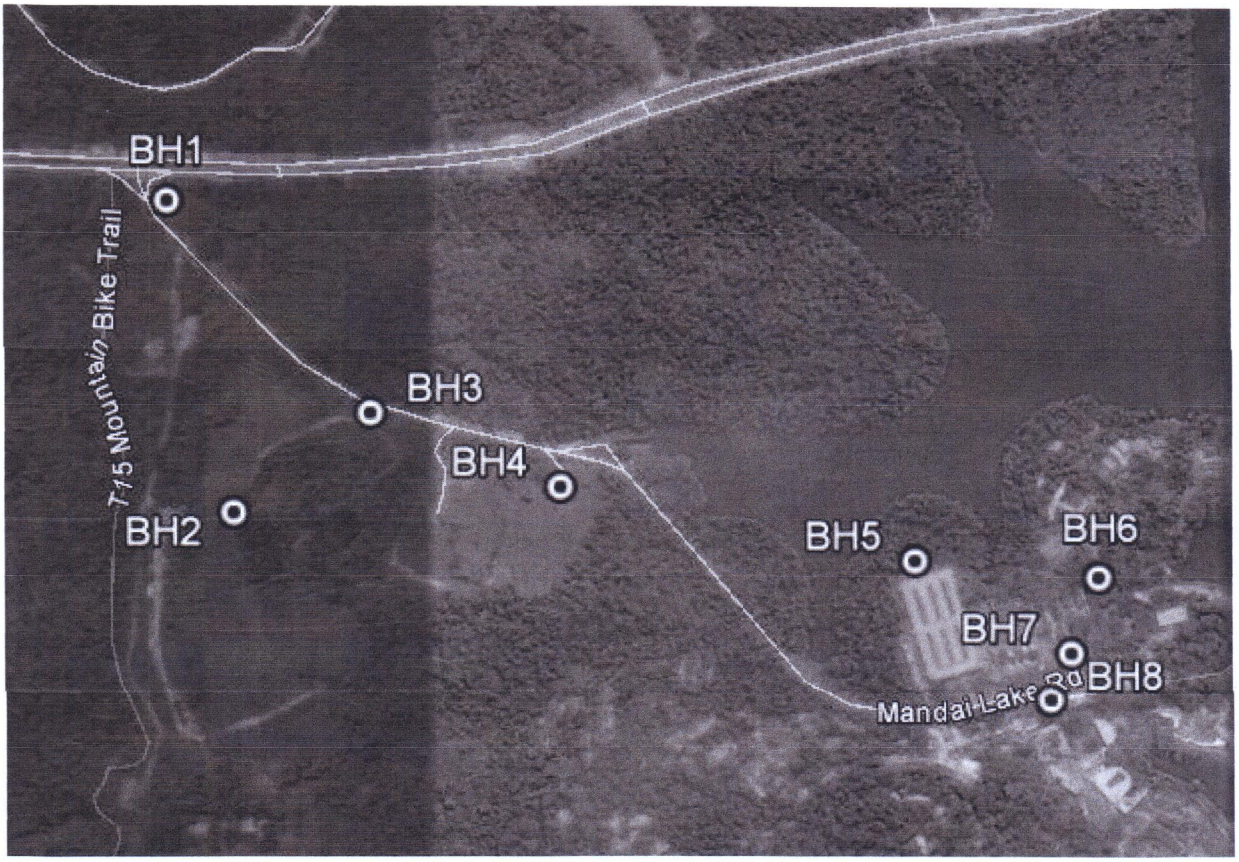
B P Tan Registered Surveyor
Blk 133 Jurong Gateway Road
#03-301 Singapore 600133
Tel: 64676108 Fax: 65611882 Email: bptan899@gmail.com

As-built Survey for Monitoring Wells

at Mandai Lake Road

TAN BOONG PING
Registered Surveyor (Singapore)

Date of Surveyed: 27 November 2015
Surveyed by: Kyaw Lwin Oo
Prepared by: Winnie
Checked by: Billy Tan



Location Sketch of Monitoring Wells at Mandai Lake Road

Report of As-built Level of Monitoring Wells at Mandai Lake Road

Reference no. of Monitoring Well	Location of Well (m)	Top of Pipe Level (m)	Ground Level next to Pipe (m)	Remarks
BH1	N. 43582.82 E. 21968.94	114.694	114.253	-
BH2	N. 43180.88 E. 22058.75	125.725	125.240	-
BH3	N. 43280.51 E. 22272.29	119.301	118.798	-
BH4	N. 43194.40 E. 22479.81	127.854	127.643	-
BH5	N. 43085.92 E. 22964.76	134.112	133.920	-
BH6	N. 43085.59 E. 23213.39	131.800	131.619	-
BH7	N. 42978.93 E. 23158.18	134.277	134.305	-
BH8	N. 42872.41 E. 23161.87	132.238	132.097	-

Notes:

1. Elevation datum based on VCP No. 80244 at Mandai Road.....RL 130.749m based on Mean Sea Level as 100m

TAN BOON PING
Registered Surveyor (Singapore)

Annex 10.0

Species Database

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
Flora Species																
1	Aristolochiaceae	*Aristolochia tagala*	Indian Birthwort	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-		-	-		-	-
2	Fabaceae	*Crotalaria retusa*	Rattleweed	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-		-	-		-	-
3	Fabaceae	*Parkia speciosa*	Petai	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-	Zone F	-	-
4	Fabaceae	*Pithecellobium dulce*	Madras Thorn	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
5	Fabaceae	*Saraca thaipingensis*	Yellow Saraca	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
6	Loranthaceae	*Dendrophthoe pentandra*	Mistletoe	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
7	Loranthaceae	*Macrosolen cochinchinensis*	Mistletoe	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
8	Loranthaceae	*Macrosolen retusus*	Mistletoe	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	Malaysia	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
9	Plantaginaceae	*Russelia juncea*	Fountain Plant	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
10	Acanthaceae	*Andrographis paniculata*	*Andrographis paniculata* (Burm. f.) Wall. ex Nees	*(2014) Mandai Gate Vegetation Survey*	O	IM + EA + AS	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
11	Acanthaceae	*Asystasia gangetica ssp. micrantha*	*Asystasia gangetica* (L.) T. Anderson *ssp. micrantha* (Nees) Ensermu	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range; Zone D; Zone A; Zone F	-	-
12	Acanthaceae	*Asystasia nemorum*	Asystasia	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	Malaysia	unknown	Not yet assessed	Not yet assessed		Parks and Trees Act (2006)			Lorong Asrama	-	-
13	Acanthaceae	*Justicia gendarussa*	*Justicia gendarussa* Burm. f.	*(2014) Mandai Gate Vegetation Survey*	O	IM + EA	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-		-	-
14	Acanthaceae	*Thunbergia fragrans*	*Thunbergia fragrans* Roxb.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone F	-	-
15	Acanthaceae	*Thunbergia grandiflora*	*Thunbergia grandiflora* Roxb.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	IM + EA +AS + Carribean + USA + Africa	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Zone F	-	-
16	Acanthaceae	*Asystasia intrusa/Asystasia gangetica*	Common Asystasia	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-	Zone D	-	-
17	Adiantaceae	*Adiantum flabellulatum*		*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	China + Japan + throughout SEA	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)			Lorong Asrama	-	-
18	Adiantaceae	*Adiantum latifolium*	*Adiantum latifolium* Lam.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone A; Zone E; Zone F	-	-
19	Alismataceae	*Limnocharis flava*	*Limnocharis flava* (L.) Buchenau	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
20	Amaranthaceae	*Alternanthera sessilis*	*Alternanthera sessilis* (L.) R. Br. ex DC.	*(2014) Mandai Gate Vegetation Survey*	O	Asia + Africa + AS + Carribean	-	LC	Least Concern ver 3.1	Cryptogenic Weed	Parks and Trees Act (2006)	-	This is a pioneer or ruderal species typically growing on disturbed parts of a variety of wetland habitats, often in species-rich associations with a range of other aquatic and wetland plants.		-	This species has a huge global range including both native and introduced distribution. It is probably no longer possible to be certain of its native range and consequently whether there may be different trends in native and introduced populations. However, it is extremely abundant and increasing in many areas, to the extent that it is widely considered a weed.
21	Anacardiaceae	*Campnosperma auriculatum*	*Campnosperma auriculatum* Hook. f.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	BO + TM	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Mandai Firing Range; Zone D; Zone A; Zone E; Zone F	-	-
22	Anacardiaceae	*Campnosperma squamatum*	*Campnosperma squamatum* Ridl.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	BO + Malaysia	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone A	-	-
23	Anacardiaceae	*Gluta wallichii*	*Gluta wallichii* (Hook. f.) Ding Hou	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone F	-	-
24	Anacardiaceae	*Mangifera foetida*	*Mangifera foetida* Lour. / Horse Mango	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	LC	Lower Risk/least concern ver 2.3	VU	Parks and Trees Act (2006)	-	In undisturbed forests up to 1500 m altitude. Often cultivated and present in forest gardens. Usually growing on hillsides and ridges on sandy soils. In secondary forests usually present as a pre-disturbance remnant, or as planted tree.	Zone D	-	Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo (Sarawak, Sabah, West-, Central- and East-Kalimantan), Celebes, Moluccas and New Guinea.
25	Anacardiaceae	*Mangifera indica*	*Mangifera indica* L.	*(2014) Mandai Gate Vegetation Survey*	O	IM + EA	No	DD	Data Deficient ver 2.3	Casual	Parks and Trees Act (2006)	-	Terrestrial		-	-
26	Anacardiaceae	*Mangifera sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone F	-	-
27	Anisophyllaceae	*Anisophyllea disticha*	*Anisophyllea disticha* (Jack) Baill.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD	Yes	LC	Lower Risk/least concern ver 2.3	Common	Parks and Trees Act (2006)	-	A widespread shrub or small tree found in the understorey of mixed dipterocarp forest and old secondary forest on various soil types.	Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
28	Annonaceae	*Artabotrys cf. constatus*	*Artabotrys constatus* King	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)	-	-	Zone F	-	-
29	Annonaceae	*Artabotrys crassifolius*	*Artabotrys crassifolius* Hook. f. & Thomson	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone E	-	-
30	Annonaceae	*Artabotrys maingayi*	*Artabotrys maingayi* Hook. f. & Thomson	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	-
31	Annonaceae	*Artabotrys sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)	-	-	Zone F	-	-
32	Annonaceae	*Artabotrys suaveolens*	*Artabotrys suaveolens* (Blume) Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone A; Zone F	-	-
33	Annonaceae	*Cyathocalyx 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Potentially VU and above	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
34	Annonaceae	*Dasymaschalon dasymaschalum*	*Dasymaschalon dasymaschalum* (Blume) I.M.Turner	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone A; Zone F Fragment 1	-	-
35	Annonaceae	*Drepananthus ramuliflorus*	*Drepananthus ramuliflorus* Maingay ex Hook. f. & Thomson	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O			Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone A	-	-
36	Annonaceae	*Drepananthus ridleyi*	*Drepananthus ridleyi* (King) Survesw. & R.M.K.Saunders	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-		-	-
37	Annonaceae	*Fissistigma 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Potentially VU and above	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
38	Annonaceae	*Fissistigma fulgens*	*Fissistigma fulgens* (Hook. f. & Thomson) Merr	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O		Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone A	-	-
39	Annonaceae	*Fissistigma latifolium var. ovoideum*	*Fissistigma latifolium* (Dunal) Merr. var. ovoideum (King) Sinclair	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone A; Zone F Fragment 1	-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing^	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
40	Annonaceae	*Fissistigma manubriatum*	*Fissistigma manubriatum* (Hook.f. & Thoms.) Merr.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU/D	Parks and Trees Act (2006)	-	-	Zone E	-	-
41	Annonaceae	*Friesodielsia glauca*	*Friesodielsia glauca* (Hook. f. & Thoms.) Steenis	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Rediscovered	Parks and Trees Act (2006)	-	-	Zone A	-	-
42	Annonaceae	*Friesodielsia latifolia*	*Friesodielsia latifolia* (Hook. f. & Thoms.) Steenis	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B; Zone A; Zone F Fragment 1	-	-
43	Annonaceae	*Goniothalamus macrophyllus*	*Goniothalamus macrophyllus* (Blume) Hook. f. & Thomson	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	Undisturbed forests up to 1240 m altitude. Quite often found in disturbed forests, but usually as a pre-disturbance remnant.	Zone A	-	-
44	Annonaceae	*Mitrella kentii*	*Mitrella kentii* (Blume) Miq.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone A; Zone B	-	-
45	Annonaceae	*Monocarpia marginalis*	*Monocarpia marginalis* (Scheff.) J. Sinclair	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	-
46	Annonaceae	*Phaeanthus ophthalmicus*	*Phaeanthus ophthalmicus* (Roxb. ex G. Don) J. Sinclair	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone D; Zone A; Zone E; Zone F Fragment 1	-	-
47	Annonaceae	*Polyalthia 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Potentially VU and above	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
48	Annonaceae	*Polyalthia angustissima*	*Polyalthia angustissim* Ridl.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	DD	Data Deficient ver 2.3	VU	Parks and Trees Act (2006)	-	Occurring in lowland forest below 100 m.	Zone A	-	This species is known from localities in Johore and Bukit Timah Forest Reserve in Singapore.
49	Annonaceae	*Polyalthia rumphii*	*Polyalthia rumphii* (Blume ex Hensch.) Merr	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	In undisturbed forests up to 950 m altitude. More or less growing all over the forest, from alluvial sites to hillsides and ridges. Mostly on sandy-clay soils, but also found in limestone areas. Quite often found in disturbed forests, but usually as a pre-disturbance remnant.	Zone F Fragment 1	-	Peninsular Malaysia, Sumatra, Java, Borneo (Sarawak, Brunei, Sabah, West-, Central-, South- and East-Kalimantan), Philippines, Celebes, Moluccas, New Guinea and the Solomon islands
50	Annonaceae	*Popowia fusca*	*Popowia fusca* King	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	Yes	LC	Lower Risk/least concern ver 2.3	VU	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	-
51	Annonaceae	*Pyramidanthe 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Potentially EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
52	Annonaceae	*Uvaria curtisii*	*Uvaria curtisii* King	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O		Yes	Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)	-		Zone A	-	-
53	Annonaceae	*Uvaria leptopoda*	*Uvaria leptopoda* (King) R.E. Fries	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-		-	-
54	Annonaceae	*Uvaria sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-		Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone A; Zone F	-	-
55	Annonaceae	*Xylopia caudata*	*Xylopia caudata* Hook. f. & Thoms.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone A	-	-
56	Annonaceae	*Xylopia malayana*	*Xylopia malayana* Hook. f. & Thoms.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone A; Zone E; Zone F	-	-
57	Apiaceae	*Centella asiatica*	*Centella asiatica* (L.) Urb.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	LC	Least Concern ver 3.1	Common	Parks and Trees Act (2006)		This species is floating emergent or terrestrial. It is rather frequent in grassland, especially along riversides, chiefly in cultivated lands. It is found in ponds and streamsides, evergreen forests, fields, or as a garden weed, from 300-1,450 m. It is found in shady, wet, grassy places, and river margins; from 200–1,900 m as well as flooded agricultural fields.	Zone F	-	The species is widespread throughout tropical and subtropical countries worldwide.
58	Apocynaceae	*Allamanda cathartica*	*Allamanda cathartica* L.	*(2014) Mandai Gate Vegetation Survey*	O	Asia + AS + South America	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-		-	-
59	Apocynaceae	*Alstonia angustifolia*	*Alstonia angustifolia* Wall. ex A. DC.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD + PH + Vietnam	Yes	LC	Lower Risk/least concern ver 2.3	Common	Parks and Trees Act (2006)	-	-	Zone A; Zone E; Zone F	-	-
60	Apocynaceae	*Alstonia angustiloba*	*Alstonia angustiloba* Miq/ Common Pulai	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	This Pulai grows in a wide variety of soils and is common in hilly mixed Dipterocarp forests and freshwater swamp forests.	Zone F	Mount Faber, Bukit Batok Nature Park.	Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and the Philippines.
61	Apocynaceae	*Alstonia scholaris*	*Alstonia scholaris* (L.) R. Br.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Asia + Oceania	Yes	LC	Lower Risk/least concern ver 2.3	Common	Parks and Trees Act (2006)	-	Terrestrial	Mandai East Camp; Zone B; Zone D; Zone A; Zone F	-	-
62	Apocynaceae	*Alyxia reinwardtii*	*Alyxia reinwardtii* Blume	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone A	-	
63	Apocynaceae	*Anodendron candolleanum*	*Anodendron candolleanum* Wight	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	TM + BO + PH	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone A; Zone E; Zone F Fragment 1	-	-
64	Apocynaceae	*Catharanthus roseus*	*Catharanthus roseus* (L.) G. Don	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone D	-	-
65	Apocynaceae	*Dyera costulata*	*Dyera costulata* (Miq.) Hook. f.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	BO + TM	Yes	LC	Lower Risk/least concern ver 2.3	Common	Parks and Trees Act (2006)	-	A large timber tree, preferring primary evergreen lowland or hill forest up to 300 m	Zone A; Zone F	-	-
66	Apocynaceae	*Hoya latifolia*	*Hoya latifolia* G. Don	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	BO + TM	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone F	-	-
67	Apocynaceae	*Hoya verticillata var. verticillata*	*Hoya verticillata* (Vahl) G. Don var. *verticillata*	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	Terrestrial (Primary rainforest, Secondary rainforest, Coastal rainforest), Shoreline (Mangrove forest)	Zone F	India, Indochina, Malesia	-
68	Apocynaceae	*Leuconotis griffithii*	*Leuconotis griffithii* Hook.f.	*(2014) Mandai Gate Vegetation Survey*	O	SD + TM	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-		-	-
69	Apocynaceae	*Strophanthus caudatus*	*Strophanthus caudatus* (L.) Kurz	*(2014) Mandai Gate Vegetation Survey*	O	IM + EA	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-		-	-
70	Apocynaceae	*Tabernaemontana corymbosa*	*Tabernaemontana corymbosa* Roxb. ex Wall.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	IM + China	Yes	LC	Lower Risk/least concern ver 2.3	EN	Parks and Trees Act (2006)	-	-	Zone A; Zone E; Zone F Fragment 1	-	-
71	Apocynaceae	*Tabernaemontana divaricata*	*Tabernaemontana divaricata* (L.) R. Br. ex Roem. & Schult.	*(2014) Mandai Gate Vegetation Survey*	O	Asia + US + Carribean	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-		-	-
72	Apocynaceae	*Willughbeia coriacea*	*Willughbeia coriacea* Wall.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	TM + BO	Yes	Not yet assessed	Not yet assessed	Erroneously extinct	Parks and Trees Act (2006)	-	-	Zone A	-	-
73	Apocynaceae	*Willughbeia sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone F	-	
74	Apocynaceae	*Cerbera odollam*	Pong-Pong Tree	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
75	Araceae	*Aglaonema commutatum*	*Aglaonema commutatum* Schott	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Mandai Firing Range; Zone B; Zone D; Zone F	-	-
76	Araceae	*Aglaonema sp.*	-	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-		Not yet assessed	Not yet assessed		Parks and Trees Act (2006)	-	-	Zone A	-	-
77	Araceae	*Alocasia longiloba*	*Alocasia longiloba* Miq.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
78	Araceae	*Alocasia macrorrhizos*	*Alocasia macrorrhizos* (L.) G. Don	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Lorong Asrama; Zone F	-	-
79	Araceae	*Anadendrum sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-		Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone A	-	

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80	Araceae	*Colocasia esculenta*	*Colocasia esculenta* (L.) Schott	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	IM + China	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Lorong Asrama; Zone F	-	In the wild it is relatively common, but it is also cultivated.
81	Araceae	*Dieffenbachia seguine*	*Dieffenbachia seguine* (Jacq.) Schott var. seguine	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range; Zone D; Zone F	-	-
82	Araceae	*Epipremnum aureum*	Epipremnum aureum (Linden ex André) Bunting	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range; Zone B; Zone D; Zone F	-	-
83	Araceae	*Epipremnum giganteum*	*Epipremnum giganteum* (Roxb.) Schott	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone F	-	-
84	Araceae	*Epipremnum pinnatum*	*Epipremnum pinnatum* (L.) Engl.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone B; Zone F	-	-
85	Araceae	*Philodendron hederaceum*	*Philodendron hederaceum* (Jacq.) Schott	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Zone D; Zone F	-	-
86	Araceae	*Rhaphidophora 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Potentially VU and above	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
87	Araceae	*Scindapsus 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northeast, Southeast of Mandai Lake Road	-	-
88	Araceae	*Scindapsus hederaceus*	*Scindapsus hederaceus* (Zoll. & Moritizi) Miq.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	PH + IC	Yes	LC	Least Concern ver 3.1	Common	Parks and Trees Act (2006)	-	It has been reported climbing on trees. Rainforest is assumed to be the suitable habitat.	Zone E; Zone F	-	The population size for this species is not known.
89	Araceae	*Scindapsus sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone A	-	-
90	Araceae	*Syngonium podophyllum*	*Syngonium podophyllum* Schott	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range; Zone B; Zone D; Zone E; Zone F	-	-
91	Araliaceae	*Arthrophyllum diversifolium*	*Arthrophyllum diversifolium* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone A; Zone F; Zone F Fragment 1	-	-
92	Araliaceae	*Polyscias diversifolia*	*Polyscias diversifolia* (Blume) Lowry & G.M.Plunkett	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-		-	-
93	Araliaceae	*Schefflera actinophylla*	*Schefflera actinophylla* (Endl.) Harms	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O		No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Zone F	-	-
94	Arecaceae	*Areca catechu*	*Areca catechu* L.	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Malesia	No	Not yet assessed	Not yet assessed	Casual; cultivated	Parks and Trees Act (2006)		Prefers deep, well-drained soilds that are slightly acidic to neutral. Has a low tolerance for salt and wind.	Mandai East Camp; Mandai Firing Range; Zone F	-	-
95	Arecaceae	*Caryota mitis*	Fishtail Palm	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range; Lorong Asrama; Zone B; Zone D; Zone A; Zone E; Zone F	-	-
96	Arecaceae	*Cocos nucifera*	Coconut Palm	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range	-	-
97	Arecaceae	*Cyrtostachys renda*	*Cyrtostachys renda* Blume	*(2014) Mandai Gate Vegetation Survey*	O	SD + Thailand	Yes	Not yet assessed	Not yet assessed	Extinct	Parks and Trees Act (2006)	-	-		-	-
98	Arecaceae	*Daemonorops sp.*	-	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-		Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone F Fragment 1	-	-
99	Arecaceae	*Dypsis lutescens*	*Dypsis lutescens* (H. Wendl.) Beentje & J. Dransf.	*(2014) Mandai Gate Vegetation Survey*	O	Madagascar	No	NT	Near Threatened ver 3.1	Cultivated only	Parks and Trees Act (2006)	-	The species occurs mainly in swampy areas along the white sand dunes in the littoral of the Indian Ocean but it may be also found on alluvium at much higher elevations (up to 300 m) in Mananara Avaratra, Makira and Daraina.		-	Abundant and frequent species where it occurs. There is evidence of some decline.
100	Arecaceae	*Elaeis guineensis*	*Elaeis guineensis* Jacq.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Mandai Firing Range; Lorong Asrama; Zone B; Zone D; Zone A; Zone F	-	-
101	Arecaceae	*Korthalsia sp.*	-	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-		Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	-
102	Arecaceae	*Licuala sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone A	-	-
103	Arecaceae	*Licuala spinosa*	*Licuala spinosa* Wurmb	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	-	-	VU	Parks and Trees Act (2006)	-	-		-	-
104	Arecaceae	*Nenga pumila var. pachystachya*	*Nenga pumila* (Mart.) H. Wendl. var. pachystachya (Blume) Fernando	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	-	-	CR	Parks and Trees Act (2006)	-	-		-	-
105	Arecaceae	*Oncosperma horridum*	*Oncosperma horridum* (Griff.) Scheff.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	PH + SD + Thailand	Yes	-	-	VU	Parks and Trees Act (2006)	-	-	Zone A; Zone E; Zone F	-	-
106	Arecaceae	*Oncosperma sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone D; Zone E; Zone F	-	-
107	Arecaceae	*Oncosperma tigillarium*	*Oncosperma tigillarium* (Jack) Ridl.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	IM	Yes	-	-	VU	Parks and Trees Act (2006)	-	-	Mandai Firing Range; Zone B; Zone D; Zone E	-	-
108	Arecaceae	*Phoenix reclinata*	*Phoenix reclinata* Jacq.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	-	-	Cultivated only	Parks and Trees Act (2006)	-	-		-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
109	Arecaceae	*Pinanga malaiana*	*Pinanga malaiana* (Mart.) Scheff	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	Yes	-	-	EN	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	-
110	Arecaceae	*Plectocomia elongata*	*Plectocomia elongata* Mart. ex Blume	*(2014) Mandai Gate Vegetation Survey*	O	SD+ IC	Yes	-	-	VU	Parks and Trees Act (2006)	-	-		-	-
111	Arecaceae	*Ptychosperma macarthurii*	MacArthur Palm	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	-	-	Naturalized	Parks and Trees Act (2006)	-	-	Lorong Asrama; Zone D; Zone A; Zone E; Zone F	-	-
112	Arecaceae	*Rattan*	-	*(2014) Mandai Gate Vegetation Survey*	O	-		-	-		Parks and Trees Act (2006)	-	-		-	-
113	Arecaceae	*Archontophoenix alexandrae*	Alexandra Palm	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
114	Arecaceae	*Livistona chinensis*	Chinese Fan Palm	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
115	Arecaceae	*Rhopaloblaste ceramica*	Seram Palm	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
116	Aristolochiaceae	*Thottea grandiflora*	*Thottea grandiflora* Rottb.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	TM	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone A	-	-
117	Asparagaceae	*Cordyline fruticosa*	*Cordyline fruticosa* (L.) A. Chev.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-		-	-
118	Asparagaceae	*Dracaena cantleyi*	*Dracaena cantleyi* Baker	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	TM + BO	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	-
119	Asparagaceae	*Dracaena fragrans*	*Dracaena fragrans* (L.) Ker Gawl.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Lorong Asrama; Zone B; Zone D; Zone F	-	-
120	Asparagaceae	*Dracaena maingayi*	*Dracaena maingayi* Hook. f.	*(2014) Mandai Gate Vegetation Survey*	O	Malaysia	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-		-	-
121	Asparagaceae	*Dracaena porteri*	*Dracaena porteri* Baker	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone A; Zone E	-	-
122	Asparagaceae	*Dracaena sanderiana*	*Dracaena sanderiana* Sander	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Native to Africa	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	Semi-shade and moderate water conditions	Zone D	-	-
123	Asparagaceae	*Dracaena sp.*	-	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp*	O	-		Not yet assessed	Not yet assessed		Parks and Trees Act (2006)	-	-	Mandai East Camp	-	-
124	Asparagaceae	*Dracaena surculosa*	*Dracaena surculosa* Lindl.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-	Zone B	-	-
125	Aspleniaceae	*Asplenium longissimum*	*Asplenium longissimum* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	IM	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B; Zone E; Zone F	-	-
126	Aspleniaceae	*Asplenium nidus*	*Asplenium nidus* L.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range; Zone B; Zone D; Zone A; Zone F	-	-
127	Asteraceae	*Ageratum conyzoides*	*Ageratum conyzoides* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
128	Asteraceae	*Bidens alba*	*Bidens rubicundula alba* T.G.J.Rayner	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)			Zone F	-	-
129	Asteraceae	*Bidens pilosa*	*Bidens pilosa* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
130	Asteraceae	*Chromolaena odorata*	*Chromolaena odorata* (L.) R.M.King & H.Rob.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
131	Asteraceae	*Eleutheranthera ruderalis*	*Eleutheranthera ruderalis* (Sw.) Sch.Bip	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone D	-	-
132	Asteraceae	*Erechtites valerianifolia*	*Erechtites valerianifolia* valerianifolius (Wolf) DC.	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	No	Not yet assessed	Not yet assessed		Parks and Trees Act (2006)	-	-	Lorong Asrama	-	-
133	Asteraceae	*Mikania cordata*	*Mikania cordata* (Burm. F.) B. L. Rob	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	-	Not yet assessed	Not yet assessed	Weed of uncertain origin	Parks and Trees Act (2006)			Lorong Asrama	-	-
134	Asteraceae	*Mikania micrantha*	*Mikania micrantha* Kunth	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone F	-	-
135	Asteraceae	*Sphagneticola trilobata*	*Sphagneticola trilobata* (L.) Pruski	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone D	-	-
136	Asteraceae	*Synedrella nodiflora*	*Synedrella nodiflora* (L.) Gaertn.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone B	-	-
137	Asteraceae	*Tridax procumbens*	*Tridax procumbens* L.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Central America	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)			Zone D	-	-
138	Asteraceae	*Vernonia cinerea*	*Vernonia cinerea* (L.) Less.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-	Lorong Asrama; Zone F	-	-
139	Asteraceae	*Wedelia trilobata(now known as Sphagneticola trilobata)*	Singapore Daisy	*NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range*	O	Central America + South America	No	Not yet assessed	Not yet assessed	Naturalised; cultivated	Parks and Trees Act (2006)			Mandai Firing Range	-	-
140	Asteraceae	*Pluchea indica*	Malayan Fleabane	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
141	Asteraceae	*Vernonia arborea*	Tree Vernonia	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
142	Asteraceae	*Wedelia biflora*	Sea Ox Eye	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
143	Bignoniaceae	*Spathodea campanulata*	*Spathodea campanulata* P. Beauv.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range; Lorong Asrama; Zone B; Zone D; Zone F	-	-
144	Bignoniaceae	*Tabebuia rosea*	*Tabebuia rosea* (Bertol.) DC.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Zone B	-	-
145	Blechnaceae	*Blechnum finlaysonianum*	*Blechnum finlaysonianum* Wall. ex Hook. & Grev.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU/D	Parks and Trees Act (2006)	-	-	Zone A	-	-
146	Blechnaceae	*Blechnum orientale*	*Blechnum orientale* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-		-	-
147	Blechnaceae	*Blechnum sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-		Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone F	-	-
148	Blechnaceae	*Stenochlaena palustris*	*Stenochlaena palustris* (Burm. f.) Bedd.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone A; Zone E; Zone F	-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
149	Boraginaceae	*Cordia cylindristachya*	Stringbush	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	Tropical America	No	Not yet assessed	Not yet assessed	Naturalised; cultivated	Parks and Trees Act (2006)	-	Thrives in fertile soil under full sun but is drought resistant and can grow in relatively poor soil; flowers are popular with butterflies.	-	-	-
150	Boraginaceae	*Ehretia microphylla*	*Ehretia microphylla* Lam	*(2014) Mandai Gate Vegetation Survey*	O	IM +AS	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
151	Boraginaceae	*Heliotropium indicum*	Indian Turnsole	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
152	Burseraceae	*Canarium sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)			Zone B	-	-
153	Burseraceae	*Canarium littorale*	*Canarium littorale* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD + Vietnam	Yes	LC	Lower Risk/least concern ver 2.3	Common	Parks and Trees Act (2006)	-	Occurring in secondary forest, especially on periodically flooded sandy alluvium.	Zone D; Zone F	-	It is locally common.
154	Burseraceae	*Canarium pilosum*	*Canarium pilosum* Benn.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	BO + Malaysia	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone A; Zone F Fragment 1	-	-
155	Burseraceae	*Dacryodes longifolia*	*Dacryodes longifolia* (King) Lam	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	PH + Malaysia	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone A; Zone F Fragment 1	-	-
156	Burseraceae	*Santiria apiculata*	*Santiria apiculata* Benn.	*(2014) Mandai Gate Vegetation Survey*	O	SD + PH	Yes	LC	Lower Risk/least concern ver 2.3	Common	Parks and Trees Act (2006)	-	-		-	-
157	Burseraceae	*Santiria griffithii*	*Santiria griffithii* (Hook. f.) Engl.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD	Yes	LC	Lower Risk/least concern ver 2.3	Common	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	-
158	Burseraceae	*Santiria laevigata*	*Santiria laevigata* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD + PH	Yes	LC	Lower Risk/least concern ver 2.3	VU	Parks and Trees Act (2006)	-	Found in mixed dipterocarp, mixed peat swamp and kerangas forests up to 1,200 m.	Zone A	-	-
159	Burseraceae	*Santiria rubiginosa*	*Santiria rubiginosa* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone A	-	-
160	Burseraceae	*Santiria tomentosa*	*Santiria tomentosa* Blume	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	LC	Lower Risk/least concern ver 2.3	EN	Parks and Trees Act (2006)	-	Found in lowland mixed dipterocarp forest.	Zone A	-	A common and widely distributed tree.
161	Burseraceae	*Trimonma maloccensis*	*Trimonma maloccensis* Hook. f.	*(2014) Mandai Gate Vegetation Survey*	O	SD	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-		-	-
162	Calophyllaceae	*Calophyllum 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
163	Calophyllaceae	*Calophyllum cf. tetrapterum*	*Calophyllum tetrapterum* Miq.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-		-	-
164	Calophyllaceae	*Calophyllum ferrugineum*	*Calophyllum ferrugineum* Ridl.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)		Can be found in primary and secondary forests. The local variety of C. ferrugineum is commonly found in lowland dipterocarp forests, to about 420 m altitude. In can sometimes be found in seasonally flooded forests as well. Flowering noted in November, December, while fruiting in December, January and April.	Zone B	Bukit Timah Nature Reserve, Central Catchment Nature Reserve.	Malay Peninsula, Singapore and Borneo.
165	Calophyllaceae	*Calophyllum pulcherrimum*	*Calophyllum pulcherrimum* Wall. ex Choisy	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone D; Zone A; Zone E; Zone F	-	-
166	Calophyllaceae	*Calophyllum rubiginosum*	*Calophyllum rubiginosum* M. R. Henderson & Wyatt-Smith	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)		C. rubiginosum is found in lowland or hilly forests, from 30 - 500 m elevation. Flowering occurs from January to May, and from July to August. Fruiting also occur twice: April to July and October to December.	Zone A	Bukit Timah Nature Reserve, Central Catchment Nature Reserve.	Southern Malay Peninsula to Sumatra and Borneo.
167	Calophyllaceae	*Calophyllum sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-		Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone F	-	-
168	Calophyllaceae	*Calophyllum tetrapterum*	*Calophyllum tetrapterum* Miq.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	LC	Least Concern ver 3.1	VU	Parks and Trees Act (2006)		Well-drained mixed dipterocarp forest up to 1,000 m.	Zone D; Zone A; Zone E; Zone F Fragment 1	-	A species occurring as two varieties; var. tetrapterum that is found throughout the species range, and var. obovale that is scattered in Peninsular Malaysia, Sumatra and Borneo.
169	Calophyllaceae	*Calophyllum teysmannii*	*Calophyllum teysmannii* Miq.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone A; Zone F; Zone F Fragment 1	-	-
170	Calophyllaceae	*Calophyllum wallichianum var. incrassatum*	*Calophyllum wallichianum* Planch. & Tr. var. incrassatum (Hend. & Wyatt-Smith) P. F. Stevens	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone D; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
171	Cannabaceae	*Gironniera nervosa*	*Gironniera nervosa* Planch.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD + IC	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
172	Cannabaceae	*Gironniera subaequalis*	*Gironniera subaequalis* Planch.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone A	-	-
173	Cannabaceae	*Trema cannabina*	*Trema cannabina* Lour.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range	-	-
174	Cannabaceae	*Trema sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O			Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone F	-	-
175	Cannaceae	*Canna indica*	*Canna indica* L.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Mandai Firing Range	-	-
176	Celastraceae	*Salacia grandiflora*	*Salacia grandiflora* Kurz	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone D; Zone A; Zone F Fragment 1	-	-
177	Celastraceae	*Salacia korthalsiana*	*Salacia korthalsiana* Miq	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone A	-	-
178	Celastraceae	*Salacia miqueliana*	*Salacia miqueliana* Loes	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-		-	-
179	Celastraceae	*Salacia sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone E	-	-
180	Centroplacaceae	*Bhesa paniculata*	*Bhesa paniculata* Arn.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	TM + PH + Indonesia	Yes	LC	Lower Risk/least concern ver 2.3	Common	Parks and Trees Act (2006)	-	Found in a variety of habitat types.	Zone B; Zone D; Zone A; Zone F	-	A common and widespread tree.
181	Centroplacaceae	*Bhesa robusta*	*Bhesa robusta* (Roxb.) Ding Hou	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	North-east India + BO		LC	Lower Risk/least concern ver 2.4	VU	Parks and Trees Act (2006)	-	Found in mixed dipterocarp forests. In undisturbed mixed dipterocarp forests up to 900 m altitude. Usually on hillsides and ridges with sandy to clay soils.	Zone F	-	-
182	Chrysobalanaceae	*Licania splendens*	*Licania splendens* (Korth.) Prance	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD + Thailand	Yes	LC	Lower Risk/least concern ver 2.3	Common	Parks and Trees Act (2006)	-	A common tree of lowland primary and secondary mixed dipterocarp forest.	Zone A; Zone E; Zone F	-	-
183	Cleomaceae	*Cleome rutidosperma*	*Cleome rutidosperma* DC.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
184	Clusiaceae	*Garcinia eugeniifolia*	*Garcinia eugeniifolia* Wall. ex T. Anderson	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-		-	-
185	Clusiaceae	*Garcinia forbesii*	*Garcinia forbesii* King	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Malaysia	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone D; Zone F	-	-
186	Clusiaceae	*Garcinia griffithii*	*Garcinia griffithii* T. Anderson	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Malaysia	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone D; Zone E	-	-
187	Clusiaceae	*Garcinia nigrolineata*	*Garcinia nigrolineata* Planch. ex T. Anderson	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-		-	-
188	Clusiaceae	*Garcinia parvifolia*	*Garcinia parvifolia* Miq.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Malaysia	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
189	Clusiaceae	*Garcinia rostrata*	*Garcinia rostrata* Hassk. ex Hook. fil.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)			Zone A	-	-
190	Clusiaceae	*Garcinia scortechinii*	*Garcinia scortechinii* King	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD	Yes	LC	Lower Risk/least concern ver 2.3	CR	Parks and Trees Act (2006)	-	A lowland species	Zone A	-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
191	Combretaceae	*Combretum indicum*	*Combretum indicum* (L.) DeFilipps	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Zone F	-	-
192	Combretaceae	*Quisqualis indica*	*Quisqualis indica* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-		-	-
193	Combretaceae	*Terminalia catappa*	Sea almond tree	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range*	O	EA + IM + TM	Yes	Not yet assessed	Not yet assessed	Commorcultivated	Parks and Trees Act (2006)		Coastal forest, mangrove forest, sandy beaches and rocky beaches	Mandai East Camp; Mandai Firing Range; Zone D; Zone F	-	-
194	Commelinaceae	*Commelina diffusa*	*Commelina diffusa* Burm. f.	*(2014) Mandai Gate Vegetation Survey*	O	IM + EA + Africa	-	LC	Least Concern ver 3.1	Cryptogenic Weed	Parks and Trees Act (2006)	-	Globally, it is a common weed usually found in damp shady places near water but also found in open swamps and marshes and sometimes found floating in mats. This species also occurs as a weed in cultivated fields, forests, thickets, streamsides, and humid open places.		-	Globally, it is a common species
195	Compositae	*Porophyllum ruderale*	*Porophyllum ruderale* (Jacq.) Cass.	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	No	Not yet assessed	Not yet assessed	Naturalised	Parks and Trees Act (2006)			Lorong Asrama	-	-
196	Connaraceae	*Agelaea borneensis*	*Agelaea borneensi* s (Hook. f.) Merr.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
197	Connaraceae	*Agelaea macrophylla*	*Agelaea macrophylla* (Zoll.) Leenh.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
198	Connaraceae	*Cnestis palala*	*Cnestis palala* (Lour.) Merr.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone A	-	-
199	Connaraceae	*Connarus semidecandrus*	*Connarus semidecandrus* Jack	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
200	Connaraceae	*Connarus sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-		Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone A	-	-
201	Connaraceae	*Rourea acutipetala ssp. acutipetala*	*Rourea acutipetala* Miq. ssp. *acutipetala*	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Rediscovered	Parks and Trees Act (2006)	-	-	Zone D; Zone A; Zone F Fragment 1	-	-
202	Connaraceae	*Rourea asplenifolia*	*Rourea asplenifolia* (Schellenb.) Jongkind.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Malaysia	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone B; Zone A; Zone E; Zone F Fragment 1	-	-
203	Connaraceae	*Rourea mimosoides*	*Rourea mimosoides* (Vahl) Planch.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone A; Zone F	-	-
204	Connaraceae	*Rourea minor*	*Rourea minor* (Gaertn.) Leenh.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	zone A; Zone E	-	-
205	Connaraceae	*Santaloides filgens*	*Santaloides filgens* (Planch.) Kuntze	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-		-	-
206	Convolvulaceae	*Argyreia nervosa*	*Argyreia nervosa* (Burm. fil.) Bojer	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-	Zone F	-	-
207	Convolvulaceae	*Erycibe leucoxyloides*	*Erycibe leucoxyloides* King ex Prain	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Malaysia	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-	Zone A	-	-
208	Convolvulaceae	*Erycibe tomentosa*	*Erycibe tomentosa* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
209	Convolvulaceae	*Ipomoea cairica*	Ipomoea cairica (L.) Sweet	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range; Zone D	-	-
210	Convolvulaceae	*Ipomoea pes-caprae*	*Ipomoea pes-caprae* (L.) R. Br.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone D	-	-
211	Convolvulaceae	*Ipomoea sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-		Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone D; Zone F	-	-
213	Convolvulaceae	*Ipomoea triloba*	*Ipomoea triloba* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
214	Convolvulaceae	*Ipomoea violacea*	Morning glory	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp*	O	Pantropical	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)			Mandai East Camp	-	-
215	Convolvulaceae	*Merremia umbellata*	*Merremia umbellata* (L.) Hallier f.	*(2014) Mandai Gate Vegetation Survey*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-		-	-
216	Convolvulaceae	*Xenostegia tridentata*	*Xenostegia tridentata* (L.) D. F. Austin and STaples	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Yes	Not yet assessed	Not yet assessed		Parks and Trees Act (2006)			Lorong Asrama	-	-
217	Costaceae	*Chrilocostus speciosus*	*Chrilocostus speciosus* (J. Koenig) C. D. Specht	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone D	-	-
218	Costaceae	*Costus lucanusianus*	*Costus lucanusianus* J. Braun & K. Sch.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Zone D	-	-
219	Costaceae	*Costus speciosus*	*Costus speciosus* (Koenig) Smith	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range*	O	IC + EA + IM	Yes	Not yet assessed	Not yet assessed	Commorc cultivated	Parks and Trees Act (2006)		Primary/secondary rainforest, disturbed areas and open grounds	Mandai East Camp; Mandai Firing Range	-	-
220	Cucurbitaceae	*Coccinia grandis*	*Coccinia grandis* (L.) Voigt	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone F	-	-
221	Cucurbitaceae	*Cucumis maderaspatanus*	*Cucumis maderaspatanus* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
222	Cucurbitaceae	*Melothria pendula*	*Melothria pendula* L./ Creeping Cucumber	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-		Not yet assessed	Not yet assessed		Parks and Trees Act (2006)	-	-	Zone D; Zone A; Zone F	-	-
223	Cucurbitaceae	*Momordica charantia*	*Momordica charantia* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-		-	-
224	Cucurbitaceae	*Mukia maderaspatana*	*Mukia maderaspatana* (L.) M. J. Roem	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone D	-	-
225	Cucurbitaceae	*Trichosanthes wuiverei*	*Trichosanthes wuiverei* Cogn.	*(2014) Mandai Gate Vegetation Survey*	O	Malaysia + Singapore	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-		-	-
226	Cyatheaceae	*Cyathea latebrosa*	*Cyathea latebrosa* (Wall.) Copel.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU/D	Parks and Trees Act (2006)	Appendix II	-	Mandai East Camp; Mandai Firing Range; Zone A	-	-
227	Cyatheaceae	*Cyathea sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone E; Zone F	-	-
228	Cyatheaceae	*Cyathea squamulata*	*Cyathea squamulata* (Blume) Copel.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	Appendix II	-	Zone A	-	-
229	Cyperaceae	*Cyperaceae*	-	*(2014) Mandai Gate Vegetation Survey*	O	-		Not yet assessed	Not yet assessed		Parks and Trees Act (2006)	-	-		-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing^	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
230	Cyperaceae	*Cyperus digitatus*	*Cyperus digitatus* Roxb.	*(2014) Mandai Gate Vegetation Survey*	O	Asia + South America	Yes	LC	Least Concern ver 3.1	Common	Parks and Trees Act (2006)	-	It is a perennial herb, found in swamps or seasonally flooded areas, wet rice fields, ditches and river banks and also open grasslands.		-	Widespread and common species in stagnant water, ponds and ditches.
231	Cyperaceae	*Cyperus javanicus*	*Cyperus javanicus* Houtt	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B	-	-
232	Cyperaceae	*Fimbristylis dichotoma*	*Fimbristylis dichotoma* (L.) Vahl ssp. dichotoma	*(2014) Mandai Gate Vegetation Survey*	O	Asia + South America + Africa	-	LC	Least Concern ver 3.1	Cryptogenic Weed	Parks and Trees Act (2006)	-	A tufted annual or perennial sedge which commonly grows in damp grasslands, shallow water in marshes, along rivers and irrigation canals, and also as a weed in paddy fields.		-	This species is one of the most widespread and 'weedy' species of Fimbristylis.
233	Cyperaceae	*Fimbristylis sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone D	-	-
234	Cyperaceae	*Fuirena ciliaris*	*Fuirena ciliaris* (L.) Roxb.	*(2014) Mandai Gate Vegetation Survey*	O	Asia + Africa	-	LC	Least Concern ver 3.1		Parks and Trees Act (2006)	-	Grows in seasonally wet ground, swamps, pools and lake edges. Also in seasonally flooded grasslands and savannas. Appears to be tolerant of disturbance and grows in rice paddies and other very wet cultivated areas. On Socotra it is described as occurring on wet ground by pools and wadis.		-	This species is described as widespread and abundant throughout most of its range, however there are no quantitative data on population trends.
235	Cyperaceae	*Kyllinga nemoralis*	*Kyllinga nemoralis* (J.R. Forst. & G. Forst.) Dandy ex Hutch. & Dalziel	*(2014) Mandai Gate Vegetation Survey*	O	Asia + Africa	-	LC	Least Concern ver 3.1	Cryptogenic Weed	Parks and Trees Act (2006)	-	Frequently grows in wet grasslands		-	It is a very common and widespread species.
236	Cyperaceae	*Kyllinga polyphylla*	*Kyllinga polyphylla* Willd. ex Kunth	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone B; Zone D	-	-
237	Cyperaceae	*Kyllinga sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone D	-	-
238	Cyperaceae	*Rhynchospora corymbosa*	*Rhynchospora corymbosa* (L.) Britton	*(2014) Mandai Gate Vegetation Survey*	O	Asia + Africa	-	LC	Least Concern ver 3.1	Cryptogenic Weed	Parks and Trees Act (2006)	-	It is perennial and common plant growing in and along streams, on the shores of lakes, pools and rivers, often found in shallow water in swamps and rice fields.		-	This is a widespread and common species
239	Cyperaceae	*Rhynchospora rubra*	*Rhynchospora rubra* (Lour.) Makino	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Weed of uncertain origin	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-	Zone D	-	-
240	Cyperaceae	*Scleria ciliaris*	Scleria ciliaris Nees	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-		-	-
241	Cyperaceae	*Scleria sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone A	-	-
242	Davalliaceae	*Davallia denticulata*	*Davallia denticulata* (Burm.) Mett.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Mandai Firing Range; Zone E; Zone F	-	-
243	Dichapetalaceae	*Dichapetalum sordidum*	*Dichapetalum sordidum* (Hook. f.) Leenh.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Rediscovered	Parks and Trees Act (2006)	-	-	Zone A	-	-
244	Dilleniaceae	*Dillenia indica*	*Dillenia indica* L.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Extinct	Parks and Trees Act (2006)	-	Mainly on stony banks of rivulets and rivers, usually at low elevation up to 500 m. Once collected at 1700 m (Aljeh, Sumatra). The dispersal of the seeds is said to be effected by animals, among others by elephants, or with current water. In the latter case the seeds may germinate in the fruit, which is left behind on the bank of a river, often partly filled up with mud which gives a favorable substratum for the germination.	Zone F	-	From Sri Lanka and India into southern China, Indochina, Peninsular Malaysia, Sumatra, Java and Borneo. Cultivated in the Philippines.
245	Dilleniaceae	*Dillenia suffruticosa*	Simpoh Ayer	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range; Lorong Asrama; Zone B; Zone D; Zone A; Zone E; Zone F	-	-
246	Dilleniaceae	*Tetracera 1*	-	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Possibly native (only one recorded exotic species on Cheong et al. 2009)	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-	Southeast of Mandai Lake Road	-	-
247	Dilleniaceae	*Tetracera akara*	*Tetracera akara* (Burm. f.) Merr.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone A	-	-
248	Dilleniaceae	*Tetracera fagifolia*	*Tetracera fagifolia* Blume	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone B; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
249	Dilleniaceae	*Tetracera indica*	*Tetracera indica* (Christm. & Panz.) Merr.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	IM	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Lorong Asrama; Zone B; Zone F	-	-
250	Dilleniaceae	*Tetracera macrophylla*	*Tetracera macrophylla* Wall. ex Hook. f. & Thoms.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD + India	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone D; Zone A; Zone F; Zone F Fragment 1	-	-
251	Dilleniaceae	*Tetracera sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone F	-	-
252	Dioscoreaceae	*Dioscorea glabra*	*Dioscorea glabra* Roxb.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone F	-	-
253	Dioscoreaceae	*Dioscorea orbiculata var. tenuifolia*	*Dioscorea orbiculata* Hook.f. subspecies *tenuifolia* (Ridl.) Thapyai	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	LC	Least Concern ver 3.1	Rediscovered	Parks and Trees Act (2006)	-	This climbing tuberous geophyte grows in mixed deciduous forest on slopes with well-drained soils and in moist evergreen forests between 50 and 450 m elevation.	Zone F	-	Dioscorea tenuifolia is found from Thailand to Sumatera (Peninsular Malaysia, Singapore, Sumatera and Peninsular Thailand).
254	Dioscoreaceae	*Dioscorea polyclados*	*Dioscorea polyclados* Hook	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone D	-	-
255	Dioscoreaceae	*Dioscorea pyrifolia*	*Dioscorea pyrifolia* Kunth	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone A; Zone F	-	-
256	Dioscoreaceae	*Dioscorea sansibarensis*	*Dioscorea sansibarensis* Pax	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone F	-	-
257	Dioscoreaceae	*Dioscorea sp.*	-	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed		Parks and Trees Act (2006)	-	-	Zone F	-	-
258	Dioscoreaceae	*Tacca integrifolia*	*Tacca integrifolia* Ker Gawl.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-		-	-
259	Dipterocarpaceae	*Anisoptera megistocarpa*	*Anisoptera megistocarpa* Slooten.	*(2014) Mandai Gate Vegetation Survey*	O	SD	Yes	CR	Critically Endangered A1cd+2cd ver 2.3	CR	Parks and Trees Act (2006)	-	A large tree scattered throughout mixed dipterocarp forest on well-drained soil.		-	-
260	Dipterocarpaceae	*Hopea mengarawan*	*Hopea mengarawan* Miq.	*(2014) Mandai Gate Vegetation Survey*	O	SD	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-		-	-
261	Dipterocarpaceae	*Shorea macroptera ssp. Macroptera*	*Shorea macroptera* Dyer ssp. *macroptera*	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	BO	Yes	EN	Endangered ver 2.3	VU	Parks and Trees Act (2006)		Shorea macroptera is generally found on well-drained soil up to an altitude of about 900 m.	Zone F	Bukit Timah Nature Reserve, Central Catchment Nature Reserves, Singapore Botanic Gardens.	-
262	Dipterocarpaceae	*Shorea ovalis ssp. ovalis*	*Shorea ovalis* Blume ssp. *Ovalis*/ Light Red Meranti	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	SD	Yes	EN	Endangered ver 2.4	CR	Parks and Trees Act (2006)		Found in lowland mixed dipterocarp forest	Zone F Fragment 1	-	-
263	Ebenaceae	*Diospyros lancifolia*	*Diospyros lancifolia* Roxb.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Endangered Species (Import and Export) Act *http://www.ava.gov.sg/docs/default-source/default-document-library/endangered-species-(import-and-export)-act.pdf?sfvrsn=0*	Appendix II	-	Zone B; Zone D; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
264	Ebenaceae	*Diospyros venosa*	*Diospyros venosa* Wall. ex A.DC.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O		Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)			Zone A	-	-
265	Elaeocarpaceae	*Elaeocarpus ferrugineus*	*Elaeocarpus ferrugineus* (Jack) Steud.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B; Zone A	-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
266	Elaeocarpaceae	*Elaeocarpus mastersii*	*Elaeocarpus mastersii* King	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Malaysia	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone A; Zone F	-	-
267	Elaeocarpaceae	*Elaeocarpus obtusus ssp. apiculatus*	*Elaeocarpus obtusus ssp. Apiculatus* (Masf)	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone B; Zone E; Zone F	-	-
268	Elaeocarpaceae	*Elaeocarpus petiolatus*	*Elaeocarpus petiolatus* (Jack) Wall	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	IM+ EA	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone A; Zone F	-	-
269	Elaeocarpaceae	*Elaeocarpus salicifolius*	*Elaeocarpus salicifolius* King	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Malaysia	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Lorong Asrama; Zone B; Zone D; Zone A; Zone F	-	-
270	Elaeocarpaceae	*Elaeocarpus sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone D	-	-
271	Elaeocarpaceae	*Elaeocarpus stipularis*	*Elaeocarpus stipularis* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	TM	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone D; Zone A	-	-
272	Euphorbiaceae	*Acalypha alopecuroides*	*Acalypha alopecuroides* Jacq.	*(2014) Mandai Gate Vegetation Survey*	O	-		Not yet assessed	Not yet assessed		Parks and Trees Act (2006)	-	-		-	-
273	Euphorbiaceae	*Acalypha hispida*	*Acalypha hispida* Burm. f.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-		-	-
274	Euphorbiaceae	*Acalypha indica*	*Acalypha indica* L.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Weed of uncertain origin	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-	Zone F	-	-
275	Euphorbiaceae	*Acalypha siamensis*	*Acalypha siamensis* Oliv. ex Gage	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Lorong Asrama	-	-
276	Euphorbiaceae	*Agrostistachys borneensis*	*Agrostistachys borneensis* Becc.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone A; Zone F Fragment 1	-	-
277	Euphorbiaceae	*Alchornea tiliifolia*	*Alchornea tiliifolia* (Benth.) Müll.Arg.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone A	-	-
278	Euphorbiaceae	*Antidesma velutinosum*	*Antidesma velutinosum* Blume	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Yes	Not yet assessed	Not yet assessed	EN; cultivated	Parks and Trees Act (2006)			Lorong Asrama	-	West Malesia
279	Euphorbiaceae	*cf. Glochidion superbum*	-	*(2014) Mandai Gate Vegetation Survey*	O	TM + BO	Yes	Not yet assessed	Not yet assessed	Common; cultivated	Parks and Trees Act (2006)	-	Primary/secondary rainforest, disturbed areas and open grounds	Southeast of Mandai Lake Road	-	-
280	Euphorbiaceae	*Claoxylon indicum*	*Claoxylon indicum* (Reinw. ex Blume) Hassk.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range; Zone B; Zone D; Zone E; Zone F	-	-
281	Euphorbiaceae	*Claoxylon longifolium*	*Claoxylon longifolium* (Blume) Endl. ex Hassk., Cat. Hort. Bog. (1844)	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	IC+TM, New Guinea, Solomon Islands	Yes	Not yet assessed	Not yet assessed	Extinct; cultivated	Parks and Trees Act (2006)		Found in disturbed and open sites in undisturbed forests up to 1,500m in altitude. Usually along river and roadsides. Also found on limestone.	Lorong Asrama	-	-
282	Euphorbiaceae	*Croton oblongus*	*Croton oblongus* Burm. f.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	In undisturbed mixed dipterocarp and sometimes swamp forests up to 700 m altitude. Mostly on hillsides and ridges, sometimes alluvial. Usually on sandy soils, but also on clay and limestone. In secondary forests usually present as a pre-disturbance remnant tree.	Zone F Fragment 1	-	Thailand, Peninsular Malaysia, Sumatra, Java, Lesser Sunda Islands, Borneo (Sarawak, Brunei, Sabah, West-, Central- and East-Kalimantan), Philippines, Celebes, Moluccas, New Guinea.
283	Euphorbiaceae	*Endospermum diadenum*	*Endospermum diadenum* (Miq.) Airy Shaw	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)		In disturbed habitats (often along roadsides in logged forests, but also in scrub and burned forests) and open places of undisturbed mixed dipterocarp, freshwater swamp and keranga forests up to 900 m altitude. Also found on ultramafic soils.	Zone E	-	Thailand, Peninsular Malaysia, Sumatra, Borneo (Sarawak, Brunei, Sabah, West-, Central-, South- and East-Kalimantan), Philippines.
284	Euphorbiaceae	*Euphorbia hirta*	*Euphorbia hirt* a L.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
285	Euphorbiaceae	*Euphorbia hypericifolia*	*Euphorbia hypericifolia* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
286	Euphorbiaceae	*Euphorbia thymifolia*	*Euphorbia thymifolia* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-		-	-
287	Euphorbiaceae	*Hevea brasiliensis*	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Lorong Asrama; Zone E; Zone F	-	-
288	Euphorbiaceae	*Hura crepitans*	*Hura crepitans* L.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-	Zone D	-	-
289	Euphorbiaceae	*Koilodepas longifolium*	*Koilodepas longifolium* Hook. f.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone D; Zone F Fragment 1	-	-
290	Euphorbiaceae	*Macaranga bancana*	*Macaranga bancana* (Miq.) Mull. Arg.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD + Thailand	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Mandai Firing Range; Zone D; Zone A; Zone F	-	-
291	Euphorbiaceae	*Macaranga conifera*	*Macaranga conifera* (Rchb.f. & Zoll.) Müll.Arg	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	Macaranga conifera is found in disturbed places in primary forest gaps, secondary forests as as well scrubland up to 1100 m. It grows on loam, sandy and limsestone soils.	Zone B; Zone D; Zone A; Zone F	Central Catchment Nature Reserve, Bukit Timah Nature Reserve	Malay Peninsula, Sumatra, Singapore, India, Borneo, Sulawesi
292	Euphorbiaceae	*Macaranga gigantea*	*Macaranga gigantea* (Rchb. f. & Zoll.) Mull. Arg.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD + Thailand	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range; Lorong Asrama; Zone B; Zone D; Zone A; Zone F; Zone F Fragment 1	-	-
293	Euphorbiaceae	*Macaranga heynei*	*Macaranga heynei* I.M. Johnst.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD + Thailand	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B; Zone A; Zone F	-	-
294	Euphorbiaceae	*Macaranga hullettii*	*Macaranga hullettii* King ex Hook. f.	*(2014) Mandai Gate Vegetation Survey*	O	SD + Thailand	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-		-	-
295	Euphorbiaceae	*Macaranga hypoleuca*	*Macaranga hypoleuca* (Rchb. f. & Zoll.) Mull. Arg.	*(2014) Mandai Gate Vegetation Survey*	O	SD + Thailand	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-		-	-
296	Euphorbiaceae	*Macaranga sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone A	-	-
297	Euphorbiaceae	*Macaranga trichocarpa*	*Macaranga trichocarpa* (Rchb.f. & Zoll.) Müll.Arg.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone A	-	-
298	Euphorbiaceae	*Macaranga triloba*	*Macaranga triloba* (Thunb.) Müll.Arg	*NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range*	O	TM + PH	Yes	Not yet assessed	Not yet assessed	Common;cultivated	Parks and Trees Act (2006)		Early successional species found in lowlands up to 1400 m in elevation. Large range of habitats, from dryland diperocarp to edges of swamp forests.	Mandai Firing Range	-	-
299	Euphorbiaceae	*Mallotus oblongifolius(syn. Mallotus peltatus)*	*Mallotus peltatus* (Geiseler) Müll.Arg	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	India + South China + New Guinea		Not yet assessed	Not yet assessed		Parks and Trees Act (2006)		Primary to secondary forests, preferring open places like river banks, forest edges, road sides, cleared areas but sometimes also in the understorey; both in wet (riverine, swampy areas) and on well drained soils.	Lorong Asrama	-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
300	Euphorbiaceae	*Mallotus paniculatus*	*Mallotus paniculatus* (Lam.) Mull. Arg.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Mandai Firing Range; Zone A; Zone E; Zone F	-	-
301	Euphorbiaceae	*Manihot carthaginensis subsp. glaziovii*	*Manihot carthaginensis subsp. glaziovii* (Müll. Arg. ssp. glaziovii (Müll. Arg.) Allem	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone B	-	-
302	Euphorbiaceae	*Manihot esculenta*	*Manihot esculenta* Crantz	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range; Lorong Asrama; Zone F	-	-
303	Fabaceae	*Acacia auriculiformis*	*Acacia auriculiformis* A. Cunn. ex Benth.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	AS + Indonesia	No	LC	Least Concern ver 3.1	Naturalized	Parks and Trees Act (2006)	-	*A. auriculiformis* is a fast growing tree, particularly drought resistant, but also tolerates seasonally waterlogged soils and it is able to grow in poor soils.	Mandai Firing Range; Lorong Asrama; Zone D; Zone F	-	Widespread and common worldwide.
304	Fabaceae	*Acacia mangium*	*Acacia mangium* Willd.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
305	Fabaceae	*Adenanthera malayana*	*Adenanthera malayana* Kosterm.	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O		Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)		Primary and secondary rain forest. Can develop into a canopy tree; crown with bright pale green foliage, spreading, flat and diffuse. Recorded from rocky and from sandy soil, but also in peat swamps; altitude sea-level up to 900 m.	Zone F Fragment 1	-	Peninsular Malaysia, Sumatra, Borneo (in Borneo represented by a different subspecies).
306	Fabaceae	*Adenanthera pavonina*	*Adenanthera pavonina* L.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone B; Zone F	-	-
307	Fabaceae	*Albizia saman*	*Albizia saman* (Jacq.) Merr.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Mandai East Camp	-	-
308	Fabaceae	*Alysicarpus vaginalis*	*Alysicarpus vaginalis* (L.) DC.	*(2014) Mandai Gate Vegetation Survey*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-		-	-
309	Fabaceae	*Andira inermis*	*Andira inermis* (W. Wright) Kunth ex DC.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Lorong Asrama; Zone F	-	-
310	Fabaceae	*Archidendron clypearia*	*Archidendron clypearia* (Jack) I. C. Nielsen	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone A; Zone F; Zone F Fragment 1	-	-
311	Fabaceae	*Archidendron jiringa*	*Archidendron jiringa* (Jack) Nielsen	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone B	-	-
312	Fabaceae	*Archidendron microcarpum*	*Archidendron microcarpum* (Benth.) Nielsen	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone A	-	-
313	Fabaceae	*Baphia nitida*	*Baphia nitida* Lodd. et al.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	IM	No	LC	Least Concern ver 3.1	Casual	Parks and Trees Act (2006)	-	Grows in rain forests in coastal regions, secondary forests and abandoned farmlands.	Zone B; Zone E; Zone F	-	*B. nitida* is described as one of the most widespread Baphia species in west Africa.
314	Fabaceae	*Bauhinia kochiana*	*Bauhinia kochiana* Korth	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)			Zone F	-	-
315	Fabaceae	*Bauhinia semibifida*	*Bauhinia semibifida* Roxb. var. semibifida	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-		-	-
316	Fabaceae	*Bauhinia semibifida var. semibifida*	*Bauhinia semibifida* Roxb. var. semibifida	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone B; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
317	Fabaceae	*Caesalpinia minax*	*Caesalpinia minax* Hance	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Zone E	-	-
318	Fabaceae	*Callerya atropurpurea*	*Callerya atropurpurea* (Wall.) Schot	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-		-	-
319	Fabaceae	*Calopogonium mucunoides*	*Calopogonium mucunoides* Desv.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Lorong Asrama; Zone D	-	-
320	Fabaceae	*Centrosema molle*	*Centrosema molle* Benth	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
321	Fabaceae	*Centrosema sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone D; Zone F	-	-
322	Fabaceae	*Crotalaria pallida*	*Crotalaria pallida* Aiton	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
323	Fabaceae	*Dalbergia pseudo-sissoo*	*Dalbergia pseudo-sissoo* Miq.	*(2014) Mandai Gate Vegetation Survey*	O	-	-	Not yet assessed	Not yet assessed	-	Endangered Species (Import and Export) Act	Appendix II	-		-	-
324	Fabaceae	*Dalbergia sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone D; Zone A; Zone F	-	-
325	Fabaceae	*Dalbergia velutina*	*Dalbergia velutina* Benth.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone F	-	-
326	Fabaceae	*Derris amoena*	*Derris amoena* Benth. var. maingayana (Baker) Prain	*(2014) Mandai Gate Vegetation Survey*	O	SD + TM	Yes	LC	Least Concern ver 3.1	VU	Parks and Trees Act (2006)	-	This perennial climbing shrub is found in lowland forests		-	This species is reported as widespread in Malaysia
327	Fabaceae	*Derris amoena var. maingayana*	*Derris amoena* Benth. var. maingayana (Baker) Prain	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone A; Zone F	-	-
328	Fabaceae	*Desmodium heterophyllum*	*Desmodium heterophyllum* (Willd.) DC.	*(2014) Mandai Gate Vegetation Survey*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-		-	-
329	Fabaceae	*Desmodium sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)			Zone D	-	-
330	Fabaceae	*Desmodium triflorum*	*Desmodium triflorum* (L.) DC.	*(2014) Mandai Gate Vegetation Survey*	O	Asia + Africa	-	LC	Least Concern ver 3.1	Cryptogenic Weed	Parks and Trees Act (2006)	-	Occurs in a variety of habitats from forests to grasslands and in secondary/disturbed vegetation		-	The species has a global tropical distribution.
331	Fabaceae	*Dialium platysepalum*	*Dialium platysepalum* Baker	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	-
332	Fabaceae	*Entada spiralis*	*Entada spiralis* Ridl	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone F	-	-
333	Fabaceae	*Erythrina crista-galli*	Cockscomb Coral Tree	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-		-	-
334	Fabaceae	*Falcataria moluccana*	*Falcataria moluccana* (Miq.) Barneby & J.W. Grimes	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range; Zone B; Zone D; Zone F	-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
335	Fabaceae	*Koompassia malaccensis*	*Koompassia malaccensis* Maingay ex Benth.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone A	-	-
336	Fabaceae	*Kunstleria ridleyi*	*Kunstleria ridleyi* Prain	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone A; Zone F	-	-
337	Fabaceae	*Leucaena leucocephala*	*Leucaena leucocephala* (Lam.) de Wit	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Lorong Asrama; Zone F	-	-
338	Fabaceae	*Macroptilium lathyroides*	*Macroptilium lathyroides* (L.) Urb.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
339	Fabaceae	*Mimosa diplotricha*	*Mimosa diplotricha* C. Wright	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone D	-	-
340	Fabaceae	*Mimosa pigra*	*Mimosa pigra* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
341	Fabaceae	*Mimosa pudica*	Sensitive Plant	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Asia + AS + Africa	No	LC	Least Concern ver 3.1	Naturalized	Parks and Trees Act (2006)	-	M. pudica inhabits thickets, savannas, roadsides in pine or oak-pine forest..	Lorong Asrama; Zone D	-	This taxon is considered to be common.
342	Fabaceae	*Mimosa sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone D	-	-
343	Fabaceae	*Ormosia bancana*	Ormosia bancana (Miq.) Merr.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-		-	-
344	Fabaceae	*Ormosia sumatrana*	Ormosia sumatrana (Miq.) Prain	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Extinct	Parks and Trees Act (2006)	-	-		-	-
345	Fabaceae	*Paraderris elliptica*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone A	-	-
346	Fabaceae	*Peltophorum pterocarpum*	Yellow Flame	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Lorong Asrama	-	-
347	Fabaceae	*Pennisetum sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone D	-	-
348	Fabaceae	*Pongamia pinnata*	*Pongamia pinnata* (L.) Pierre	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	LC	Least concern ver 3.1	EN	Parks and Trees Act (2006)	-	P. pinnata is found in coastal areas, often along beaches or rivers and in thickets close to sea level.	Zone F	-	Pongamia pinnata has a large native distribution in Asia and Australia and is found in cultivation in a large number of countries.
349	Fabaceae	*Pterocarpus indicus*	Burmese Rosewood	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD + IC + Oceania	No	VU	Vulnerable A1d ver 2.3	Casual	Parks and Trees Act (2006)	-	A widespread tree found in lowland primary and some secondary forest, mainly along tidal creeks and rocky shores.	Mandai East Camp; Lorong Asrama; Zone A	-	-
350	Fabaceae	*Pueraria phaseoloides*	*Pueraria phaseoloides* (Roxb.) Benth.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone D	-	-
351	Fabaceae	*Saccharum sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone D; Zone F	-	-
352	Fabaceae	*Senna alata*	*Senna alata* (L.) Roxb.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-		-	-
353	Fabaceae	*Senna sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone F	-	
354	Fabaceae	*Sindora wallichii*	*Sindora wallichii* Benth.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-		-	-
355	Fabaceae	*Spatholobus ferrugineus*	*Spatholobus ferrugineus* (Zoll. & Moritzi) Benth.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone A; Zone E; Zone F	-	-
356	Fabaceae	*Spatholobus maingayi*	*Spatholobus maingayi* King	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Extinct	Parks and Trees Act (2006)	-	-		-	-
357	Fabaceae	*Spatholobus ridleyi*	*Spatholobus ridleyi* King	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone A	-	-
358	Fabaceae	*Stylosanthes humata*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
359	Fabaceae	*Tamarindus indica*	*Tamarindus indica* L.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Zone F	-	-
360	Fagaceae	*Castanopsis 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
361	Fagaceae	*Castanopsis wallichii*	*Castanopsis wallichii* King ex Hook. f.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Malaysia + Singapore	Yes	VU	Vulnerable B1+2c ver 2.3	CR	Parks and Trees Act (2006)	-	Lowland rainforest.	Zone D; Zone A	-	-
362	Fagaceae	*Lithocarpus conocarpus*	*Lithocarpus conocarpus* (Oudem.) Rehd.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-		-	-
363	Fagaceae	*Lithocarpus ewyckii*	*Lithocarpus ewyckii* (Korth.) Rehd.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone A; Zone E	-	-
364	Flagellariaceae	*Flagellaria indica*	*Flagellaria indica* L.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone F	-	-
365	Gentianaceae	*Cyrtophyllum fragrans*	*Cyrtophyllum fragrans* (Roxb.) DC. / Tembusu	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report* *[Syn. Fagraea fragrans]* *Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	Northern India +Southeast Asia + New Guinea	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	Primary/secondary rainforest; monsoon forest; coastal forest; freshwater swamp forest; disturbed areas and open ground	Zone F	Central Catchment Nature Reserve, Kent Ridgw, Pulau Ubin	Northern India, Bengal, Andaman Islands, Southeast Asia, New Guinea
366	Gleicheniaceae	*Dicranopteris curranii*	*Dicranopteris curranii* Copel.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)			Zone A	-	-
367	Gleicheniaceae	*Dicranopteris linearis*	*Dicranopteris linearis* (Burm. f.) Underw.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Lorong Asrama; Zone B; Zone A; Zone F	-	-
368	Gleicheniaceae	*Sticherus truncatus*	*Sticherus truncatus* (Willd.) Nakai	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-		-	-
369	Gnetaceae	*Gnetum 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Potentially CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
370	Gnetaceae	*Gnetum sp.*	-	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-		Not yet assessed	Not yet assessed		Parks and Trees Act (2006)	-	-	Zone A	-	-
371	Guttiferae	*Garcinia mangostana*	Mangosteen	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	IC + Malesia	No	Not yet assessed	Not yet assessed	Casual; cultivated	Parks and Trees Act (2006)			Lorong Asrama	-	-
372	Heliconiaceae	*Heliconia psittacorum*	*Heliconia psittacorum* L. f.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Lorong Asrama; Zone B	-	-
373	Heliconiaceae	*Heliconia rostrata*	*Heliconia rostrata* Ruiz & Pav.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-		-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
374	Heliconiaceae	*Heliconia spp*	Heliconia	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Tropical americas	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	Full sun or semi shade with lots of water.	Zone D	-	-
375	Hypericaceae	*Cratoxylum arborescens*	*Cratoxylum arborescens* (Vahl) Blume	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	IM	Yes	LC	Lower Risk/least concern ver 2.2	VU	Parks and Trees Act (2006)	-	Occurring in various habitat types, including thickets in logged-over forest.	Zone D	-	
376	Hypericaceae	*Cratoxylum formosum*	Pink Mempat	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	IC + BO + PH	Yes	LC	Lower Risk/least concern ver 2.3	EN	Parks and Trees Act (2006)	-	A widespread species found mainly in lowland primary and secondary forest recorded on many soil types	Zone B; Zone F	-	-
377	Hypericaceae	*Cratoxylum maingayi*	*Cratoxylum maingayi* Dyer	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	TM + IC	Yes	LC	Lower Risk/least concern ver 2.3	CR	Parks and Trees Act (2006)	-	A rare tree found scattered in lowland primary and secondary forests.	Zone A; Zone E	-	-
378	Icacinaceae	*Phytocrene bracteata*	*Phytocrene bracteata* Wall.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone D; Zone F; Zone F Fragment 1	-	-
379	Ixonanthaceae	*Ixonanthes icosandra*	*Ixonanthes icosandra* Jack	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone D; Zone A; Zone F	-	-
380	Ixonanthaceae	*Ixonanthes reticulata*	*Ixonanthes reticulata* Jack	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B	-	-
381	Lamiaceae	*Clerodendron paniculatum*	Pagoda Flower	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	Tropical and subtropical Asia, from Bangladesh to the Moluccas	No	Not yet assessed	Not yet assessed	Casual; cultivated	Parks and Trees Act (2006)	-	Various, from waste-ground to rainforest, often close to fresh water	-	-	-
382	Lamiaceae	*Clerodendrum deflexum*	*Clerodendrum deflexum* Wall.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone A	-	-
383	Lamiaceae	*Clerodendrum disparifolium*	*Clerodendrum disparifolium* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
384	Lamiaceae	*Clerodendrum inerme (syn Elevsine indica)*	*Clerodendrum inerme* (L.) Gaertn	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	[*Elevsine indica*] It grows in moist as well as marshy areas, puddles, shallow ponds, fields, river and stream edges, ditches, canals etc. It is tolerant of heavy disturbance like trampling, organic pollution and can grow along sewage lines, gutters easily.	Zone F	-	-
385	Lamiaceae	*Clerodendrum paniculatum*	*Clerodendrum paniculatum* L.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Zone D	-	-
386	Lamiaceae	*Clerodendrum villosum*	*Clerodendrum villosum* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone E; Zone F	-	-
387	Lamiaceae	*Hyptis capitata*	*Hyptis capitata* Jacq.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone D	-	-
388	Lamiaceae	*Ocimum basilicum*	*Ocimum basilicum* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-		-	-
389	Lamiaceae	*Plectranthus monostachyus*	*Plectranthus monostachyus* (P.Beauv.) B.J.Pollard	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-	Zone F	-	-
390	Lamiaceae	*Plectranthus sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone F	-	-
391	Lamiaceae	*Vitex pinnata*	Malayan Teak	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone F	-	-
392	Lauraceae	*Actinodaphne macrophylla*	*Actinodaphne macrophylla* (Blume) Nees	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Rediscovered	Parks and Trees Act (2006)	-	-		-	-
393	Lauraceae	*Alseodaphne bancana*	*Alseodaphne bancana* Miq.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	-
394	Lauraceae	*Beilschmiedia kunstleri*	*Beilschmiedia kunstleri* Gamble	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)		In undisturbed mixed dipterocarp, swamp, keranga and sub-montane forests up to 900 m altitude. On alluvial sites as well as hillsides and ridges. On clay to sandy soils. In secondary forests usually present as a pre-disturbance remnant tree.	Zone F Fragment 1	-	Peninsular Malaysia, Borneo (throughout the island).
395	Lauraceae	*Beilschmiedia madang*	*Beilschmiedia madang* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone B; Zone A	-	-
396	Lauraceae	*Cassytha filiformis*	*Cassytha filiformis* L.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone D	-	-
397	Lauraceae	*cf. Alseodaphne malaccensis*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
398	Lauraceae	*Cinnamomum iners*	Wild Cinnamon	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range; Lorong Asrama; Zone B; Zone D; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
399	Lauraceae	*Cryptocarya griffithiana*	*Cryptocarya griffithiana* Wight	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	In undisturbed mixed dipterocarp, peat-swamp, keranga, coastal and sub-montane forests up to 1700 m altitude. Common on both alluvial as well as dry sites, usually on sandy soils, but also on clay and limestone. In secondary forests usually present as a pre-disturbance remnant tree.	Zone F Fragment 1	-	Burma, Thailand, Peninsular Malaysia, Sumatra, Borneo (Sarawak, Brunei, Sabah, Central- and East-Kalimantan), Philippines, Celebes, Moluccas.
400	Lauraceae	*Lauraceae 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast, Southeast of Mandai Lake Road	-	-
401	Lauraceae	*Lauraceae 2*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
402	Lauraceae	*Lauraceae 3*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
403	Lauraceae	*Lauraceae 4*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
404	Lauraceae	*Lauraceae 5*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
405	Lauraceae	*Lauraceae 6*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
406	Lauraceae	*Lauraceae 7*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
407	Lauraceae	*Lindera lucida*	*Lindera lucida* (Blume) Boerl.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone B; Zone A; Zone E; Zone F	-	-
408	Lauraceae	*Litsea accedens*	*Litsea accedens* (Blume) Boerl.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-		-	-
409	Lauraceae	*Litsea castanea*	*Litsea castanea* Hook. f.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone D; Zone A; Zone F	-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
410	Lauraceae	*Litsea elliptica*	*Litsea elliptica* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone A; Zone F; Zone F Fragment 1	-	-
411	Lauraceae	*Litsea erectinervia*	*Litsea erectinervia* Kosterm.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-		-	-
412	Lauraceae	*Litsea ferruginea*	*Litsea ferruginea* Blume	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-		-	-
413	Lauraceae	*Litsea firma*	*Litsea firma* Hook. f.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone B; Zone F	-	-
414	Lauraceae	*Litsea grandis*	*Litsea grandis* Hook. f.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone A	-	-
415	Lauraceae	*Litsea lancifolia*	*Litsea lancifolia* (Roxb. ex Nees in Wall.) Benth. & Hook. fil. ex Villar	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	In undisturbed mixed dipterocarp to sub-montane forests up to 1600 m altitude. Common on alluvial sites but also on hillsides and ridges. Usually on sandy soils, but also on limestone. In secondary forests usually present as a pre-disturbance remnant tree.	Zone A	-	India, South China, Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo (Sarawak, Sabah, East-Kalimantan), Philippines.
416	Lauraceae	*Litsea ridleyi*	*Litsea ridleyi* Gamble	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone B	-	
417	Lauraceae	*Litsea sp.*		*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone F	-	-
418	Lauraceae	*Neolitsea cassia*	*Neolitsea cassia* (L.) Kosterm	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone E; Zone F	-	-
419	Lauraceae	*Nothaphoebe umbelliflora*	*Nothaphoebe umbelliflora* (Bl.) Bl.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	In undisturbed mixed dipterocarp and swamp forests up to 900 m altitude. Both common on alluvial sites and along rivers as well as on hillsides and ridges. On clay to sandy soils. In secondary forests usually present as a pre-disturbance remnant tree.	Zone A	-	Peninsular Malaysia, Sumatra, Java, Lesser Sunda Islands, Borneo (throughout the island), Philippines.
420	Lecythidaceae	*Barringtonia racemosa*	*Barringtonia racemosa* Spreng.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	Is found in primary and secondary forest, mostly restricted to inundated flood plains on tidal river banks, or in swampy localities, also behind the mangrove or in the upper mangrove swamp. It grows well under slightly saline conditions or on beaches near high water level, with a preference for heavy clay, loam or rich volcanic soils, usually a little above sea-level and occasionally up to 500 m altitude.	Zone F	-	From eastern Africa and Madagascar to Sri Lanka, India, Burma (Myanmar), Indo-China, southern China, Taiwan, the Ryukyu Islands, Thailand, the Andaman and Nicobar Islands, throughout the Malesian region towards Micronesia, Polynesia (east to Fiji and Samoa) and northern Australia.
421	Leguminosae	*Centrosema plumieri*	Butterfly pea	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	Tropical America	No	Not yet assessed	Not yet assessed		Parks and Trees Act (2006)	-	Secondary rainforest, disturbed areas, open ground	Lorong Asrama	-	-
422	Linaceae	*Indorouchera griffithiana*	*Indorouchera griffithiana* (Planch.) Hall., fil.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	Often in open places, like recent swidden areas and secondary forests. On quite variable soils, but often found in swampy places.	Zone B; Zone F	Central Catchment, Nee Soon Swamp Forest, Pulau Tekong and Pulau Ubin.	India to Borneo.
423	Loganiaceae	*Spigelia anthelmia*	*Spigelia anthelmia* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
424	Loganiaceae	*Strychnos ignatii*	*Strychnos ignatii* P.J. Bergius	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone D; Zone A	-	-
425	Loganiaceae	*Strychnos maingayi*	*Strychnos maingayi* C. B. Cl.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone A	-	-
426	Loganiaceae	*Strychnos sp.*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-		-	-
427	Lythraceae	*Lagerstroemia speciosa*	*Lagerstroemia speciosa* (L.) Pers.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-		-	-
428	Magnoliaceae	*Magnolia sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-		Not yet assessed	Not yet assessed	NA	Parks and Trees Act (2006)			Zone A	-	-
429	Magnoliaceae	*Magnolia villosa*	*Magnolia villosa* (Miq.) H.Keng	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD	Yes	DD	Data Deficient ver 3.1	CR	Parks and Trees Act (2006)	-	-	Zone A	In Singapore, this species was formerly described from Chua Chu Kang, Ang Mo Kio, Kranji but is now limited to the water catchment area	-
430	Magnoliaceae	*Michelia champaca*	Orange Champaka	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	IM + EA	-	LC	Least Concern ver 3.1	-	Parks and Trees Act (2006)	-	It is found scattered in riparian primary lowland to montane evergreen broadleaf forests in moist vegetation.		-	There is no population information available
431	Malpighiaceae	*Aspidopterys concava*	*Aspidopterys concava* (Wall.) A. Juss	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
432	Malvaceae	*Byttneria maingayi*	*Byttneria maingayi* Mast.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone A	-	-
433	Malvaceae	*Commersonia bartramia*	*Commersonia bartramia* (L.) Merr	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD + AS	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	In Australia it is found in subtropical rainforest and in Indonesia, Malaysia, and Papua New Guinea it is found in grasslands, thickets, and secondary forest below 1250 m.	Zone F	-	-
434	Malvaceae	*Durio singaporensis*	*Durio singaporensis* Ridl.	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	In lowland forests.	Zone F Fragment 1	-	Peninsular Malaysia, Singapore.
435	Malvaceae	*Durio zibethinus*	Durian	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Mandai East Camp; Mandai Firing Range; Lorong Asrama; Zone B; Zone D; Zone A	-	-
436	Malvaceae	*Grewia laevigata*	*Grewia laevigata* Vahl	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone A; Zone F	-	-
437	Malvaceae	*Hibiscus rosa-sinensis*	Chinese Hibiscus	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp*	O	-	No	Not yet assessed	Not yet assessed	Casual; cultivated	Parks and Trees Act (2006)	-	Full sun with moderate water	-	-	-
438	Malvaceae	*Hibiscus tiliaceus*	*Hibiscus tiliaceus* L.	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	Worldwide	Yes	Not yet assessed	Not yet assessed	Commor;cultivated	Parks and Trees Act (2006)		commonly found along the seashore and back mangroves, indicating the high water mark and boundary between the end of the salt water penetration and beginning of freshwater swamp. Also grows in limestone and volcanic areas.	Lorong Asrama	-	-
439	Malvaceae	*Malvaceae 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	North, South East of Mandai Lake Road	-	-
440	Malvaceae	*Pentace triptera*	*Pentace triptera* Mast.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-		-	-
441	Malvaceae	*Sciaphium macropodum*	*Sciaphium macropodum* (Miq.) Beumée ex K.Heyne / Malva Nut	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	IC + TM	Yes	LC	Least Concern ver 2.3	EN	Parks and Trees Act (2006)	-	In undisturbed mixed dipterocarp, (peat)-swamp and sub-montane forests up to 1200 m altitude. Usually on hillsides and ridges. In secondary forests usually present as a pre-disturbance remnant.	Zone A	-	Sumatra, Borneo, Singapore, Peninsular Malaysia, Thailand, Cambodia.
442	Malvaceae	*Sida acuta*	*Sida acuta* Burm. f.	*(2014) Mandai Gate Vegetation Survey*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-		-	-
443	Malvaceae	*Sterculia balanghas*	*Sterculia balanghas* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
445	Malvaceae	*Sterculia lanceolata var. coccinea*	*Sterculia lanceolata coccinea* (Jack) C. Phengklai	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	Java, peninsular Malaysia, Thailand, Vietnam, Nepal, Bhutan, Assam, Sumatra, Nicobars (Central Nicobars), Myanmar, Borneo, Laos
446	Malvaceae	*Sterculia parviflora*	*Sterculia parviflora* Roxb.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	India + SD	Yes	LC	Least Concern ver 2.3	CR	Parks and Trees Act (2006)	-	A commonly scattered species of lowland forest and hill forest, found on a variety of substrates, including basalt and calcareous shale.	Zone A	-	-
447	Malvaceae	*Sterculia rubiginosa*	*Sterculia rubiginosa* Vent.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Southeast of Mandai Lake Road; Zone A; Zone F; Zone F Fragment 1	-	-
448	Malvaceae	*Sterculia sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone D	-	-
449	Malvaceae	*Taliparitii tiliaceum*	*Taliparitii tiliaceum* (L.) Fryxell	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Central South of Mandai Lake Road; Zone F	-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
450	Malvaceae	*Theobroma cacao*	*Theobroma cacao* L.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-	Northwest, Central South, Southeast of Mandai Lake Road	-	-
451	Malvaceae	*Ceiba pentandra*	Kapok Tree	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-	-	-	-
452	Marantaceae	*Calathea ornata*	Calathea ornata (Linden ex Lem.) Korn.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-	Northwest of Mandai Lake Road; Zone B	-	-
453	Marantaceae	*Calathea picturata*	*Calathea picturata* K.Koch & Linden	*NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range*	O	Venezuela	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)			Mandai Firing Range	-	-
454	Marantaceae	*Thalia geniculata*	*Thalia geniculata* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-	Central South of Mandai Lake Road	-	-
455	Melastomaceae	*Dissochaeta 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	-	-	Potentially VU and above	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
456	Melastomaceae	*Memecylon 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
457	Melastomaceae	*Memecylon 2*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
458	Melastomaceae	*Memecylon c.f. lilacinum*	-	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Peninsular Malaysia and Singapore	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone B; Zone A; Zone E; Zone F Fragment 1	-	-
459	Melastomataceae	*Clidemia hirta*	*Clidemia hirta* (L.) D. Don	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	North, Central South, Southeast of Mandai Lake Road; Mandai East Camp; Mandai Firing Range; Zone B; Zone D; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
460	Melastomataceae	*Dissochaeta sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone A	-	-
461	Melastomataceae	*Melastoma malabathricum*	Sendudok	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Entire area around Mandai Lake Road; Mandai East Camp; Mandai Firing Range; Zone B; Zone D; Zone A; Zone F	-	-
462	Melastomataceae	*Memecylon amplexicaule*	*Memecylon amplexicaule* Roxb.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone A; Zone F Fragment 1	-	-
463	Melastomataceae	*Memecylon paniculatum*	*Memecylon paniculatum* Jack	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A; Zone E	-	-
464	Melastomataceae	*Memecylon sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone E; Zone F	-	-
465	Melastomataceae	*Pternandra coerulescens*	*Pternandra caerulescens* Jack	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Southeast of Mandai Lake Road; Zone D; Zone E; Zone F Fragment 1	-	-
466	Melastomataceae	*Pternandra echinata*	*Pternandra echinata* Jack	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northeast, Central South, Southeast of Mandai Lake Road; Zone E; Zone F	-	-
467	Meliaceae	*Aglaia sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone A	-	-
468	Meliaceae	*Aphanamixis polystachya*	*Aphanamixis polystachya* (Wall.) R.N. Parker	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	IM	Yes	LC	Least Concern ver 2.3	EN	Parks and Trees Act (2006)		In Viet Nam, this tree occurs in evergreen tropical rainforest or monsoon forest.	Zone F	-	A widespread species found in Indo-China and western Malaysia.
469	Meliaceae	*Dysoxylum cauliflorum*	*Dysoxylum cauliflorum* Hiern	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	Occurs in rain forest up to 1500 m altitude.	Zone A; Zone F Fragment 1	-	It is a common tree from Southeast Asia and west Malesia, eastwards to Borneo and Palawan.
470	Meliaceae	*Lansium domesticum*	Langsat	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	TM	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)			Lorong Asrama; Zone A	-	-
471	Meliaceae	*Lansium parasiticum*	*Lansium parasiticum* (Osbeck) K.C.Sahni & Bennet	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-	Northwest, Southeast of Mandai Lake Road	-	-
472	Meliaceae	*Meliaceae 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
473	Meliaceae	*Meliaceae 2*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
474	Meliaceae	*Meliaceae 3*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
475	Meliaceae	*Meliaceae 4*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
476	Meliaceae	*Meliaceae 5*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
477	Meliaceae	*Sandoricum beccarianum*	*Sandoricum beccarianum* Baill.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
478	Meliaceae	*Sandoricum koetjape*	*Sandoricum koetjape* Merrill	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Probably native to SE Asia	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	The tree is completely intolerant to frost and has only survived introduction to Neotropics in a few locations in Central America and Southern Florida.	Zone E	-	-
479	Meliaceae	*Swietenia macrophylla*	*Swietenia macrophylla* King	*(2014) Mandai Gate Vegetation Survey*	O	Central America + South America	No	VU	Vulnerable A1cd+2cd ver 2.3	Casual	Endangered Species (Import and Export) Act	Appendix II	Various forest types	Southwest of Mandai Lake Road	-	Basic inventories are lacking for most of its range. Good stands apparently still remain in parts of Brazil and Bolivia.
480	Menispermaceae	*Coscinium fenestratum*	*Coscinium fenestratum* Colebr.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	DD	Data Deficient ver 3.1	EN	Parks and Trees Act (2006)	-	It is a large dioecious woody climber and grows in tropical moist low land forest.	Zone A; Zone F Fragment 1	-	This species has been recorded in the Western Ghats of southern India and also in Sri Lanka, Cambodia, Viet Nam and west Malaysia.
481	Menispermaceae	*Cyclea laxiflora*	*Cyclea laxiflora* Miers	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
482	Menispermaceae	*Fibraurea tinctoria*	*Fibraurea tinctoria* Lour.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	North, Southeast of Mandai Lake Road; Zone B; Zone D; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
483	Menispermaceae	*Limacia scandens*	*Limacia scandens* Lour.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
484	Menispermaceae	*Stephania capitata*	*Stephania capitata* (BL) Spreng	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone D	-	-
485	Menispermaceae	*Tinomiscium petiolare*	*Tinomiscium petiolare* Miers	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone A	-	-
486	Menispermaceae	*Tinospora macrocarpa*	*Tinospora macrocarpa* Diels	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	-
487	Moraceae	*Artocarpus elasticus*	*Artocarpus elasticus* Reinw. ex Blume	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	North, Southeast of Mandai Lake Road; Lorong Asrama; Zone B; Zone A; Zone F; Zone F Fragment 1	-	-
488	Moraceae	*Artocarpus heterophyllus*	*Artocarpus heterophyllus* Lam.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Northwest, Southwest, Central South of Mandai Lake Road; Mandai East Camp; Mandai Firing Range; Zone D; Zone F	-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
489	Moraceae	*Artocarpus integer*	*Artocarpus integer* (Thunb.) Merr.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	North, Southwest of Madai Lake Road; Lorong Asrama; Zone D	-	-
490	Moraceae	*Artocarpus lacucha*	*Artocarpus lacucha* Buchanan-Hamilton ex D. Don	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone E	-	-
491	Moraceae	*Artocarpus sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone F	-	-
492	Moraceae	*Cecropia peltata*	Snake wood	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	Tropical America	No	Not yet assessed	Not yet assessed	Naturalised; cultivated	Parks and Trees Act (2006)		Light demanding, fast growing pioneer species and rapidly invades disturbed areas such as forest canopy gaps, roadsides, agricultural sites, urban locations and other disturbed areas.	Lorong Asrama as per the rapid biodiversity survey; It has once been thought to be the species that has naturalised in Singapore but research in 2010 identified the numerous Cecropia sp trees in the Mandai area to be Cecropia pachystachya.	One small population near the Singapore Botanic Gardens along mid-point of Tyersall Avenue and one large tree cultivated inside the National Orchid Garden.	Nominated as among 100 of the World's Worst invaders.
493	Moraceae	*Ficus 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
494	Moraceae	*Ficus apiocarpa*	*Ficus apiocarpa* (Miq.) Miq	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone D; Zone E; Zone F	-	-
495	Moraceae	*Ficus aurata var. aurata*	*Ficus aurata* (Miq.) Miq	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	In severely disturbed sites (bekukar, road sides, clearings, etc.) or open sites in Mixed dipterocarp and montane forests up to 1500 m altitude. Common along rivers and streams and hillsides. Often on clay soils, but also on sand and ultrabasic.	Zone F	-	Indo-China, Peninsular Malaysia, Sumatra, Borneo, Philippines
496	Moraceae	*Ficus benghalensis*	Indian Banyan	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	India and Pakistan	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	Tropical forest, but frequently cultivated elsewhere and is drought resistant.	-	-	-
497	Moraceae	*Ficus benjamina*	Waringin	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-	Northwest of Mandai Lake Road; Zone B	-	-
498	Moraceae	*Ficus cf. vasculosa*	-	*(2014) Mandai Gate Vegetation Survey*	O	BO + IM	Yes	Not yet assessed	Not yet assessed	EN; cultivated	Parks and Trees Act (2006)	-	Primary/secondary rainforest	Northeast, Southeast of Mandai Lake Road	-	-
499	Moraceae	*Ficus fistulosa*	*Ficus fistulosa* Reinw. ex Blume	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Entire area around Mandai Lake Road; Lorong Asrama; Zone D; Zone E; Zone F	-	-
500	Moraceae	*Ficus globosa*	*Ficus globosa* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A; Zone F; Zone F Fragment 1	-	-
501	Moraceae	*Ficus grossularioides*	White-leafed fig	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	IM	Yes	Not yet assessed	Not yet assessed	Commorcultivated	Parks and Trees Act (2006)		Primary and secondary lowland forests, forest edges, and along streams up to 1350 m altitude.	Mandai East Camp; Mandai Firing Range; Lorong Asrama; Zone F	Occurs in Singapore in Pulau Ubin, Pulau Tekong, in the vicinity of Upper Seletar Reservoir, Nee Soon Swamp Forest, Old Upper Thomson Road and Lazarus Island.	
502	Moraceae	*Ficus heteropleura*	Ficus heteropleura Blume	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northwest, Southwest, Central South of Mandai Lake Road; Lorong Asrama; Zone D; Zone F	-	-
503	Moraceae	*Ficus lyrata*	*Ficus lyrata* Warb.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-	South Central of Mandai Lake Road	-	-
504	Moraceae	*Ficus microcarpa*	Malayan Banyan	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northwest, Central South of Mandai Lake Road; Mandai East Camp; Zone B; Zone D; Zone E; Zone F	-	-
505	Moraceae	*Ficus microsyce*	*Ficus microsyce* Ridl.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)		In open sites in undisturbed mixed dipterocarp to submontane forests up to 1700 m altitude. Usually along rivers and streams on sandy to limestone soils.	Zone A	-	Peninsular Thailand and Malaysia, Sumatra, Java, Borneo, Philippines, Sulawesi.
506	Moraceae	*Ficus obscura var. borneensis (syn. Ficus microsyce? (Plants of Southeast Asia))*	*Ficus obscura* Blum var. *borneensis* (Miq.) Corner	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	In open sites in undisturbed mixed dipterocarp to submontane forests up to 1700 m altitude. Usually along rivers and streams on sandy to limestone soils.	Zone D	-	-
507	Moraceae	*Ficus piscarpa*	*Ficus piscarpa* Bl.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone D	-	-
508	Moraceae	*Ficus pumila*	*Ficus pumila* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Central South of Mandai Lake Road	-	-
509	Moraceae	*Ficus punctata*	*Ficus punctata* Thunb.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A; Zone F	-	-
510	Moraceae	*Ficus sagittata*	*Ficus sagittata* Vahl	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone E; Zone F	-	-
511	Moraceae	*Ficus sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone F	-	-
512	Moraceae	*Ficus stricta*	*Ficus stricta* (Miq.) Miq	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	Inhabits forests up to 2000 m above sea-level.	Zone B	It is only known from Changi and Pulau Ubin.	It ranges from South China, Myanmar (Andaman Islands), Indochina, the Philippines (Luzon, probably cultivated), the Malay Peninsula, Sumatra, and Java.
513	Moraceae	*Ficus variegata*	*Ficus variegata* Röding	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone D; Zone F	-	-
514	Moraceae	*Ficus vasculosa*	*Ficus vasculosa* Wall. ex Miq.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone D; Zone F Fragment 1	-	-
515	Moraceae	*Ficus virens*	*Ficus virens* W. T. Aiton	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone B	-	-
516	Moraceae	*Streblus elongatus*	*Streblus elongatus* (Miq.) Corner	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A; Zone F	-	-
517	Moraceae	*Ficus auriculata*	Roxburgh's Fig	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-	-	-	-
518	Moraceae	*Ficus elastica*	Indian Rubber Tree	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-	Zone F	-	-
519	Moraceae	*Ficus religiosa*	Bodh-Tree	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-	-	-	-
520	Muntingiaceae	*Muntingia calabura*	Buah Cheri	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Southwest, Central South of Mandai Lake Road; Lorong Asrama; Zone D; Zone F	-	-
521	Musaceae	*Musa acuminata*	*Musa acuminata* Colla var. sumatrana	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-	Northwest, Southwest, Central South of Mandai Lake Road	-	-
522	Musaceae	*Musa esculenta*	-	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp*	O	-	No	Not yet assessed	Not yet assessed		Parks and Trees Act (2006)	-	-	Lorong Asrama	-	-
523	Musaceae	*Musa sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	Cultivated only	Parks and Trees Act (2006)	-	-	Zone D	-	-
524	Myricaceae	*Morella esculenta*	*Morella esculenta* (Buch.-Ham. ex D. Don) I.M. Turner	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
525	Myristicaceae	*Gymnacranthera bancana*	*Gymnacranthera bancana* (Miq.) J. Sinclair	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone A	-	-
526	Myristicaceae	*Horsfieldia crassifolia*	*Horsfieldia crassifolia (Hook.f. & Th.) Warb*	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	BO + Singapore	Yes	NT	Near Threatened ver 2.3	CR	Parks and Trees Act (2006)	-	A lowland tree which is fairly widespread in marshy forest and freshwater peat-swamp forest.	Zone A	-	Peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo.
527	Myristicaceae	*Horsfieldia polypsperula*	*Horsfieldia polypsperula* (Hook. f. emend. King) J. Sinclair	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A; Zone F; Zone F Fragment 1	-	-
528	Myristicaceae	*Horsfieldia punctatifolia*	*Horsfieldia punctatifolia* Sinclair	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	BO + Singapore	Yes	LC	Least Concern ver 2.3	CR	Parks and Trees Act (2006)	-	A fairly widespread species found in many habitat types.	Zone B; Zone F	-	-
529	Myristicaceae	*Horsfieldia sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone A	-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing^	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
530	Myristicaceae	*Horsfieldia sucosa*	*Horsfieldia sucosa* (King) Warb.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	In undisturbed mixed dipterocarp and coastal forests up to 800 m altitude. Often on alluvial sites near or along rivers and streams, but also on hillsides and ridges. On sand and limestone soils.	Zone F	-	Peninsular Malaysia, Sumatra, Borneo.
531	Myristicaceae	*Knema communis*	*Knema communis* J. Sinclair	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Malaysia	Yes	VU	Vulnerable A1c ver 2.3	EN	Parks and Trees Act (2006)	-	This scattered species grows in lowland and hill rainforest up to 270 m.	Northeast of Mandai Lake Road; Zone A; Zone F Fragment 1	-	-
532	Myristicaceae	*Knema curtisii*	*Knema curtisii* (King) Warb. var. paludosa J. Sinclair	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A	-	-
533	Myristicaceae	*Knema intermedia*	*Knema intermedia* (BL) Warb.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD	Yes	NT	Near Threatened ver 2.3	EN	Parks and Trees Act (2006)	-	-	Zone A	-	-
534	Myristicaceae	*Knema latericia ssp. Ridleyi*	*Knema latericia ssp. Ridleyi* (Gandog.) de Wilde	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	SD	Yes	LC	Least Concern ver 2.3	EN	Parks and Trees Act (2006)	-	-	Zone A; Zone E; Zone F Fragment 1	-	A widely distributed species in west Malaysia. It is rare in Sumatra.
535	Myristicaceae	*Knema malayana*	*Knema malayana* Warb.	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	SD	Yes	LC	Least Concern ver 2.4	EN	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	A species widely distributed in Peninsular Malaysia and Peninsular Thailand.
536	Myristicaceae	*Knema sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone A; Zone E	-	-
537	Myristicaceae	*Myristica laviana*	*Myristica laviana* King	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	BO + Singapore	Yes	NT	Near Threatened ver 2.3	CR	Parks and Trees Act (2006)	-	This tree is mainly found in peat-swamp forest; it is rarely found on dry land.	Zone E	-	-
538	Myrtaceae	*c.f. Decaspermum fruticosum*	-	*(2014) Mandai Gate Vegetation Survey*	O	BO + EA	Yes	Not yet assessed	-	VU; cultivated	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
539	Myrtaceae	*c.f. Syzygium*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Southeast of Mandai Lake Road	-	-
540	Myrtaceae	*Callistemon speciosa*	Bottlebrush Tree	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-	-	-	-
541	Myrtaceae	*Psidium guajava*	Guava	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	Tropical America	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	-	-	-
542	Myrtaceae	*Rhodamnia cinerea*	Silverback	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Lorong Asrama; Zone B; Zone D; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
543	Myrtaceae	*Syzygium (Eugenia) grande*	Sea Apple	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	IM + TM + SD	Yes	Not yet assessed	Not yet assessed	Common; cultivated	Parks and Trees Act (2006)	-	Secondary rainforest and coastal forest	-	-	-
544	Myrtaceae	*Syzygium (Eugenia) jambos*	Rose Apple	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	IM + EA	No	Not yet assessed	Not yet assessed	Casual; cultivated	Parks and Trees Act (2006)	-	-	-	-	-
545	Myrtaceae	*Syzygium (Eugenia) polyanthum*	Salam	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	IM + TM + SD	Yes	Not yet assessed	Not yet assessed	VU; cultivated	Parks and Trees Act (2006)	-	Primary/secondary rainforest, grassland, savannah and scrubland	-	-	-
546	Myrtaceae	*Syzygium acuminatissimum*	*Syzygium acuminatissimum* (Blume) DC.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A	-	-
547	Myrtaceae	*Syzygium aqueum*	*Syzygium aqueum* (Burm. f.) Alston	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-	Northwest of Mandai Lake Road	-	-
548	Myrtaceae	*Syzygium borneense*	*Syzygium borneense* (Miq.) Miq.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	North, Central South, Southeast of Mandai Lake Road; Lorong Asrama; Zone B; Zone D; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
549	Myrtaceae	*Syzygium chloranthum*	*Syzygium chloranthum* (Duthie) Merr. & L.M.Perry	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	-
550	Myrtaceae	*Syzygium claviflorum*	*Syzygium claviflorum* (Roxb.) Wall. ex A.M.Cowan & Cowan var. claviflorum	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A	-	-
551	Myrtaceae	*Syzygium filiforme*	*Syzygium filiforme* (Wall. ex Duthie) Chantaran. & J. Parn. var. filiforme	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	North of Mandai Lake Road; Zone A; Zone F Fragment 1	-	-
552	Myrtaceae	*Syzygium glabratum*	*Syzygium glabratum* (DC.) Veldkamp	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	Yes	Not yet assessed	Not yet assessed	Extinct	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	-
553	Myrtaceae	*Syzygium grande*	*Syzygium grande* (Wight) Walp.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	North, Central South, Southeast of Mandai Lake Road; Lorong Asrama; Zone B; Zone A; Zone E; Zone F	-	-
554	Myrtaceae	*Syzygium inophyllum*	*Syzygium inophyllum* DC	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O		Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone E	-	-
555	Myrtaceae	*Syzygium jambos*	*Syzygium jambos* (L.) Alston	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Southwest of Mandai Lake Road	-	-
556	Myrtaceae	*Syzygium lineatum*	*Syzygium lineatum* (DC.) Merr. & L.M. Perry	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Entire area around Mandai Lake Road; Lorong Asrama; Zone B; Zone D; Zone A; Zone E; Zone F	-	-
557	Myrtaceae	*Syzygium malaccense*	*Syzygium malaccense* (L.) Merr. & L. M. Perry	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Central South of Mandai Lake Road	-	-
558	Myrtaceae	*Syzygium malaccense*	Jambu Bol	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	Malaysia, Indonesia	No	Not yet assessed	Not yet assessed	Casual; cultivated	Parks and Trees Act (2006)	-	Terrestrial (riverine)	-	-	-
559	Myrtaceae	*Syzygium myrtifolium*	*Syzygium myrtifolium* Walp.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Extinct	Parks and Trees Act (2006)	-	-	Northwest, Central South of Mandai Lake Road	-	-
560	Myrtaceae	*Syzygium polyanthum*	*Syzygium polyanthum* (Wight) Walp.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northwest, Central South, Southeast of Mandai Lake Road; Zone B; Zone D; Zone A; Zone F	-	-
561	Myrtaceae	*Syzygium pseudoformosum*	*Syzygium pseudoformosum* (King) Merr. & L.M.Perry	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone B; Zone E; Zone F Fragment 1	-	-
562	Myrtaceae	*Syzygium ridleyi*	*Syzygium ridleyi* (King) P. Chantaranothai & J. Parn.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast, Southeast of Mandai Lake Road; Zone F Fragment 1	-	-
563	Myrtaceae	*Syzygium scortechinii*	*Syzygium scortechinii* (King) P.Chantaranothai & J.Parn. var. scortechinii	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Rediscovered	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
564	Myrtaceae	*Syzygium singaporense*	*Syzygium singaporense* (King) Airy Shaw	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
565	Myrtaceae	*Syzygium sp.*	-	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-		Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone B; Zone A; Zone E; Zone F	-	-
566	Myrtaceae	*Syzygium zeylanicum*	*Syzygium zeylanicum* (L.) DC.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Central South, Southeast of Mandai Lake Road; Zone B; Zone D; Zone E; Zone F	-	-
567	Nyctaginaceae	*Boerhavia diffusa*	*Boerhavia diffusa* L.	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	No	Not yet assessed	Not yet assessed	Weed of uncertain origin	Parks and Trees Act (2006)			Lorong Asrama	-	-
568	Nyctaginaceae	*Bougainvillea glabra*	*Bougainvillea glabra* Choisy	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-	Central South of Mandai Lake Road; Zone D	-	-
569	Olacaceae	*Ochanostachys amentacea*	*Ochanostachys amentacea* Mast.	*(2014) Mandai Gate Vegetation Survey*	O	SD	Yes	DD	Data Deficient ver 2.3	VU	Parks and Trees Act (2006)	-	Found scattered in the understorey, occasionally reaching the canopy, of primary and secondary lowland rainforest, often mixed dipterocarp forest.	Northeast of Mandai Lake Road	-	-
570	Olacaceae	*Scorodocarpus borneensis*	*Scorodocarpus borneensis* Becc.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road Zone F Fragment 1	-	-
571	Olacaceae	*Strombosia ceylanica*	*Strombosia ceylanica* Gardn.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A; Zone F Fragment 1	-	-
572	Oleandraceae	*Nephrolepis auriculata*	*Nephrolepis auriculata* (L.) Trimen	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-	Entire area around Mandai Lake Road; Mandai East Camp; Zone B; Zone D; Zone A; Zone F	-	-
573	Oleandraceae	*Nephrolepis biserrata*	*Nephrolepis biserrata* (Sw.) Schott	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-	Entire area around Mandai Lake Road; Mandai East Camp; Mandai Firing Range	-	-
574	Onagraceae	*Ludwigia hyssopifolia*	Water primrose	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	Pantropical	-	LC	Least Concern v3.1	Weed of uncertain origin	Parks and Trees Act (2006)		wet places, marshes, temporary pools and shallow waters. Can be found growing in the plains up to 500 m.	Lorong Asrama	-	Widespread and common. Stable population trend. Suffers localised threats (habitat loss) but since very widespread and common, is considered least concern.
575	Onagraceae	*Ludwigia octovalvis*	*Ludwigia octovalvis* (Jacq.) P.H. Raven	*(2014) Mandai Gate Vegetation Survey*	O	Asia + Africa + South America + AS	-	LC	Least Concern ver 3.1	Cryptogenic Weed	Parks and Trees Act (2006)	-	-	Southwest, Central South of Mandai Lake Road	-	There is no information on population trends for this species, however it is described as a "pantropical" weed, suggesting that it is abundant and potentially invasive.
576	Onagraceae	*Ludwigia peruviana*	*Ludwigia peruviana* (L.) Hara	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	No	Not yet assessed	Not yet assessed	Naturalised	Parks and Trees Act (2006)		-	Lorong Asrama	-	-
577	Opiliaceae	*Champereia manillana*	*Champereia manillana* (Blume) Merr	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone E	-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
578	Orchidaceae	*Dendrobium crumenatum*	Pigeon orchid	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	IC + IM + PH	Yes	Not yet assessed	Not yet assessed	Commorcultivated	Endangered Species Act Parks and Trees Act (2006)	Appendix II	Semi deciduous and deciduous dry lowland forests and savannah-like woodlands at an altitude of 500 m	Mandai East Camp; Zone D; Zone F	-	-
579	Orchidaceae	*Spathoglottis plicata*	*Spathoglottis plicata* Blume	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Endangered Species (Import and Export) Act	Appendix II	-	Central South of Mandai Lake Road; Lorong Asrama; Zone D	-	-
580	Oxalidaceae	*Averrhoa bilimbi*	Belimbing	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	-	-	-
581	Oxalidaceae	*Averrhoa carambola*	Starfruit	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Northwest, Central South of Mandai Lake Road	-	-
582	Oxalidaceae	*Oxalis barrelieri*	*Oxalis barrelieri* L.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Southwest, Central South of Mandai Lake Road; Lorong Asrama	-	-
583	Pandaceae	*Galearia fulva*	*Galearia fulva* (Tul.) Miq	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)		In undisturbed mixed dipterocarp, freshwater swamp and sub-montane forests up to 1200 m altitude. On alluvial and dry sites with sandy to clay soils. In secondary forests usually present as a pre-disturbance remnant tree.	Zone F Fragment 1	-	Birma, Indo-China, Thailand, Peninsular Malaysia, Sumatra, Borneo (Sarawak, Brunei, Sabah, West-, Central-, South- and East-Kalimantan), Philippines.
584	Pandanaceae	*Freycinetia javanica*	*Freycinetia javanica* Blume	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	Yes	Not yet assessed	Not yet assessed	Rediscovered	Parks and Trees Act (2006)	-	In humid lowland to montane forests up to 1,800 m altitude, often in pristine forests, valleys and along waterfalls	Zone F Fragment 1	Kranji, Bukit Mandai, Bukit Timah, Seletar, and Nee Soon Swamp Forest	Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, and Borneo
585	Pandanaceae	*Freycinetia sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone F	-	-
586	Pandanaceae	*Freycinetia sumatrana*	*Freycinetia sumatrana* Hemsley	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
587	Pandanaceae	*Pandanus amaryllifolius*	*Pandanus amaryllifolius* Roxb.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Northwest, Central South of Mandai Lake Road; Zone B; Zone D	-	-
588	Pandanaceae	*Pandanus atrocarpus*	*Pandanus atrocarpus* Griff.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone B; Zone A	-	-
589	Pandanaceae	*Pandanus sp.*	-	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-		Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone E; Zone F	-	-
590	Passifloraceae	*Passiflora foetida*	*Passiflora foetida* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Central South of Mandai Lake Road	-	-
591	Passifloraceae	*Passiflora laurifolia*	*Passiflora laurifolia* L.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Northeast, Central South of Mandai Lake Road; Zone F	-	-
592	Passifloraceae	*Passiflora suberosa*	*Passiflora suberosa* L.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone F	-	-
593	Pentaphylacaceae	*Adinandra dumosa*	Tiup Tiup	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Malaysia	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-	Zone F	-	-
594	Phyllantaceae	*Aporosa sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone D; Zone F	-	-
595	Phyllantaceae	*Phyllanthaceae 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
596	Phyllanthaceae	*Antidesma coriaceum*	*Antidesma coriaceum* Tul.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	In undisturbed peat swamp, freshwater swamp, and keranga forests up to 200 m altitude. Usually on alluvial sites, occasionally on dry, open places on sandy soils. In secondary forests usually present as a pre-disturbance remnant tree.	Zone F	-	Peninsular Malaysia, Sumatra, Borneo (Sarawak, Brunei, Sabah, West-, Central-, South- and East-Kalimantan).
597	Phyllanthaceae	*Antidesma cuspidatum*	*Antidesma cuspidatum* Müll. Arg.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A; Zone F Fragment 1	-	-
598	Phyllanthaceae	*Aporosa 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
599	Phyllanthaceae	*Aporosa 2*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
600	Phyllanthaceae	*Aporosa frutescens*	*Aporosa frutescens* Blume	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	North, Southeast of Mandai Lake Road; Zone B; Zone D; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
601	Phyllanthaceae	*Aporosa lucida*	*Aporosa lucida* (Miq.) Airy Shaw var. lucida	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone B; Zone D; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
602	Phyllanthaceae	*Aporosa lunata*	*Aporosa lunata* (Miq.) Kurz	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone F Fragment 1	-	-
603	Phyllanthaceae	*Aporosa nervosa*	*Aporosa nervosa* Hook. f.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone E; Zone F Fragment 1	-	-
604	Phyllanthaceae	*Aporosa symplocoides*	*Aporosa symplocoides* s (Hook.f.) Gage	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O		Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	-
605	Phyllanthaceae	*Baccaurea macrophylla*	*Baccaurea macrophylla* (Müll.Arg.) Müll.Arg	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O		Yes	Not yet assessed	Not yet assessed	Extinct	Parks and Trees Act (2006)	-	-	Zone E	-	-
606	Phyllanthaceae	*Baccaurea motleyana*	*Baccaurea motleyana* (Müll. Arg.) Müll. Arg.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Southeast of Mandai Lake Road; Lorong Asrama	-	-
607	Phyllanthaceae	*Baccaurea parviflora*	*Baccaurea parviflora* (Müll. Arg.) Müll. Arg.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)			Northeast of Mandai Lake Road; Zone B; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
608	Phyllanthaceae	*Baccaurea polyneura*	*Baccaurea polyneura* Hook.f.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O		Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	In undisturbed to slightly disturbed mixed dipterocarp forests up to 700 m altitude. On hillsides and ridges, but also on alluvial sites. On sandy, clay, granite, loam soils.	Zone A; Zone E; Zone F	-	Peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo
609	Phyllanthaceae	*Breynia coronata*	*Breynia coronata* Hook. f.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
610	Phyllanthaceae	*Breynia discigera*	*Breynia discigera* Müll.Arg	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone F	-	-
611	Phyllanthaceae	*Bridelia sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone B	-	
612	Phyllanthaceae	*Bridelia stipularis*	*Bridelia stipularis* (L.) Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northwest, Southwest, Central South of Mandai Lake Road; Zone F	-	-
613	Phyllanthaceae	*Bridelia tomentosa*	*Bridelia tomentosa* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northwest , Southeast of Mandai Lake Road; Zone B; Zone F	-	-
614	Phyllanthaceae	*Phyllanthus debilis*	*Phyllanthus debilis* Klein ex Willd.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Southwest of Mandai Lake Road	-	-
615	Piperaceae	*Peperomia pellucida*	*Peperomia pellucida* (L.) Kunth	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Southeast of Mandai Lake Road; Zone B; Zone F	-	-
616	Piperaceae	*Piper aduncum*	*Piper aduncum* L.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	South, Northwest of Mandai Lake Road; Mandai East Camp; Mandai Firing Range; Zone B; Zone D; Zone F	-	-
617	Piperaceae	*Piper betle*	*Piper betle* L.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Central South of Mandai Lake Road; Zone D; Zone F	-	-
618	Piperaceae	*Piper flavimarginatum*	*Piper flavimarginatum* C. DC.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone B; Zone E; Zone F; Zone F Fragment 1	-	-
619	Piperaceae	*Piper muricatum*	*Piper muricatum* Blume	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone D	-	-
620	Piperaceae	*Piper pedicellosum*	*Piper pedicellosum* Wall	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone B; Zone D; Zone A; Zone F; Zone F Fragment 1	-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
621	Piperaceae	*Piper sarmentosum*	*Piper sarmentosum* Roxb.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	South, Northwest of Mandai Lake Road; Mandai East Camp; Mandai Firing Range; Zone B; Zone D	-	-
622	Piperaceae	*Piper sp. 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-		-	-		Parks and Trees Act (2006)	-	-	North, Southeast of Mandai Lake Road	-	-
623	Poaceae	*Axonopus compressus*	*Axonopus compressus* (Sw.) Beauv.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Central South, Southwest of Mandai Lake Road; Mandai Firing Range; Zone B; Zone D; Zone F	-	-
624	Poaceae	*Bambusa sp*	-	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-		-	-		Parks and Trees Act (2006)	-	-	Central South, Southwest of Mandai Lake Road; Mandai East Camp; Mandai Firing Range; Zone D; Zone F	-	-
625	Poaceae	*Bambusa vulgaris*	*Bambusa vulgaris* Schrad. ex J. C. Wendl.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	No	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	Central South of Mandai Lake Road; Lorong Asrama	-	-
626	Poaceae	*Cenchrus echinatus*	*Cenchrus echinatus* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Central South, Southeast of Mandai Lake Road	-	-
627	Poaceae	*Centotheca lappacea*	*Centotheca lappacea* (L.) Desv.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northwest, Southeast of Mandai Lake Road; Lorong Asrama; Zone D; Zone F	-	-
628	Poaceae	*Chloris barbata*	*Chloris barbata* Sw.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Central South, Southwest of Mandai Lake Road	-	-
629	Poaceae	*Coix lacryma-jobi*	*Coix lacryma-jobi* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Central South, Southwest of Mandai Lake Road	-	-
630	Poaceae	*Cynodon dactylon*	*Cynodon dactylon* (L.) Pers.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Central South of Mandai Lake Road	-	-
631	Poaceae	*Dactyloctenium aegyptium*	*Dactyloctenium aegyptium* (L.) Willd.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Southwest of Mandai Lake Road	-	-
632	Poaceae	*Digitaria longiflora*	*Digitaria longiflora* (Retz.) Pers.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Central South, Southwest of Mandai Lake Road	-	-
633	Poaceae	*Eleusine indica*	*Eleusine indica* (L.) Gaertn.	*(2014) Mandai Gate Vegetation Survey*	O	Asia + Africa + Europe (Portugal, Poland)	No	LC	Least Concern ver 3.1	Naturalized	Parks and Trees Act (2006)	-	It grows in moist as well as marshy areas, puddles, shallow ponds, fields, river and stream edges, ditches, canals etc	Southwest of Mandai Lake Road	-	This is a very widespread species, common in many localities, tolerant of heavy disturbance.
634	Poaceae	*Imperata cylindrica*	*Imperata cylindrica* (L.) P. Beauv.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-	Northwest, Central South, Southwest of Mandai Lake Road; Mandai East Camp; Mandai Firing Range; Lorong Asrama; Zone D	-	-
635	Poaceae	*Ischaemum ciliare*	*Ischaemum ciliare* Retz.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-	Southwest of Mandai Lake Road; Zone D	-	-
636	Poaceae	*Ischaemum muticum*	*Ischaemum muticum* L.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Oceania + India	Yes	LC	Least Concern ver 3.1	Common	Parks and Trees Act (2006)	-	It is found growing in stagnant water around pools and in seasonally flooded and marshy places. It also inhabits backwaters, coastal sands, estuaries and salt marshes	Northeast, Central South of Mandai Lake Road; Zone D	-	This is a common and widespread species.
637	Poaceae	*Ottochloa nodosa*	*Ottochloa nodosa* (Kunth) Dandy / Slender panic grass	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O		No	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)		*O. nodosa* occurs from sea-level up to 600 m, mainly in forest, rubber, or oil-palm plantations. It also occurs in rice fields and disturbed habitats.	Zone B; Zone D; Zone A; Zone E; Zone F	-	Occurs throughout South-East Asia and also in India, Burma and Sri Lanka. It has been introduced to Mexico and parts of Africa and Australia.
638	Poaceae	*Panicum maximum*	*Panicum maximum* Jacq.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Northwest, Central South of Mandai Lake Road	-	-
639	Poaceae	*Panicum sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone D	-	-
640	Poaceae	*Paspalum conjugatum*	*Paspalum conjugatum* P.J. Bergius	*(2014) Mandai Gate Vegetation Survey*	O	South America + Asia	No	LC	Least Concern ver 3.1	Naturalized	Parks and Trees Act (2006)	-	It grows from near sea-level up to 1700 m altitude in open to moderately shaded and moist places. It is adapted to humid climates. It is found growing gregariously under plantation crops and also frequently found on the banks of water courses, back waters and roadsides and in disturbed areas, and polluted waters. It also grows in seasonally flooded places, in marshes, in ditches, in rice fields and draining plantations.	Central South of Mandai Lake Road	-	Its occurrence has been reported as frequent.
641	Poaceae	*Paspalum scrobiculatum*	*Paspalum scrobiculatum* L. var. biscuspidatum Hack.	*(2014) Mandai Gate Vegetation Survey*	O	Africa + AS + Asia (India, China)	-	LC	Least Concern ver 3.1	Cryptogenic Weed	Parks and Trees Act (2006)	-	This species typically occurs in seasonally inundated areas and wet depressions, often association with cultivation and settlements, such as along roadsides, ditches, waste ground and rice fields	Central South of Mandai Lake Road	-	This species appears to be widespread and abundant throughout much of its range and has an extensive non-native population, however there is no information available on population trends in this species.
642	Poaceae	*Pennisetum purpureum*	*Pennisetum purpureum* Schumach.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Northwest, Southwest, Central South of Mandai Lake Road; Mandai East Camp; Mandai Firing Range	-	-
643	Poaceae	*Setaria barbata*	*Setaria barbata* (Lam.) Kunth	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Northwest of Mandai Lake Road	-	-
644	Poaceae	*Sporobolus indicus*	*Sporobolus indicus* (L.) R. Br. var. flaccidus (Roem. & Schult.) Veldk.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Central South, Southwest of Mandai Lake Road	-	-
645	Poaceae	*Stenotaphrum secundatum*	*Stenotaphrum secundatum* (Walter) Kuntze	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Southwest of Mandai Lake Road	-	-
646	Poaceae	*Themeda villosa*	*Themeda villosa* (Poir.) A. Camus	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northwest of Mandai Lake Road	-	-
647	Poaceae	*Zoysia matrella*	*Zoysia matrella* (L.) Merr.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	South Central of Mandai Lake Road	-	-
648	Polygalaceae	*Xanthophyllum 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
649	Polygalaceae	*Xanthophyllum ellipticum*	*Xanthophyllum ellipticum* Korth.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	North, Southeast of Mandai Lake Road; Zone B; Zone A	-	-
650	Polygalaceae	*Xanthophyllum eurhynchum*	*Xanthophyllum eurhynchum* Miq.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northeast, Southeast of Mandai Lake Road; Zone A; Zone F Fragment 1	-	-
651	Polygalaceae	*Xanthophyllum flavescens*	*Xanthophyllum flavescens* Roxb.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	North, Southeast of Mandai Lake Road; Zone B; Zone D; Zone A; Zone E; Zone F	-	-
652	Polygalaceae	*Xanthophyllum vitellinum*	*Xanthophyllum vitellinum* (Blume) Dietr.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northwest of Mandai Lake Road	-	-
653	Polygonaceae	*Antigonon leptopus*	*Antigonon leptopus* Hook. & Arn.	*(2014) Mandai Gate Vegetation Survey*	O	-	no	Not yet assessed	Not yet assessed	Casual	Parks and Trees Act (2006)	-	-	South Central of Mandai Lake Road	-	-
654	Polypodiaceae	*Drynaria quercifolia*	*Drynaria quercifolia* (L.) J. Sm.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	This fern grows as an epiphyte in lowland forest, secondary forest, urban areas and wayside trees	South Central of Mandai Lake Road; Zone F	Throughout Singapore	India, South China, Malaysia to Fiji and tropical Australia.
655	Polypodiaceae	*Microsorum punctatum*	*Microsorum punctatum* (L.) Copel	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	Grows best in humind environments.	Zone F	-	-
656	Polypodiaceae	*Phymatosorus scolopendria*	*Phymatosorus scolopendria* (Burm. fil.) Pichi-Serm.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone F	-	-
657	Polypodiaceae	*Pyrrosia longifolia*	*Pyrrosia longifolia* (Burm. fil.) C. V. Morton	*NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	TM + EA	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)		Primary/secondary rainforest, monsoon forest, coastal forest, freshwater swamp forest, disturbed area/open ground	Mandai Firing Range; Zone F	Throughout Singapore	-
658	Polypodiaceae	*Pyrrosia piloselloides*	*Pyrrosia piloselloides* (L.) M. Price	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	The fern grows on the bark of old trees, including mangroves, sometimes totally covering the trunk.	Zone D; Zone F	Throughout Singapore	Extends from north-eastern India throughout Southeast Asia.
659	Primulaceae	*Ardisia 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
660	Primulaceae	*Ardisia elliptica*	Seashore Ardisia	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northwest of Mandai Lake Road; Zone F	-	-
661	Primulaceae	*Ardisia sanguinolenta*	*Ardisia sanguinolenta* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone B; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing^	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
662	Primulaceae	*Ardisia teysmanniana*	*Ardisia teysmanniana* Scheff.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A; Zone F Fragment 1	-	-
663	Primulaceae	*Grenacheria amentacea*	*Grenacheria amentacea* (C.B. Clarke) Mez	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Rediscovered	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A	-	-
664	Pteridaceae	*Pteris vittata*	*Pteris vittata* L.	*(2014) Mandai Gate Vegetation Survey*	O	Asia + America + Africa + AS	-	LC	Least Concern ver 3.1	Cryptogenic Weed	Parks and Trees Act (2006)	-	This species typically grows in humid or moist walls, cliffs and rocks near or on the margins of streams, usually in shade and usually near permanent water	South Central of Mandai Lake Road	-	There is no quantitative information on population trends in this species
665	Pteridaceae	*Taenitis blechnoides*	*Taenitis blechnoides* (Willd.) Sw.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northeast, Southeast of Mandai Lake Road; Zone E	-	-
666	Pteridaceae	*Taenitis sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	Common	Parks and Trees Act (2006)			Zone A; Zone E; Zone F	-	
667	Putranjivaceae	*Drypetes pendula*	*Drypetes pendula* Ridl.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A	-	-
668	Rhamnaceae	*Smythea lanceata*	*Smythea lanceata* Summerh.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
669	Rhamnaceae	*Ventilago lanceata*	*Ventilago lanceata* Tul.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone A	-	-
670	Rhamnaceae	*Ventilago malaccensis*	*Ventilago malaccensis* Ridl.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast, Southeast of Mandai Lake Road; Zone A; Zone F; Zone F Fragment 1	-	-
671	Rhamnaceae	*Ziziphus calophylla*	*Ziziphus calophylla* Wall. ex Hook.f.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northeast, Southeast of Mandai Lake Road; Zone A; Zone F Fragment 1	-	-
672	Rhizophoraceae	*Gynotroches axillaris*	*Gynotroches axillaris* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northeast, Southeast of Mandai Lake Road; Zone D; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
673	Rhizophoraceae	*Pellacalyx axillaris*	*Pellacalyx axillaris* Korth.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
674	Rosaceae	*Prunus grisea* var. *tomentosa*	*Prunus grisea var. tomentosa* (K. & V.) Kalkm.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	PH	Yes	VU	Vulnerable A1d ver 2.3	CR	Parks and Trees Act (2006)	-	-	Zone A	-	-
675	Rosaceae	*Prunus polystachya*	*Prunus polystachya* (Hook. f.) Kalkm.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Singapore	Yes	LC	Lower Risk/least concern ver 2.3	Common	Parks and Trees Act (2006)	-	-	North of Mandai Lake Road; Zone B; Zone A; Zone F	-	-
676	Rubiaceae	*Aidia densiflora*	*Aidia densiflora* (Wall.) Masam	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	In undisturbed to slightly disturbed (open) mixed dipterocarp and sub-montane forests up to 1200 m altitude. On hillsides and ridges with sandy to clay soils. In secondary forests usually present as a pre-disturbance remnant.	Zone A	-	India, Andaman Islands, Burma, Thailand, Peninsular Malaysia, Sumatra, Borneo (Sarawak, West-, South- and East-Kalimantan).
677	Rubiaceae	*Chassalia sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone A	-	-
678	Rubiaceae	*Coffea canephora*	*Coffea canephora* Pierre ex A.Froehner	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-	Zone D	-	-
679	Rubiaceae	*Diplospora malaccensis*	*Diplospora malaccensis* Hook. f.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
680	Rubiaceae	*Gaertnera grisea*	*Gaertnera grisea* Hook.f. ex C.B.Clarke	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone A	-	-
681	Rubiaceae	*Gaertnera obesa*	*Gaertnera obesa* Hook. f. ex C.B. Clarke	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A	-	-
682	Rubiaceae	*Gynochthodes coriacea*	*Gynochthodes coriacea* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A; Zone F; Zone F Fragment 1	-	-
683	Rubiaceae	*Gynochthodes sublanceolata*	*Gynochthodes sublanceolata* Miq.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northwest of Mandai Lake Road	-	-
684	Rubiaceae	*Hedyotis verticillata*	*Hedyotis verticillata* (L.) Lam	*(2014) Mandai Gate Vegetation Survey*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-	Southwest of Mandai Lake Road	-	-
685	Rubiaceae	*Ixora congesta*	Malayan Ixora	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northeast, Southeast of Mandai Lake Road; Zone B; Zone D; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
686	Rubiaceae	*Ixora lobbii*	*Ixora lobbii* Loudon	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
687	Rubiaceae	*Ixora sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone A	-	-
688	Rubiaceae	*Ixora sp. A*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone A	-	-
689	Rubiaceae	*Lasianthus sp.*	-	*(2014) Mandai Gate Vegetation Survey*	O	-		-	-		Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
690	Rubiaceae	*Morinda citrifolia*	Mengkudu Besar	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-	-	-	-
691	Rubiaceae	*Morinda rigida*	*Morinda rigida* Miq.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Rediscovered	Parks and Trees Act (2006)	-	-	Zone F	-	-
692	Rubiaceae	*Mussaenda glabra*	*Mussaenda glabra* Vahl	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
693	Rubiaceae	*Nauclea officinalis*	*Nauclea officinalis* (Pierre ex Pit.) Merr. & Chun	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)		In undisturbed mixed dipterocarp and keranga forests up to 600 m altitude. On hillsides and ridges with sandy to clay soils. In secondary forests usually present as a pre-disturbance remnant.	Zone F Fragment 1	Southern China, Indo-China, Thailand, Peninsular Malaysia, Sumatra, Borneo (Sarawak, Sabah, Central- and East-Kalimantan).	Plants of Southeast Asia. http://www.asianplant.net/Rubiaceae/Nauclea_officinalis.htm
694	Rubiaceae	*Oxyceros bispinosus*	*Oxyceros bispinosus* (Griff.) Tirveng.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A; Zone F Fragment 1	-	-
695	Rubiaceae	*Oxyceros longiflorus*	*Oxyceros longiflorus* (Lam.) T.Yamaz	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone A	-	-
696	Rubiaceae	*Paederia foetida*	*Paederia foetida* L.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northwest, South Central of Mandai Lake Road; Zone F	-	-
697	Rubiaceae	*Pavetta wallichiana*	*Pavetta wallichiana* Steud.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
698	Rubiaceae	*Porterandia anisophylla*	*Porterandia anisophylla* (Jack ex Roxb.) Ridl.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	North , Southeast of Mandai Lake Road; Zone D; Zone A; Zone F; Zone F Fragment 1	-	-
699	Rubiaceae	*Psychotria helferiana*	*Psychotria helferiana* Kurz	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
700	Rubiaceae	*Psychotria penangensis*	*Psychotria penangensis* Hook. f.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A	-	-
701	Rubiaceae	*Psychotria sarmentosa*	*Psychotria sarmentosa* Blume	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone F	-	-
702	Rubiaceae	*Psydrax sp. 10*	-	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-		Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A	-	-
703	Rubiaceae	*Psydrax sp. 10*	-	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	-	-	-	Not Assessed	Parks and Trees Act (2006)			Zone F Fragment 1	-	-
704	Rubiaceae	*Rothmannia macrophylla*	*Rothmannia macrophylla* (Hook.f.) Bremek	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O		Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone A; Zone F Fragment 1	-	-
705	Rubiaceae	*Rubiaceae 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	North of Mandai Lake Road	-	-
706	Rubiaceae	*Rubiaceae 2*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast, Southwest of Mandai Lake Road	-	-
707	Rubiaceae	*Rubiaceae 3*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast, South Central of Mandai Lake Road	-	-
708	Rubiaceae	*Rubiaceae 4*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast, Southwest of Mandai Lake Road	-	-
709	Rubiaceae	*Rubiaceae 5*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast, Southwest of Mandai Lake Road	-	-
710	Rubiaceae	*Spermacoce laevis*	*Spermacoce laevis* Lam.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Northwest,Southwest of Mandai Lake Road	-	-
711	Rubiaceae	*Spermacoce remota*	*Spermacoce remota* Lam.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone D	-	-
712	Rubiaceae	*Timonius flavescens*	*Timonius flavescens* (Jack) Baker	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
713	Rubiaceae	*Timonius wallichianus*	*Timonius wallichianus* (Korth.) Valeton	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone D; Zone A; Zone E; Zone F	-	-
714	Rubiaceae	*Uncaria 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	Possibly native (only two recorded exotic Uncaria sp on Chong et al 2009)	-	-	-	Parks and Trees Act (2006)	-	-	Northeast, Southeast of Mandai Lake Road	-	-
715	Rubiaceae	*Uncaria 2*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast, Southeast of Mandai Lake Road	-	-
716	Rubiaceae	*Uncaria cf. lanosa*	*Uncaria lanosa* Wall.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)	-	-	Zone A	-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
717	Rubiaceae	*Uncaria longiflora var. pteropoda*	*Uncaria longiflora* (Poir.) Merr. *var. pteropoda* (Miq.)	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O		Yes	-	-	CR	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	-
718	Rubiaceae	*Uncaria sp.*	-	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-		Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Mandai East Camp; Zone A; Zone F Fragment 1	-	-
719	Rubiaceae	*Uncaria sp. 1*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone F	-	-
720	Rubiaceae	*Uncaria sp. 2*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone F	-	-
721	Rubiaceae	*Uncaria sp. 3*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone F	-	-
722	Rubiaceae	*Urophyllum sp. 2*	-	*(2014) Mandai Gate Vegetation Survey*	O	-		-	-		Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
723	Rubiaceae	*Ixora pendula*	Pink Needles	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	TM	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-	-	-	-
724	Rutaceae	*Citrus spp.*	Lime	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	-	-	-
725	Rutaceae	*Clausena excavata*	*Clausena excavata* Burm. f.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northwest, South of Mandai Lake Road; Zone B; Zone D; Zone E; Zone F	-	-
726	Rutaceae	*Glycosmis chlorosperma var. chlorosperma*	*Glycosmis chlorosperma* (Blume) Spreng. var. *chlorosperma*	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A; Zone E; Zone F; Zone F Fragment 1	-	-
727	Rutaceae	*Luvunga crassifolia*	*Luvunga crassifolia* Tanaka	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A; Zone F; Zone F Fragment 1	-	-
728	Rutaceae	*Maclurodendron porteri*	*Maclurodendron porteri* (Hook. f.) T.G. Hartley	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A	-	-
729	Rutaceae	*Melicope lunu-ankenda*	*Melicope lunu-ankenda* (Gaertn.) T.G. Hartley	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone D	-	-
730	Sabiaceae	*Meliosma simplicifolia ssp. fruticosa*	*Meliosma simplicifolia* (Roxb.) Walp. *ssp. fruticosa* Blume	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Zone A	-	-
731	Salicaceae	*Osmelia philippina*	*Osmelia philippina* (Turcz.) Benth.	(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone F Fragment 1	-	-
732	Sapindaceae	*Dimocarpus longan*	*Dimocarpus longan* Lour.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	China (Hainan)	No	NT	Lower Risk/near threatened ver 2.3	Casual	Parks and Trees Act (2006)	-	-	Northwest, South of Mandai Lake Road; Zone B; Zone D; Zone F	-	-
733	Sapindaceae	*Guioa pleuropteris*	*Guioa pleuropteris* (Blume) Radlk.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A	-	-
734	Sapindaceae	*Guioa pubescens*	*Guioa pubescens* (Zoll. & Mor.) Radlk.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone A	-	-
735	Sapindaceae	*Guioa sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone F	-	-
736	Sapindaceae	*Lepisanthes rubiginosa*	*Lepisanthes rubiginosa* (Roxb.) Leenhouts	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)		In disturbed and open habitat types, including coastal (beach) and swamp areas up to 200 m altitude. On hillsides and ridges and alluvial sites with sandy soils, but also on limestone.	Zone B	-	From India and southern China to New Guinea and Australia. In Borneo collected in Brunei, Sabah, South- and East-Kalimantan.
737	Sapindaceae	*Nephelium lappaceum*	Rambutan	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	TM + Indonesia + Vietnam	Yes	LC	Lower Risk/least concern ver 2.3	CR	Parks and Trees Act (2006)	-	Rambutan is a widely-cultivated fruit tree.	North, Southwest of Madai Lake Road; Mandai East Camp; Mandai Firing Range; Lorong Asrama; Zone B; Zone D; Zone A; Zone E; Zone F	-	-
738	Sapindaceae	*Nephelium ramboutan-ake*	*Nephelium ramboutan-ake* (Labill.) Leenh.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Rediscovered	Parks and Trees Act (2006)	-	-	Northwest of Mandai Lake Road; Zone B	-	-
739	Sapindaceae	*Pometia pinnata*	*Pometia pinnata* J.R. Forst. & G. Forst	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)		In undisturbed mixed dipterocarp forests up to 700 m altitude. Often on alluvial sites and along or near rivers and streams, but also on hillsides. On sandy to clay soils. In secondary forests usually present as a pre disturbance remnant.	Zone F	-	From Sri Lanka and southern China to New Guinea and the western Pacific. In Borneo throughout the island.
740	Sapotaceae	*Madhuca sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone E	-	
741	Sapotaceae	*Palaquium hexandrum*	*Palaquium hexandrum* (Griff.) Baill.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	In undisturbed mixed dipterocarp forests up to 1000 m altitude. On alluvial sites, but also on ridges with sandy soils. Also on limestone. In secondary forests usually present as a pre-disturbance remnant.	Zone E	-	Peninsular Malaysia, Sumatra, Borneo (throughout the island).
742	Sapotaceae	*Palaquium obovatum*	*Palaquium obovatum* (Griff.) Engl.	*(2014) Mandai Gate Vegetation Survey* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone B; Zone A; Zone F; Zone F Fragment 1	-	-
743	Sapotaceae	*Palaquium sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone B	-	
744	Sapotaceae	*Pouteria obovata*	*Pouteria obovata* (R.Br.) Baehni	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)		This coppery tree is often seen on our wild shores: natural cliffs, rocky and sandy shores as well as secondary forests. In the wild, it originally also grew in the back mangroves.	Zone B; Zone D; Zone A	-	Coastal regions from Japan, to Taiwan, Vietnam, Peninsular Malaysia, Indonesia, Philippines to Papua New Guinea, Australia and western Pacific. Peninsular Malaysia, Sumatra, Borneo (throughout the island).
745	Schizaeaceae	*Lygodium circinnatum*	*Lygodium circinnatum* (Burm. f.) Sw.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Southeast of Mandai Lake Road	-	-
746	Schizaeaceae	*Lygodium longifolium*	*Lygodium longifolium* (Willd.) Sw.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	Zone B; Zone E; Zone F	-	-
747	Schizaeaceae	*Lygodium microphyllum*	*Lygodium microphyllum* (Cav.) R. Br.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Africa + Asia	Yes	LC	Least Concern ver 3.1	Common	Parks and Trees Act (2006)	-	Grows in open marshy or semi marshy areas and disturbed forests from plains to high altitudes as climber	North, Southeast of Mandai Lake Road; Zone B; Zone A; Zone F	-	Widely distributed and commonly occurring species.
748	Schizaeaceae	*Lygodium sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone D; Zone F	-	-
749	Selaginellaceae	*Selaginella sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone F	-	-
750	Simaroubaceae	*Eurycoma longifolia*	*Eurycoma longifolia* Jack	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A; Zone F	-	-
751	Smilacaceae	*Smilax setosa*	*Smilax setosa* Mkq.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Southeast of Mandai Lake Road; Zone D; Zone A; Zone F	-	-
752	Solanaceae	*Solanum torvum*	*Solanum torvum* Sw.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Southwest of Mandai Lake Road; Mandai East Camp; Mandai Firing Range; Lorong Asrama; Zone B; Zone D	-	-
753	Sterculiaceae	*Sterculiaceae 1*	-	*(2014) Mandai Gate Vegetation Survey*	O	-	-	-	-	-	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-

Item	Family	Genus species	Full name and authorship / Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore	IUCN Category	IUCN Status	Local Status^	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
754	Symplocaceae	*Symplocos fasciculata*	*Symplocos fasciculata* (Roxb.) Zoll.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	In primary high and open secondary forest and thickets, common in disturbed forest, rather indifferent to soils, besides on latosols, recorded from sand (Banka), in Borneo from sandstone, black soils, seasonally swampy land and Dipterocarp forest, also riparian, in Udjong Kulon from raised coral limestone, from sea-level up to c. 2200 m.	Zone B; Zone D; Zone A; Zone E; Zone F	-	From Peninsular Thailand to New Guinea (apparently absent on the Lesser Sunda Islands). In Borneo found throughout the island.
755	Theaceae	*Gordonia multinervis*	*Gordonia multinervis* King	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Malaysia + Singapore	Yes	VU	Vulnerable ver 2.3	EN	Parks and Trees Act (2006)	-	This tree occurs in lowland and hill forest.	Zone A; Zone F; Zone F Fragment 1	-	Perak, Kelantan, Terengganu, Pahang, Penang, Malacca, Johore and Singapore.
756	Thelypteridaceae	*Christella dentata*	*Christella dentata* (Forsk.) Brownsey & Jermy	*(2014) Mandai Gate Vegetation Survey*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-	Northwest, Southeast of Mandai Lake Road	-	-
757	Thelypteridaceae	*Christella subpubescens*	*Christella subpubescens* (Blume) Holttum	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Southwest of Mandai Lake Road	-	-
758	Thelypteridaceae	*Cyclosorus dentatus*	*Cyclosorus dentatus* (Forsskal) R. C. Ching	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	Cryptogenic Weed	Parks and Trees Act (2006)	-	-	Zone B; Zone A	-	-
759	Thelypteridaceae	*Cyclosorus opulentus*	*Cyclosorus opulentus* (Kaulf.) Nakaike	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Zone B; Zone D	-	-
760	Thelypteridaceae	*Cyclosorus sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone D; Zone F	-	-
761	Thelypteridaceae	*Cyclosorus subpubescens*	*Cyclosorus parasiticus subpubescens* (Bl.) Tardieu & C. Chr.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Zone D	-	-
762	Thelypteridaceae	*Cyclosorus triphyllus*	*Cyclosorus triphyllus* (Sw.) Tardieu ex Tardieu & C. Chr.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)		On dry banks of rivers in shade at low altitudes.	Zone A; Zone E; Zone F	-	Tropics of Asia to Australia, north to southern edge of Japan.
763	Thymelaeaceae	*Aquilaria hirta*	*Aquilaria hirta* Ridl.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Indonesia + Singapore	Yes	VU	Vulnerable A1d ver 2.3	Rediscovered	Endangered Species (Import and Export) Act	Appendix II	A small tree occurring in lowland forest on hill slopes.	Northeast of Mandai Lake Road; Zone B	-	-
764	Thymelaeaceae	*Aquilaria malaccensis*	*Aquilaria malaccensis* Lamk.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	IM + Iran	Yes	VU	Vulnerable A1d ver 2.3	VU	Endangered Species (Import and Export) Act	Appendix II	-	Northeast of Mandai Lake Road; Zone D; Zone A; Zone E; Zone F	-	-
765	Thymelaeaceae	*Aquilaria microcarpa*	*Aquilaria microcarpa* Baill.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	Native to Indonesia (Kalimantan, Sumatera); Singapore	Yes	VU	Vulnerable ver 2.3	CR	Parks and Trees Act (2006)		This species grows in lowland forest up to 200 m altitude.	Zone A	-	Peninsular Malaysia, Sumatra and Borneo.
766	Thymelaeaceae	*Aquilaria sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone F	-	
767	Thymelaeaceae	*Enkleia malaccensis*	*Enkleia malaccensis* Griff.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone A; Zone E	-	-
768	Thymelaeaceae	*Gonystylus confusus*	*Gonystylus confusus* Airy Shaw	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	Appendix II	-	Northeast of Mandai Lake Road; Zone A; Zone F	-	-
769	Typhaceae	*Typha angustifolia*	Cat-tail	*Suharaj, R (2007) Wildlife and Vegetation Report (Mandai)*	O	Europe + Asia (China) + USA	-	LC	Least Concern ver 3.1	-	Parks and Trees Act (2006)	-	It grows in shallow water of lakes, rivers, ponds, marshes, and ditches.	-	-	No studies on global populations are available.
770	Urticaceae	*Cecropia pachystachya*	*Cecropia pachystachya* Trécul	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	North, South West of Mandai Lake Road; Mandai East Camp; Mandai Firing Range; Zone B; Zone D; Zone F	-	-
771	Urticaceae	*Pilea microphylla*	*Pilea microphylla* (L.) Liebm.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone F	-	-
772	Urticaceae	*Pipturus argenteus*	*Pipturus argenteus* (G. Forst.) Wedd.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	South Central of Mandai Lake Road; Zone F	-	-
773	Urticaceae	*Poikilospermum suaveolens*	*Poikilospermum suaveolens* (Blume) Merr.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	VU	Parks and Trees Act (2006)	-	-	South Central of Mandai Lake Road; Zone D; Zone F	-	-
774	Verbenaceae	*Lantana camara*	Common Lantana	*Suharaj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	Zone D	-	-
775	Verbenaceae	*Stachytarpheta indica*	Indian snakeweed	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp*	O	Africa	No	Not yet assessed	Not yet assessed	Naturalised; cultivated	Parks and Trees Act (2006)		Found in tropical environments with a distinct dry season. Coastal forest, disturbed areas and open ground	Mandai East Camp	-	
776	Verbenaceae	*Stachytarpheta jamaicensis*	*Stachytarpheta jamaicensis* (L.) Vahl	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Naturalized	Parks and Trees Act (2006)	-	-	South Central of Mandai Lake Road	-	-
777	Vitaceae	*Ampelocissus elegans*	*Ampelocissus elegans* (Kurz) Gegnep.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone B; Zone E; Zone F	-	-
778	Vitaceae	*Ampelocissus gracilis*	*Ampelocissus gracilis* (Wall.) Planch.	*(2014) Mandai Gate Vegetation Survey* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road; Zone B; Zone A; Zone F; Zone F Fragment 1	-	-
779	Vitaceae	*Ampelocissus sp.*	-	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	-	-	-	NA	Parks and Trees Act (2006)			Zone F	-	-
780	Vitaceae	*Ampelocissus spicifer*	*Ampelocissus spicifer* (Gräf.) Planch.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)	-	-	Northeast of Mandai Lake Road	-	-
781	Vitaceae	*Cissus hastata*	*Cissus hastata* Miq.	*(2014) Mandai Gate Vegetation Survey*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Southeast of Mandai Lake Road; Zone F	-	-
782	Vitaceae	*Cissus repens*	*Cissus repens* Lam.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	EN	Parks and Trees Act (2006)	-	Cissus species in Singapore are creepers or climbers with leaf-opposed tendrils not ending in adhesive discs, inhabiting the fringes of lowland dipterocarp forest and secondary forest.	Zone F	Pulau Ubin, the coastal Khatib Bongsu, and deeper inland at Orchard Boulevard and Jalan Bahar.	India, Myanmar, Kampuchea, Vietnam, Thailand, and Malesia.
783	Vitaceae	*Leea indica*	*Leea indica* (Burm. f.) Merr.	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Common	Parks and Trees Act (2006)	-	-	Northwest, South of Mandai Lake Road; Mandai East Camp; Mandai Firing Range; Lorong Asrama; Zone B; Zone D; Zone E; Zone F	-	-
784	Vitaceae	*Leea rubra*	*Leea rubra* Bl.	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	Extinct	Parks and Trees Act (2006)		In secondary regrowth and scrub up to 500 m altitude. Often in dry monsoon and savanna forest. Also on limestone.	Zone F	-	From India and southern China to New Guinea and Australia
785	Vitaceae	*Nothocissus spicifera*	*Nothocissus spicifera* (Griff.) A. Latiff	*(2015) Floristic and Vegetation Surveys of the Mandai Lake Road Area Final Report*	O	-	Yes	Not yet assessed	Not yet assessed	CR	Parks and Trees Act (2006)		It is found in the fringes of lowland dipterocarp forest, often along rivers and streams.	Zone A	-	Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, and Borneo
786	Zingiberaceae	*Alpinia purpurata*	*Alpinia purpurata* (Vieill.) K. Schum.	*(2014) Mandai Gate Vegetation Survey*	O	-	No	Not yet assessed	Not yet assessed	Cultivated only	Parks and Trees Act (2006)	-	-	South Central of Mandai Lake Road	-	-
787	Zingiberaceae	*Etlingera elatior*	Torch Ginger	*(2014) Mandai Gate Vegetation Survey* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range*	O	-	-	Not yet assessed	Not yet assessed	-	Parks and Trees Act (2006)	-	-	Mandai Firing Range	-	-

^ Local status obtained from Singapore Red Data Book and Chong et al Vascular Flora of Singapore

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TM = Thai-Malay Peninsula, which includes only Myanmar, Thailand, Singapore and Peninsular Malaysia
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IM = Indomalaya Ecozone, which includes South Asian countries, Southeast Asian countries, Southern China and parts of East Asia
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Item	Family	Genus Species	Common Name	Source	Presence[#]	Current endemicity listing[*]	IUCN Category	IUCN Status	Local Status (SRDB)	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
Mammals Species															
1	Pteropodidae	*Callosciurus notatus*	Plantain Squirrel	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	-	Not yet assessed	Not yet assessed	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	North and South of Mandai Lake Road Zones A, B, D, E, F, H	-	-
2	Pteropodidae	*Cynopterus brachyotis*	Common Fruit Bat	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Can be found from habitats ranging from orchards, gardens to forested tracts	North and South of Mandai Lake Road Zones D, F	Throughout tropical Indomalaya westward along the Himalayan foothills westward into Nepal and eastward into southwest China, and on the islands of Sumatra and Borneo	Generally locally abundant and most common in disturbed and residential areas
3	Pteropodidae	*Eonycteris spelaea*	Cave Nectar Bat	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	-	-	-
4	Cynocephalidae	*Galeopterus variegatus*	Malayan Colugo	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + SD	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forest-dependent species, but can be found in secondary habitats close to human populations	North of Mandai Lake Road Zones B, E, F	Throughout Thai-Malay peninsula and Sundaic region	This species is probably declining due to habitat loss, and traditional hunting in Java and perhaps elsewhere. More information is needed on this population declines
5	Sciuridae	*Iomys horsfieldii*	Horsfield's Flying Squirrel	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	BO + TM	LC	Least Concern ver 3.1	EN	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	This species can be found up to 1,000 m in primary forests, secondary, degraded forests and scrub, as well as cultivated areas. They use tree hollow as their own home.	Zone A, H	-	-
6	Cercopithecidae	*Macaca fascicularis*	Long-tailed Macaque	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *Chua AHM (2015) Mandai Safari Park Biodiversity Survey. Camera Trapping Final Report* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O/A	TM + SD	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Extremely tolerant of a range of habitats, including mangrove and swamp forests, and can be found in agricultural areas near forest (secondary growth, secondary forest, and primary forest)	North and South of Mandai Lake Road; Zones A, B, D, E, F	Throughout Thai-Malay peninsula and Sundaic region	Widespread and often abundant species, and is sometimes commensal with humans
7	Manidae	*Manis javanica*	Malayan Pangolin/ Sunda Pangolin	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Chua AHM (2015) Mandai Safari Park Biodiversity Survey. Camera Trapping Final Report*	O/N	IC + SD	EN	Endangered A2d + 3d + 4d ver 3.1	CR	Endangered Species (Import and Export) Act Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CITES Appendix II	Found in primary and secondary forest, and is found in cultivated areas including gardens and plantations, including near human settlements.	North of Mandai Lake Road; Zones A, D, E	Throughout Sundaic and Indochinese region	No information is available on population levels as these species are rarely observed due to their secretive, solitary, and nocturnal habits
8	Vespertilionidae	*Myotis hasselti* (Earlier included under *Myotis adversus* but now considered distinct)	Grey Large-footed Myotis	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *WRS Data*	O	SD + IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Widespread in Singapore and spends the day roosting in drain culverts and in roof spaces of buildings. At dusk, flies low over large water bodies scopping insects and possibly small fish off the surface. In SEA, known to roost in mangrove forests and further inland.	Zone F	Recorded from many locations in Singapore including CCNR and Sungei Buloh.	This is a reasonably common, but locally distributed species. In South Asia, although it is a fairly common bat a declining trend in the population has been observed
9	Pteropodidae	*Myotis muricola*	Whiskered Myotis	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	-	-	-	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	South of Mandai Lake Road Zone F	-	-
10	Viverridae	*Paradoxurus musangus* (Formerly *Paradoxurus hermaphroditus* , split into three species with the Singapore form to be *P musangus*)	Common Palm Civet/ Sumatran Palm Civet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Chua AHM (2015) Mandai Safari Park Biodiversity Survey. Camera Trapping Final Report* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Endangered Species (Import and Export) Act Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CITES Appendix III	This species has been found in a wide range of habitats including evergreen and deciduous forest (primary and secondary), plantations and near humans, in habitats up to 2,400 m	Zones A, D, E	-	The population status is poorly known
11	Vespertilionidae	*Pipistrellus javanicus*	Javan Pipistrelle	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	This species is found in varied habitat types from primary and secondary forested regions, agricultural landscapes (including rubber plantations) to urban areas	Zone D	-	This species is widely distributed, common and the population seems stable and doing well
12	Pteropodidae	*Pipistrellus sp.*	Pipistrelle	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	-	-	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	South of Mandai Lake Road	-	-
13	Cercopithecidae	*Presbytis femoralis*	Banded Leaf Monkey	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *Biodiversity in WRS Parks (Pre-2013)*	O	SD+IC	NT	Near Threatened ver 3.1	CR	Endangered Species (Import and Export) Act	-	Based on what is known of closely-related species, such as P. siamensis and P. melalophos, this species is found in mixed mangrove, primary freshwater, riverbank, primary lowland logged, scrub-grassland riverbank, and secondary riverbank habitats (Wilson and Wilson 1976; Crockett and Wilson 1980). It is found in taller trees of swampy peat forest in Malay Peninsula (J. Hon pers. comm.), while in Singapore it is found in primary, secondary, swamp, and dryland rainforests (Lucas et al. 1988).	Zones A, F	Indonesia (east-central Sumatra) and the Malay Peninsula which is restricted to the far south and to the northwest, extending north throughout peninsular Thailand and southern Myanmar. In Sumatra it is found between the Rokan and Siak Rivers. Locally known from the Nee Soon Swamp Forest area in the CCNR	-
14	Felidae	*Prionailurus bengalensis*	Leopard Cat	*NSS report on STB Project in Mandai*	O/N	IM	LC	Least Concern ver 3.1	CR	Endangered Species (Import and Export) Act Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CITES Appendix II	Occurs in a broad spectrum of habitats, from tropical rainforest to temperate broadleaf and, marginally, coniferous forest, as well as shrub forest and successional grasslands	Unknown, limited studies	Throughout tropical Indomalaya westward along the Himalayan foothills westward into Nepal and eastward into southwest China and southern Japan and on the islands of Sumatra and Borneo	Frequently recorded across most of its wide range, in comparison with sympatric species and with its broad distribution has an abundant population
15	Chiroptera	*Pyeropus vampyrus*	Malayan Flying Fox	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	-	-	-	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	-	-	-
16	Muridae	*Rattus annandalei*	Singapore Rat	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	SD	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	It has been collected from lowland secondary forest, and in rubber estates whenever traps were set low in trees. Several specimens were also taken on the ground.	Zone F	-	Large numbers in Selangor (Malaysia)
17	-	*Rattus tanezumi*	Oriental House Rat	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	TM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	-	This highly adaptable species is commonly found in and around villages and agricultural areas.	Zone F	Both the native and introduced geographic distribution of this very widespread species remains somewhat unclear.	This species is listed as Least Concern due to its wide distribution and tolerance of a wide variety of habitat types. It is a common to abundant species where it occurs.
18	-	*Rattus* sp.	Rat	*Chua AHM (2015) Mandai Safari Park Biodiversity Survey. Camera Trapping Final Report* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	-							Zones A, B, D, E, F		
19	Rhinolophidae	*Rhinolophus lepidus*	Blyth's Horseshoe Bat	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	This species can be found in both dry and moist forest and fringe areas	-	-	It is locally common throughout much of its range.
20	Cervidae	*Rusa unicolor*	Sambar Dear	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Chua AHM (2015) Mandai Safari Park Biodiversity Survey. Camera Trapping Final Report* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	VU	Vulnerable A2cd + 3cd + 4cd ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Occurs in dense evergreen closed-canopy forest, highly tolerant of forest degradation; forest-dependent species (Subaraj, 2007)	North and South of Mandai Lake Road; Zones A, B D, E	Large distribution range extending from India in South Asia eastward through entire Southeast Asia up to Taiwan and Southern China	This species is in rapid decline leading to a widespread distribution of very low numbers and many local-level extinctions, other than the populations in Taiwan.

Item	Family	Genus Species	Common Name	Source	Presence#	Current endemicity listing*	IUCN Category	IUCN Status	Local Status (SRDB)	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
21	Emballonuridae	*Saccolaimus saccolaimus*	Pouched Tomb Bat	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Dense forests, swampy areas and plantations.	South of Mandai Lake Road Zones D, F	-	In South Asia, the population status is considered to be poorly known. In the Philippines, it is poorly known, but might be moderately common in agricultural areas, and is probably common in populated areas, but this require confirmation as there has been little direct survey work undertaken in these modified habitats. It is locally common in other parts of its Southeast Asian range outside of the Philippines.
22	Pteropodidae	*Scotophilus kuhlii*	Asiatic Lesser Yellow House Bat	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	-	-	-	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	North and South of Mandai Lake Road Zones D, F, G	-	-
23	Soricidae	*Suncus murinus*	House Shrew	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006		This species is found in a very wide variety of habitats, including natural forests, scrubland and grasslands and nearly all secondary amd degraded habitats, such as plantations, pasture, cultivated fields, suburbans and urban areas. It is a human commensal.	Zone G	-	Introduced: Bahrain; Comoros; Djibouti; Egypt; Eritrea; Guam; Iraq; Japan; Kenya; Kuwait; Madagascar; Mauritius; Oman; Philippines; Réunion; Rwanda; Saudi Arabia; Sudan; Tanzania, United Republic of; Yemen
24	Pteropodidae	*Sundasciurus tenuis*	Slender Squirrel	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	-	-	-	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forest-dependent species	North and South of Mandai Lake Road Zones A, B, D, E, F, G, H	-	-
25	Suidae	*Sus scrofa*	Wild Boar	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *Chua AHM (2015) Mandai Safari Park Biodiversity Survey, Camera Trapping Final Report* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM + EA + others	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	The Eurasian wild pig occupies a wide variety of temperate and tropical habitats, from semi-desert to tropical rain forests, temperate woodlands, grasslands and reed jungles; often venturing onto agricultural land to forage. It is found in a variety of habitats.	Zones A, B, D, E, H	-	This species is abundant in many parts of its range, though populations can be depressed in places where hunting intensity is high
26	Tragulidae	*Tragulus kanchil*	Lesser Mousedeer	*NSS report on STB Project in Mandai* *Chua AHM (2015) Mandai Safari Park Biodiversity Survey, Camera Trapping Final Report*	O/N	TM + SD	LC	Least Concern ver 3.1	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Generally found in lowland/foothill primary and secondary forests	Zone A, B, E	Throughout Thai-Malay peninsula and Sundaic region	A reliable population estimate is lacking
27	Tupaiidae	*Tupaia glis*	Common Treeshrew	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *Chua AHM (2015) Mandai Safari Park Biodiversity Survey, Camera Trapping Final Report* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + SD	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	North and South of Mandai Lake Road; Zones A, B, D, E, F, H	-	-
28	Vespertilionidae	*Tylonycteris pachypus*	Lesser Bamboo Bat	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	SD+ PH + EA + IM + IC	LC	Least Concern ver 3.1	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	This species is found in prime tropical deciduous forests with extensive bamboo growth, and has been recorded from lowland agricultural areas and disturbed habitats (Heaney et al. 1998; Esselstyn et al. 2004). It prefers to roost in internodal spaces of hollow bamboo and narrow crevices in other trees. The roosting site is located 0.25 to 10 m from the ground. It is a gregarious species and roosts in groups of up to 40 individuals.	Zones D, F	-	-
29	Vespertilionidae	*Tylonycteris robustula*	Greater Bamboo Bat	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	EA + BO + IC + Timor-Leste	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	This species is associated with bamboo vegetation in both intact and disturbed habitats (Heaney and Alcala 1986; Bates and Harrison 1997; Smith and Xie 2008). Small colonies, of up to 32 animals, can be encountered roosting in both bamboo and rock crevices (Bates and Harrison 1997).	Zones D	-	-
30	Vespertilionidae	*Tylonycteris* sp.	Bamboo Bat	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *WRS Data*	O	-	Not yet assessed	Not yet assessed	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	Zone F	-	-

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Bird Species															
1	Accipitridae	*Accipiter gularis*	Japannese Sparrowhawk	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Commonly found in subtropical or tropical lowland rainforest	Zone A	Throughout tropical Indomalaya westward along the Himalayan foothills westward into Nepal and eastward into southwest China, and on the islands of Sumatra and Borneo	The population is estimated to number in the tens of thousands
2	Accipitridae	*Accipiter soloensis*	Chinese Goshawk	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary and secondary forests, old plantations, scrub and parklands	South of Mandai Lake Road Zones A, B, D, E, F, H	-	The population is estimated to number in the tens of thousands.
3	Sturnidae	*Acridotheres javanicus*	Javan Myna	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	-	Not yet assessed	Not yet assessed	Not listed	Not Protected by the Wild Animals and Birds Act, 2000	-	Secondary forests, forest edge, scrub, old plantations, parkland, urban areas	North and South of Mandai Lake Road, Mandai East Camp, Mandai Firing Range, Lorong Asrama Zone F	Java, Bali, TM	-
4	Sturnidae	*Acridotheres tristis*	Common Myna	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	EA+IC+TM+IM+Islamic Republic of; Kazakhstan	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	A wide range of habitats in warm areas with access to water. In their native range, common mynas inhabit open agricultural areas such as farmlands as well as cities. They are often found on the outskirts of towns and also outlying homesteads in desert or forest. They tend to avoid dense vegetation. They are most common in dry woodlands and partly open forests.roost in isolated stands of tall trees with dense canopies. ("Factsheets: Common Myna", 2003; Invasive Species Specialist Group, 2006; Kannan and James, 2001)	Zones E, F	Found throughout Singapore and its offshore islands.	Native: Afghanistan; Bangladesh; Bhutan; Cambodia; China; India; Iran, Islamic Republic of; Kazakhstan; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Pakistan; Singapore; Sri Lanka; Thailand; Viet Nam Introduced: Australia; Bahrain; British Indian Ocean Territory; Brunei Darussalam; Comoros; Cook Islands; Egypt; Fiji; Hong Kong; Indonesia; Iraq; Kiribati; Kuwait; Kyrgyzstan; Madagascar; Maldives; Mauritius; New Caledonia; New Zealand; Oman; Qatar; Réunion; Saint Helena, Ascension and Tristan da Cunha; Samoa; Saudi Arabia; Seychelles; Solomon Islands; South Africa; Tajikistan; Tonga; Turkey; Turkmenistan; United Arab Emirates; United States; Uzbekistan; Vanuatu; Zimbabwe
5	Acrocephalidae	*Acrocephalus orientalis*	Oriental reed warbler	*WRS Data*	O	EA	Not recognised as a species	-	Not Listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Marsh, reedbed	Zone F	Botanic Gardens, Neo Tiew, Punggol, Sungei Buloh, Tuas, Woodlands	-
6	Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM + EA + others	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Sandy shores, coastal mudflats, freshwater marshes, wet grasslandsand concretised canals	North of Mandai Lake Road Zone F	-	2,600,000-3,200,000 individuals
7	Aegithinidae	*Aegithina tiphia*	Common Iora	*Mandai Conceptual Masterplan Study Appendix C (2014)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	North and South of Mandai Lake Road; Lorong Asrama Zones B, D, E, F, H	Indian sub-continent, South China, mainland SEA, TM, Greater Sundas, Palawan	The global population size has not been quantified, but the species is described as common
8	Apodidae	*Aerodramus brevirostris* (Previously placed in the genus *Collocalia* and split as *C. brevirostris* and *C. rogersi*)	Himalayan Swiftlet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	North and South of Mandai Lake Road; Lorong Asrama Zones D, E, F	-	The global population size has not been quantified, but the species is reported to be common throughout most of breeding range

Item	Family	Genus Species	Common Name	Source	Presence#	Current endemicity listing*	IUCN Category	IUCN Status	Local Status (SRDB)	Protected by Local Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
9	Apodidae	*Aerodramus maximus* (Previously placed in the genus *Collocalia* as *C. maxima*)	Black-nest Swiftlet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	-	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	North and South of Mandai Lake Road; Lorong Asrama Zone F	-	Population trend appears to be decreasing due to harvesting of eggs and nestlings
10	Nectariniidae	*Aethopyga siparaja*	Crimson Sunbird	*Mandai Conceptual Masterplan Study Appendix C (2014)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Commonly found in subtropical or tropical lowland rainforest	North and South of Mandai Lake Road Zones A, B, D, E, F, H	Throughout tropical Indomalaya westward along the Himalayan foothills westward into Nepal and eastward into southwest China, and on the islands of Sumatra and Borneo	The global population size has not been quantified, but the species is described as usually common
11	Alcedinidae	*Alcedo atthis*	Common Kingfisher	*NParks (Presentation on 20 August 2015) Biodiversity in Mandai* *WRS Data*	O	BO + TM + IC + IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006			Vicinity of waterbodies within Project Area Zone F	Widespread in the region to Europe, Middle East and East Asia	Global population is estimated to number < c.600,000 individuals
12	Alcedinidae	*Alcedo meninting*	Blue-eared Kingfisher	*NParks (Presentation on 20 August 2015) Biodiversity in Mandai* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	BO + TM + SD	LC	Least Concern ver 3.1	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006		Forest, wetlands (inland)	Forested areas within Project Area Zones A, F	In Singapore, mainly confined to the CCNR (mostly in MacRitchie). Also recorded in Poyan, Pulau Tekong, SBWR. Outside Singapore, widespread in SEA, East and South Asia.	Suspected to be in decline owing to clearance of streamside habitat
13	Rallidae	*Amaurornis phoenicurus*	White-breasted Waterhen	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Mangroves, secondary forests and scrub, marshes, ponds with well vegetated fringes, wet grassland and parkland	North and South of Mandai Lake Road; Lorong Asrama Zones D, E, F	-	10,000-100,000 individuals
14	Bucerotidae	*Anthracoceros albirostris*	Oriental Pied Hornbill	*NParks (Presentation on 20 August 2015) Biodiversity in Mandai*	O	IC + SD + TM	LC	Least Concern ver 3.1	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006		Can be found outside primary rainforests and inhabited areas if fruit sources are present. Dependent on large living trees for nesting sites.	Forested areas within Project Area	In Singapore, Pulau Ubin, Changi, Botanic Gardens, Bidadari. Widespread resident in northern South Asia, southern China, Indochina and western Indonesia.	Population trend believed to be stable; may be the most common hornbill species.
15	Nectariniidae	*Anthreptes malacensis*	Brown-throated Sunbird	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + SD + PH	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Commonly found in tropical lowland rainforest	North and South of Mandai Lake Road; Lorong Asrama Zones A, B, D, E, F, H	Found throughout Singapore and its offshore islands. Throughout Thai-Malay peninsula, Sundaic region and the Philippines	The global population size has not been quantified, but the species is described as common
16	Motacillidae	*Anthus rufulus*	Paddyfield Pipit	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	Asia	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Grassland dependent species	South of Mandai Lake Road	Afghanistan, Indian sub-continent, SW China, SEA, east to Phillipines, Lesser Sundas	The global population size has not been quantified, but the species is described as common throughout most of its range
17	Sturnidae	*Aplonis panayensis*	Asian Glossy Starling	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	PH + BO + TM + India	LC	Least Concern ver 3.1	Not listed	Not protected under the Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary forests, forest edge, scrub, old plantations, parklands, urban areas	North and South of Mandai Lake Road; Mandai East Camp; Mandai Firing Range Zones A, B, D, E, F, H	East India, SEA, TM, Greater Sundas, Phillipines, Sulawesi	The global population size has not been quantified
18	Apodidae	*Apus affinis*	House Swift	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	Asia, Africa, Spain, Middle East	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	Lorong Asrama Zone F	-	The global population size has not been quantified.

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19	Nectariniidae	*Arachnothera chrysogenys*	Yellow-eared Spiderhunter	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	TM + BO	LC	Least Concern ver 3.1	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forest dependent species (Subaraj, 2007)	South of Mandai Lake Road	TM, Sumatra, Borneo, Java Central Catchment Nature Reserve	Global population size has not been quantified, but the species is described as local and uncommon on Sumatra, rare in west Java and very scarce on Borneo
20	Nectariniidae	*Arachnothera longirostra*	Little Spiderhunter	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Commonly found in subtropical or tropical lowland rainforest; Forest dependent species (Subaraj, 2007)	North and South of Mandai Lake Road Zones A, B, D, E, F, H	Throughout tropical Indomalaya westward along the Himalayan foothills westward into Nepal and eastward into southwest China, and on the islands of Sumatra and Borneo	The global population size has not been quantified, but the species is described as common to rare
21	Ardeidae	*Ardea cinerea*	Grey Heron	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	Asia + Africa + Europe	LC	Least Concern ver 3.1	VU	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Sandy beaches, reefs, mangroves, coastal mudflats, freshwater marshes,wet grasslands and canals	North and South of Mandai Lake Road Zones A, F	-	The global population is estimated to number c.790,000-3,700,000 individuals
22	Ardeidae	*Ardea purpurea*	Purple Heron	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	Asia + Africa + Europe	LC	Least Concern ver 3.1	EN	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Mangroves, freshwater marshes, wet grasslands, water bodies with well-vegetated fringes	North and South of Mandai Lake Road Zones A, B, D, E, F	-	The global population is estimated to number c.270,000-570,000 individuals
23	Ardeidae	*Ardeola bacchus*	Chinese Pond Heron	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	EA + IM + IC + SD	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Frequents paddyfields, swamps, ponds, riverbanks; also in mangroves and at tidal pools.	Zone F	-	Native: Brunei Darussalam; Cambodia; China; India; Indonesia; Japan; Korea, Democratic People's Republic of; Korea, Republic of; Lao People's Democratic Republic; Malaysia; Myanmar; Philippines; Russian Federation; Singapore; Taiwan, Province of China; Thailand; Viet Nam Vagrant: Bangladesh; Guam; Mongolia; Sri Lanka Present - origin uncertain: Bhutan; Northern Mariana Islands
24	Ardeidae	*Bubulcus coromandus* (considered a subspecies of *Bubulcus ibis*)	Eastern Cattle Egret	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	SE Asia, from Pakistan to Japan. Now range may include Australia and New Zealand.	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Grassland dependent species	Zone F	Widespread across Indian subcontinent and East Asia, SEA, Greater and Lesser Sundas,Phillipines, east to Australia	-
25	Ardeidae	*Bubulcus ibis*	Cattle Egret	*Mandai Conceptual Masterplan Study Appendix C (2014)* *WRS Data*	O	Asia + Africa + Europe + Oceania + United States	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Grassland dependent species	South of Mandai Lake Road Zone F	-	The population is estimated to number 3,800,000-7,600,000 individuals.
26	Ardeidae	*Butorides striatus*	Little Heron	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	Asia + Americas + Australia + Africa + TM + BO + IC + Europe	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Mangrove-lined shores and estuaries, or dense woody vegetation fringing ponds, rivers, lakes and streams. Canals, artificial ponds, mudflats, marshland, pastures, ricefields and other flooded cultivation.	Zones A, F	Extremely large range; in Singapore, found at suitable habitats	Overall population trend is decreasing although some populations may be stable and others have unknown trends.
27	Cuculidae	*Cacomantis merulinus*	Plaintive Cuckoo	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Commonly found in subtropical or tropical lowland rainforest	North and South of Mandai Lake Road Zones A, E, F	Throughout tropical Indomalaya westward along the Himalayan foothills westward into Nepal and eastward into southwest China, and on the islands of Sumatra and Borneo	The global population size has not been quantified, but the species is reported to be common throughout its range
28	Cuculidae	*Cacomantis sonneratii*	Banded Bay Cuckoo	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Zones A, B, D, E, F	Zones A, B, D, E, F	-	The global population size has not been quantified, but the species is reported to be common to fairly common in much of its range
29	Caprimulgidae	*Caprimulgus macrurus*	Large-tailed Nightjar	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA + Oceania	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Zones A, D, F, G			The global population size has not been quantified, but the species is reported to be common to locally abundant throughout much of its range.
30	Ardeidae	*Casmerodius albus* (synonym: *Ardea alba*)	Great Egret	*NParks (Presentation on 20 August 2015) Biodiversity in Mandai*	O	Asia + Americas + Australia + Africa + TM + BO + IC + Europe	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006		Inhabits all kinds of inland and coastal wetlands, frequenting river margins, lake shores, marshes, flood plains, reservoirs and mangroves.	Vicinity of waterbodies within Project Area	Extremely large range	The overall population trend is uncertain, as some populations are decreasing, while others are increasing, stable fluctuating or have unknown trends
31	Cuculidae	*Centropus bengalensis*	Lesser Coucal	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Adapted to open grasslands and secondary growths that result from human interference. Amongst the first to colonise a new patch of lalang and other wasteland. Prefers grassland areas as compared to greater coucal.	Mandai East Camp, Mandai Firing Range, Lorong Asrama Zones B, D, F	Common resident throughout Singapore and the northern offshore islands. World distribution from India to East Indonesia.	The global population size has not been quantified, but the species is reported to be abundant in open country, while national population sizes have been estimated at c.10,000-100,000 breeding pairs and c.1,000-10,000 individuals on migration in China and c.10,000-100,000 breeding pairs in Taiwan.
32	Cuculidae	*Centropus sinensis*	Greater Coucal	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NSS Report on STB Project* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM + PH + IC	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary forest, tall grassland, thickets, bamboo, scrub near cultivation, paddyfields. Prefers wooded areas as compared to lesser coucal.	Lorong Asrama Zones D, E, H	Uncommon resident throughout Singapore. Sighted at CCNR, Pasir Ris, Sungei Buloh and Venus Drive.	The global population size has not been quantified, but the species is reported to be common almost everywhere throughout its range. ing pairs in Taiwan .
33	Alcedinidae	*Ceyx erithaca*	Black-backed Kingfisher; Oriental Dwarf Kingfisher; Three-toed Kingfisher	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (Presentation on 20 August 2015) Biodiversity in Mandai*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary and secondary forests, usually along streams or in swampy areas	-	-	The global population size has not been quantified, but the species is described as scarce, although easily overlooked

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34	Columbidae	*Chalcophaps indica*	Emerald Dove	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Althought this species has adapted to feeding in parks and agricultural land, still require natural wooded areas to nest in.	Mandai East Camp, Mandai Firing Range Zones A, B, D, E, F	Common throughout the island and North and South offshore islands at wooded areas.	The global population size has not been quantified, but the species is described as usually common, although scarce on Java and Bali and uncommon on the Ryukyu islands
35	Chloropseidae	*Chloropsis cochinchinensis*	Blue-winged Leafbird	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary and secondary forests	Zones A, F and H	NE India, SE Bangladesh, SW China, SEA, TM, Greater Sundas Central Catchment and Bukit Timah Nature Reserve, Sentosa	The population size is unknown, but the species is described as relatively common throughout much of its range, although scarce in Singapore and rather rare in Java
36	Cuculidae	*Chrysococcyx minutillus*	Little Bronze Cuckoo	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	PH + SD + Thailand + Australia +Papua New Guinea + Timor-Leste	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Lowland forest and forest edge, monsoon forest and honeymyrtle (Melaleuca) swamp forest	Zones E, F	Bukit Batok Nature Park, Bedok, Choa Chu Kang, Changi, Fort Canning Park, Khatib Bongsu, Kranji, Kent Ridge Park, Lim Chu Kang, Lower Seletar Dam, Loyang, Punggol, Poyan, Pasir Ris Park, Pulau Sudong, Pulau Ubin, Sungei Buloh Wetland Reserve, Sentosa, Mangrove Mangroves, West Coast Park, and Yishun.	Asia Pacific and South East Asia
37	Cuculidae	*Chrysococcyx xanthorhynchus*	Violet Cuckoo	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	LC	Least Concern ver 3.1	EN	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	Lorong Asrama Zones A, D, E, F	-	The global population size has not been quantified but the species is reported to be uncommon in most of its range
38	Picidae	*Chrysophlegma miniaceum*	Banded Woodpecker	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	BO + TM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	North and South of Mandai Lake Road; Lorong Asrama Zones A, B, D, E, F	-	The global population size has not been quantified, but the species is reported to be uncommon to fairly common
39	Apodidae	*Collocalia fuciphagus* (Formerly *Aerodramus fuciphagus* then split into *C. fuciphaga* and *C. germani*)	Edible-nest Swiftlet	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *Mandai Conceptual Masterplan Study Appendix C (2014)* *WRS Data*	O	TM + SD + PH	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Covers a range of habitats from coastal areas to the montane forest, occurring up to 2,800 metres above sea-level	South of Mandai Lake Road Zone F	Throughout Thai-Malay peninsula, Sundaic region and the Philippines	The global population size has not been quantified, but the species is reported to be abundant in suitable habitat
40	Apodidae	*Collocalia germani* (Formerly *Aerodramus fuciphagus* then split into *C. fuciphaga* and *C. germani*) Now not recognised as a species by BirdLife International	Germain's Swiftlet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	-	Not yet assessed	Not yet assessed	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	Zones A, B, D, E, F	-	-
41	Muscicapidae	*Copsychus malabaricus*	White-rumped Shama	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	IM + China	LC	Least Concern ver 3.1	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	This species inhabits lowland tropical moist forest, swamp forest, overgrown tree plantations, secondary jungle, mangroves and forest clearings, from sea-level to 1500 m in Thailand, but more usually to 500-600 m. It tends to prefer undergrowth and shady ravines	North of Mandai Lake Road	Himalayan foothills, South and NE India, SEA, TM, Greater Sundas	The global population size has not been quantified, but it is believed to be large as the species is described as common in at least parts of its range
42	Muscicapidae	*Copsychus saularis*	Oriental Magpie-Robin	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + China	LC	Least Concern ver 3.1	EN	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary and secondary forests, mangroves, forest edge, scrub, parkland, urban areas	North and South of Mandai Lake Road Zones D, E, F	Indian sub-continent, South and East China, SEA, TM, Greater Sundas	The global population size has not been quantified, but the species is described as common to abundant, although generally uncommon in the Philippines
43	Corvidae	*Corvus macrorhynchos*	Large-billed Crow	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IC + TM + BO + IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary forests, mangroves, forest edge, scrub, old plantations, parkland, urban areas	North and South of Mandai Lake Road Zones D, E, F	Himalayan foothills, East India, much of China north to East Russia, Japan, SEA east to Lesser Sundas	The global population size has not been quantified, but the species is reported to be everywhere common if not abundant
44	Corvidae	*Corvus splendens*	House Crow	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Not Protected by the Wild Animals and Birds Act, 2000	-	Old plantations, scrub, mangroves, parkland and urban areas	Zones D, F	Coastal Iran, Indian sub-continent, SEA	The global population size has not been quantified, but the species is reported to be very abundant
45	Cuculidae	*Cuculus micropterus*	Indian Cuckoo	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Commonly found in forests and open woodland at up to 3,600 m	North of Mandai Lake Road Zone F	Throughout tropical Indomalaya westward along the Himalayan foothills westward into Nepal and eastward into southwest China, and on the islands of Sumatra and Borneo	The global population size has not been quantified, but the species is reported to be fairly common and widespread
46	Cuculidae	*Cuculus saturatus*	Himalayan Cuckoo	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	-	-	The global population size has not been quantified, though in Europe, the breeding population is estimated to number 250,000-500,000 breeding pairs, equating to 750,000-1,500,000 individuals, with Europe forming <5% of the global range.
47	Muscicapidae	*Cyanoptila cyanomelana*	Blue-and-White Flycatcher	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	North of Mandai Lake Road		The population size is unknown, but the species is described as an uncommon to rare non-breeding visitor to the Malay peninsular, Singapore and the Philippines and a rare non-breeding visitor to Sumatra

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48	Apodidae	*Cypsiurus balasiensis*	Asian palm swift	*WRS Data*	O	BO + TM + IM	Least Concern ver 3.1	LC	Not Listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007		Primary dependence on fan palms	Zone F	Bukit Timah, CCNR, Choa Chu Kang Cemetery, Lor Halus, Kent Ridge, Poyan, Pulau Ubin	Population expected to be stable
49	Picidae	*Dendrocopos moluccensis (also known as Picoides moluccensis)*	Sunda Pygmy Woodpecker	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	LC	Least Concern ver 3.2	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	-	Found in a range of habitats, e.g. Subtropical/Tropical Moist Lowland forests, Subtropical/Tropical Moist Montane forests, mangrove, dry shrublands, and artificial habitats including plantations, rural gardens and urban areas.	Zone D	This species has a very large range. Its native distribution includes Brunei Darussalam, Indonesia, Malaysia and Singapore.	The global population size has not been quantified, but the species is reported to be uncommon to locally common in most of its range.
50	Motacillidae	*Dendronanthus indicus*	Forest Wagtail	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary and secondary forests, old plantations, mangroves, scrub	North of Mandai Lake Road Zone D, F	East and NE China, Russian Far East, Koran, Japan, NE and SW India, Sri Lanka, South China, SEA, TM, Greater Sundas	The global population size has not been quantified, but the species is reported to be locally common
51	Dicaeidae	*Dicaeum cruentatum*	Scarlet-backed Flowerpecker	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + China	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary forests, old plantations, mangroves, parklands, urban green spaces	North and South of Mandai Lake Road; Lorong Asrama Zones D, E, F	Himalayn foothills, NE India, SE China, SEA, TM, Sumatra, Borneo	The global population size has not been quantified, but the species is described as generally common, although very common in Thailand and rare in Nepal and Bhutan, while the population in China has been estimated at c.100-10,000 breeding pairs
52	Dicaeidae	*Dicaeum triogonostigma*	Orange-bellied Flowerpecker	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Commonly found in subtropical or tropical lowland rainforests, subtropical or tropical mangrove forests, and subtropical or tropical montane rainforests; Forest dependent species (Subaraj, 2007)	North and South of Mandai Lake Road Zones A, B, D, E, F, H	Throughout tropical Indomalaya westward along the Himalayan foothills westward into Nepal and eastward into southwest China, and on the islands of Sumatra and Borneo	The global population size has not been quantified, but the species is described as common to locally common
53	Dicruridae	*Dicrurus paradiseus*	Greater Racket-tailed Drongo	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Commonly found in subtropical or tropical lowland rainforest	North and South of Mandai Lake Road Zones A, B, D, E, F, G, H	Throughout tropical Indomalaya westward along the Himalayan foothills westward into Nepal and eastward into southwest China, and on the islands of Sumatra and Borneo	The global population size has not been quantified, but the species is described as locally common to uncommon
54	Picidae	*Dinopium javanense*	Common Flameback	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not Listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary forests, scrub, old plantations, mangroves, urban parks near woodlands Has colonised secondary woodland and parklands Yong et al (2013) A Naturalist Guide to the Birds of Singapore	Zones A, B, D, E, F, H	Himalayan foothills, NE India, South China, mainland SEA through Greater Sundas and Palawan	The global population size has not been quantified, but the species is reported to be locally fairly common to uncommon
55	Columbidae	*Ducula bicolor*	Pied Imperial Pigeon	*WRS Data*	O	IM	LC	Least Concern ver 3.1	Not Listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forests, mangroves and coconut plantations	Zone F	Brunei Darussalam; Cambodia; India; Indonesia; Malaysia; Myanmar; Philippines; Singapore; Thailand; Viet Nam	The population is suspected to be in decline owing to ongoing habitat destruction and unsustainable levels of exploitation
56	Ardeidae	*Egretta garzetta*	Little Egret	*WRS Data*	O	Old World including Australia and New Zealand	Not yet assessed	-	Not Listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Estuaries, mudflats, ponds, mangroves and canals.	Zone F	Throughout the island, including North offshore islands.	-
57	Cuculidae	*Eudynamys scolopacea*	Asian Koel	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Not Listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	Zones A, B, D, E, F	-	The global population size has not been quantified, but the species is described as common throughout most of its range, although less common in the Greater Sundas, while national population sizes have been estimated at c.10,000-100,000 breeding pairs and c.1,000-10,000 individuals on migration in China and < c.50 individuals on migration and c.100-10,000 breeding pairs in Taiwan

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58	Coraciidae	*Eurystomus orientalis*	Dollarbird	*Mandai Conceptual Masterplan Study Appendix C (2014)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM + EA + AS	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary forests, forest edge, scrub,old plantations and parklands, mangroves	North and South of Mandai Lake Road; Mandai East Camp; Mandai Firing Range Zones A, B, D, E, F	-	The global population size has not been quantified, but the species is reported to be frequent to common throughout most of its range
59	Muscicapidae	*Ficedula zanthopygia*	Yellow-rumped flycatcher	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + EA	LC	Least Concern ver 3.2	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	-	Found in a range of habitats, e.g. Temperate forests, Subtropical/Tropical Moist Lowland forests, mangrove, moist shrublands, and artificial habitats including rural gardens and urban areas.	Zone F	This species has a very large range, which includes China, Hong Kong, Indonesia, Korea, Laos, Malaysia, Mongolia, Russia, Singapore, Taiwan, Thailand and Vietnam.	The population size is unknown, but national population estimates include: c.10,000-100,000 breeding pairs and c.1,000-10,000 individuals on migration in China; c.10,000-100,000 breeding pairs and c.1,000-10,000 individuals on migration in Korea and c.10,000-100,000 breeding pairs and c.1,000-10,000 individuals on migration in Russia.
60	Scolopacidae	*Gallinago gallinago*	Common Snipe	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	IM + EA + others	LC	Least Concern ver 3.1	Reduction in number of habitats *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Grassland dependent species	South of Mandai Lake Road	-	4,000,000 individuals
61	Scolopacidae	*Gallinago stenura*	Pin-tailed Snipe	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM + EA + PH + IC + TM + Middle East + Cocos (Keeling) Islands +	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Migratory and travels over land on a broad front between its breeding and wintering grounds (del Hoyo et al. 1996). It breeds in Arctic and boreal wetlands up to 2,300 m above sea-level on damp meadows along river valleys (Johnsgard 1981, del Hoyo et al. 1996), in grassy and mossy swamps (Flint et al. 1984), swampy taiga forest (Johnsgard 1981, Flint et al. 1984), sphagnum bogs (Johnsgard 1981) and shrub tundra with patches of dwarf birch Betula nana (del Hoyo et al. 1996). Non-breeding In its wintering range the species inhabits a wider variety of wetland habitats including flooded paddy-fields, wet grasslands, seepage swamps and marshland (del Hoyo et al. 1996), often foraging on the muddy shorelines of swamps and along streams (Johnsgard 1981, del Hoyo et al. 1996). The nest is a shallow depressionusually well-concealed in dense cover (del Hoyo et al. 1996).	Zone D	-	The global population is estimated to number c.50,000-2,000,000 individuals (Wetlands International 2006), while national population estimates include: c.1,000-10,000 individuals on migration and c.50-1,000 wintering individuals in China; c.50-1,000 individuals on migration and c.50-1,000 wintering individuals in Taiwan; < c.1,000 individuals on migration and < c.1,000 wintering individuals in Japan and c.10,000-100,000 breeding pairs and c.1,000-10,000 individuals on migration in Russia (Brazil 2009).
62	Rallidae	*Gallirallus striatus*	Slaty-breasted Rail	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	EA + IC + SD + Bangladesh + India	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Seasonally Flooded Agricultural Land, Arable Land, Rural Gardens, Subtropical/Tropical Mangrove Vegetation Above High Tide Level, Subtropical/Tropical Dry, Subtropical/Tropical Seasonally Wet/Flooded, Subtropical/Tropical Dry, Bogs, Marshes, Swamps, Fens, Peatlands.	Zones D, E	-	The global population size has not been quantified, though national population sizes have been estimated at c.100-100,000 breeding pairs in China and c.100-10,000 breeding pairs in Taiwan (Brazil 2009).
63	Phasianidae	*Gallus gallus*	Red Junglefowl	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM + TM + IC	LC	Least Concern ver 3.1	EN	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Pastureland, Subtropical/Tropical Mangrove Vegetation Above High Tide Level, Subtropical/Tropical Moist Lowland, Subtropical/Tropical Moist Montane	Zone A, B, D, F	Pulau Ubin	Tamil Nadu, South India, eastwards across southern China and into Malaysia, Singapore, Philippines and Indonesia. Junglefowl are established on several of the Hawaiian Islands, including Kauai
64	Timaliidae	*Garrulax leucolophus*	White-crested Laughingthrush	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary forests, forest edge, scrub, old plantations	Lorong Asrama Zones B, E, F	Himalayan foothills to NE India, South China, SEA	The global population size has not been quantified, but the species is described as generally common
65	Columbidae	*Geopelia striata*	Zebra Dove/ Peaceful dove	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment at Mandai Firing Range* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	South of Mandai Lake Road; Mandai Firing Range Zones D, E, F		The global population size has not been quantified, but the species is described as usually common over most of its range, although scarce in Bali and Java and uncommon in the Philippines and Borneo.

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66	Acanthizidae	*Gerygone sulphurea*	Golden-bellied Gerygone	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	BO + TM + PH	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006		Parks, gardens, tree-lined roadsides, coastal areas and mangrove forests.	Lorong Asrama Zone F	Found throughout Singapore and its offshore islands. Outside Singapore, South Thailand, south Vietnam, Peninsular Malaysia, Sumatra, Borneo, Java, Bali, Sulawesi and the Philippines.	Population size has not been quantified but species is described as widespread and often common. However, population suspected to be in decline owing to ongoing habitat loss and degradation.
67	Sturnidae	*Gracula religiosa*	Hill Myna	*NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Endangered Species (Import and Export) Act, 2008 Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CITES Appendix II	Commonly found in moist or semi-evergreen forest in lowlands, hills and mountains	North and South of Mandai Lake Road Zones A, B, D, E, F	Throughout tropical Indomalaya westward along the Himalayan foothills westward into Nepal and eastward into southwest China, and on the islands of Sumatra and Borneo	The global population size has not been quantified, but the species is described as common to abundant
68	Alcedinidae	*Halcyon coromanda*	Ruddy Kingfisher	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	IM + EA	LC	Least Concern ver 3.1	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary forests, scrub, old plantations, parklands	-	-	The global population size has not been quantified, but the species is reported to be widespread but generally rare and uncommon, while national population estimates include: c.100-10,000 breeding pairs and c.50-1,000 individuals on migration in China; < c.1,000 individuals on migration in Taiwan; c.100-10,000 breeding pairs and c.50-1,000 individuals on migration in Korea and c.100-10,000 breeding pairs, c.50-1,000 individuals on migration and c.10,000-100,000 breeding pairs in Japan.
69	Alcedinidae	*Halcyon smyrnensis*	White-throated Kingfisher	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary scrub, oldplantations, reedy fringes of reservoirs, open playing fields and parkland	North and South of Mandai Lake Road; Mandai East Camp; Mandai Firing Range Zones A, B, D, E, F	-	The global population size has not been quantified, though in Europe, the breeding population is estimated to number 90-170 breeding pairs, equating to 270-510 individuals), with Europe forming <5% of the global range.
70	Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA + Oceania	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	North and South of Mandai Lake Road Zones A, D, E, F, H	-	The global population is estimated to number c.1,000-10,000 individuals, equivalent to c.670-6,700 mature individuals. The population in China has been estimated at c.100-10,000 breeding pairs.
71	Accipitridae	*Haliastur indus*	Brahminy Kite	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Commonly found on the coast and in inland wetlands	North and South of Mandai Lake Road Zone D and F	Throughout tropical Indomalaya westward along the Himalayan foothills westward into Nepal and eastward into southwest China, and on the islands of Sumatra and Borneo	The global population is estimated to number > c.100,000 individuals
72	Heliornithidae	*Heliopais personata*	Masked Finfoot	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	IM	EN	Endangered A2cd+3cd+4cd; C2a(i) ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Mangroves and secluded well-forested inlets of reservoirs.	-	-	The species appears to have declined dramatically and is now known from comparatively few sites, occurring at low densities everywhere. The population may now number as low as 1,000 individuals, and so is placed in the band 1,000-2,499 individuals. This equates to 667-1,666 mature individuals, rounded here to 600-1,700 mature individuals.
73	Hemiprocnidae	*Hemiprocne longipennis*	Grey-rumped Treeswift	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	SD	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Population has declined in recent years. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	-	-	The global population size has not been quantified, but the species is reported to be common throughout most of its range
74	Pycnonotidae	*Hemixos flavala*	Ashy Bulbul	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IC	LC	Least Concern ver 3.2	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	-	Found in a range of habitats, e.g. Subtropical/Tropical Moist Lowland forests, Subtropical/Tropical Moist Montane forests, and artificial habitats including rural gardens and urban areas.	Zone F	This species has an extremelt large range, which includes Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Thailand and Vietnam.	The global population size has not been quantified, but the species is described as generally scarce and local, although locally common in northern Thailand, Laos and Vietnam.
75	Hirundinidae	*Hirundo daurica*	Red-rumped Swallow	*WRS Data*	O	Global	Not yet assessed	LC	Not Listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Open hilly country and mountains, river gorges, valleys, sea cliffs, cultivation	Zone F	-	-

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76	Hirundinidae	*Hirundo rustica*	Barn Swallow	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	Asia, Africa, Europe, Oceania, United States	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Occurs over all habitats	Zones D, F	Americas, Eurasia, Africa, Australia, Indian sub-continent, SEA, Australia, West Pacific *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	The global population is estimated to number > c.190,000,000 individuals
77	Hirundinidae	*Hirundo tahitica*	Pacific Swallow	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	BO + AS + IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Occurs over all hibtats	North and South of Mandai Lake Road; Mandai East Camp; Mandai Firing Range Zones A, B, D, E, F, H	SEA, TM, east to Maluku, New Guinea and West Pacific Islands, Ryukyus in South Japan *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	The global population size has not been quantified, but the species is described as generally common
78	Accipitridae	*Icthyophaga ichthyaetus*	Grey-headed Fish Eagle	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + BO + TM + PH	NT	Near Threatened ver 3.1	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forest dependent species. Found near slow moving rivers and streams, lakes, reservoirs and tidal lagoons in wooded country, usually in lowlands but ascending locally to 1,525 m.	North and South of Mandai Lake Road Zones A, D, E, F	Mainly recorded in the CCNR, BBNP, BTNR, Lentor Avenue, Poyan Reservoir, Rifle Range Road, Singapore Botanic Gardens, SBWR, Springleaf, Tanjong Murai and West Coast.	Global population is preliminarily estimated at 10,000-100,000 mature individuals. A moderately rapid and on-going population decline is suspected on the basis of rates of habitat degradation and levels of pollution and over fishing.
79	Irenidae	*Irena puella*	Asian Fairy-Bluebird	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary and secondary forests, adjacent scrub	Zones E and F	Southwest and East India, southernmost China, SEA, TM, Greater Sundas, Palawan	The global population size has not been quantified, as common throughout its range, although locally uncommon or rare
80	Ardeidae	*Ixobrychus flavicollis*	Black Bittern	*NParks (Presentation on 20 August 2015) Biodiversity in Mandai*	O	EA + IM + BO + TM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	Vicinity of waterbodies within Project Area	-	Global population is estimated to number c.63,000-320,000 individuals. Overall population is decreasing although some populations have unknown trends.
81	Ardeidae	*Ixobrychus sinensis*	Yellow Bittern	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	IM + EA + others	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Mangroves, freshwater marshes and wet grasslands	North of Mandai Lake Road	-	The global population is estimated to number c.100,000-1,000,000 individuals
82	Strigidae	*Ketupa ketupu*	Buffy Fish Owl	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IC + TM + Bangladesh	LC	Least Concern ver 3.1	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Aquaculture Ponds, Irrigated Land, Pastureland, Plantations, Rural Gardens, Urban Areas, Subtropical/Tropical Moist Lowland, Permanent Freshwater Marshes/Pools/Ponds, Permanent Rivers/Streams/Creeks, Seasonal/Intermittent Freshwater Lakes and Seasonal/Intermittent/Irregular Rivers/Streams/Creeks	Zone A	Lim Chu Kang, Pasir Ris, Pulau Ubin, Sungei Buloh Wetland Reserve and Tuas.	Ranges from South Assam, Vietnam, South Thailand, Peninsular Malaysia, Singapore to Sumatra, Borneo, Java, and Bali.
83	Campephagidae	*Lalage nigra*	Pied Triller	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Mangroves, parklands, urban areas, coastal scrub	Lorong Asrama Zones D, E, F	TM, Greater Sundas, Phillipines	The global population size has not been quantified, but the species is described as regular and common on the south and westernern coastal plains of Peninsular Malaysia, locally common to uncommon in southern Thailand, fairly common in the Greater Sundas, uncommon to rare in the nicobar islands and elsewhere local and uncommon to rare.
84	Laniidae	*Lanius cristatus*	Brown shrike	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Grassland dependent species	North and South of Mandai Lake Road Zones D, E	Central Siberia, east to NE China, Korea, Japan, Kamchatka, south to East Tibetan Plateau, Indian sub-continent, South China, SEA	The global population has not been quantified
85	Laniidae	*Lanius tigrinus*	Tiger shrike	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IC + SD + EA + Bangladesh	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Arable Land, Rural Gardens, Urban Areas, Subtropical/Tropical Mangrove Vegetation Above High Tide Level., Subtropical/Tropical Moist Lowland, temperate forest and shrublands.	Zones A, E, F	-	Rare in China and Russia, relatively common in Korea, uncommon in Japan and locally uncommon to common throughout its non-breeding range (Harris and Franklin 2,000). Brazil (2009) estimates that there are: c.100-10,000 breeding pairs and c.50-1,000 individuals on migration in China; c.100-10,000 breeding pairs and c.50-1,000 individuals on migration in Korea; < c.100 breeding pairs and < c.50 individuals on migration in Japan and c.100-10,000 breeding pairs and c.50-1,000 individuals on migration in Russia (Brazil 2009).
86	Nectariniidae	*Leptocoma calcostetha*	Copper-throated Sunbird	*WRS Data*	O	SD + IM	Not yet assessed	-	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	-	Mangroves, heath forest, -alluvial forest, secondary forest, coastal vegetation	Zone F	Myanmar, Thailand, Cambodia, Peninsular Malaysia, Philippines coasts of Borneo and Java	Not globally threatened

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87	Rallidae	*Lewinia striata* (Previously *Gallirallus striatus*)	Slaty-breasted Rail	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Grassland dependent species; Secondary scrub, marshes, wet grasslands, well wooded parkland	South of Mandai Lake Road	-	The global population size has not been quantified
88	Estrildidae	*Lonchura atricapilla*	Chestnut Munia	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Grassland, secondary scrub, parkland, gold courses	Zones D, E	East India, South China, SEA, TM, Sumatra, Borneo, Phillipines, Sulawesi, Maluku	The global population size has not been quantified, but the species is described as locally common
89	Estrilididae	*Lonchura maja*	White-headed Munia	*NParks (2008) A Rapid Biodiversity Assessment of Lorong Asrama*	O	TM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006		Open grassland, rice fields, marshes	Lorong Asrama	Suitable grassland in Singapore. Otherwise distributed in W Malaysia, Sumatra, Java and Bali.	The global population size has not been quantified, but the species is described as fairly common or locally common
90	Estrilididae	*Lonchura punctulata*	Scaly-breasted Munia	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM + China	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Grassland dependent species	South of Mandai Lake Road; Lorong Asrama Zone E	Himalyan foothills, Indian sub-continent, South China, SEA, TM, Greater and Lesser Sundas, Phillipines	The global population size has not been quantified, but the species is described as abundant, common or locally common
91	Psittacidae	*Loriculus galgulus*	Blue-crowned Hanging Parrot	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	EN	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary and primary forests, forest edges, old plantations, mangroves, parklands, orchards, coconut groves, urban areas.	Zones D, E, F	Widespread in Singapore	The global population size has not been quantified, but the species is reported to be common and widespread throughout most of its range
92	Muscicapidae	*Luscinia cyane*	Siberian Blue Robin	*Mandai Conceptual Masterplan Study Appendix C (2014)* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary and secondary forests, forest edge, old plantations, scrub	North of Mandai Lake Road Zone F	Central Siberia, Russian Far East, Kamchatka, south to NE China, Korea, NE India, SEA, TM, Greater Sundas	The global population size has not been quantified, but the species is described as common throughout its range, except for northern Vietnam, where it is rare
93	Timaliidae	*Macronous gularis*	Striped Tit Babbler	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary and secondary forests, forest edge, scrub, old plantations, wooded gardens , mangroves	North and South of Mandai Lake Road; Mandai Firing Range, Lorong Asrama Zones A, B, D, E, F, H	Himalayan foothills, NE India, South China, SEA, TM, Sumatra	The global population size has not been quantified, but the species is described as generally common
94	Timaliidae	*Malacocincla abbotti*	Abbott's Babbler	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary forests, forest edge, old plantations, scrub, mangroves	Central Catchment Nature Area Zones A, B, D, E, F, H	Himalayan foothills, NE India, SEA, TM, Sumatra, Borneo	The global population size has not been quantified, but the species is described as fairly common in much of its range, although very rare and local in most of Nepal and rare in Bhutan
95	Timaliidae	*Malacocincla malaccensis*	Short-tailed Babbler	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	TM + SD	NT	Near Threatened ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	This species occurs in lowland evergreen forest, including swamp forest, up to 1,000 m. Although it is most frequent in primary forest, it is also recorded from secondary growth, overgrown plantations, scrub and streamside thickets.	Bukit Timah and Central Catchment Nature Area Zones A, E, H	TM, Sumatra, Borneo	The global population size has not been quantified, but the species is described as fairly common to common
96	Meropidae	*Merops philippinus*	Blue-tailed Bee-eater	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary forest, forest edge, scrub, old plantations, parkland, urban gardens	North and South of Mandai Lake Road Zone E, F	-	The global population size has not been quantified, but the species is reported to be uncommon to locally common, while national population sizes have been estimated at c.100-10,000 breeding pairs and c.50-1,000 individuals on migration in China and c.100-10,000 breeding pairs and c.50-1,000 individuals on migration in Taiwan.
97	Meropidae	*Merops viridis*	Blue-throated Bee-eater	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + SD + PH	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Commonly found in subtropical or tropical mangrove forest	North and South of Mandai Lake Road Zones A, D, E, F, H	Throughout Thai-Malay peninsula, Sundaic region and the Philippines	The global population size has not been quantified, but the species is reported to be widespread and regarded as common
98	Ardeidae	*Mesophoyx intermedia*	Intermediate Egret	*WRS Data*	O	African through Asia to Japan and Australia	Not yet assessed	Not yet assessed	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007		Hunt in freshwater (marshes, cultivated fields), can also be found in mangroves, mudflats and estuaries. Prefer to roost in reedbeds but will do so in mangroves too.	Zone F	Throughout Singapore, including North offshore islands	-
99	Picidae	*Micropternus brachyurus*	Rufous Woodpecker	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + China	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Old growth and secondary forests, scrub and old plantations Has colonised secondary scrub Yong et al (2013) A Naturalist Guide to the Birds of Singapore	South of Mandai Lake Road Zones A, F	South China, Himalayan foothills to East India, mainland SEA, TM, Greater Sundas	The global population size has not been quantified, but the species is reported to be locally common to uncommon, while the population in China has been estimated at c. 100-10,000 breeding pairs.

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100	Motacillidae	*Motacilla cinerea*	Grey wagtail	*WRS Data*	O	Global	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007		-	Zone F	Pulau Ubin	-
101	Muscicapidae	*Muscicapa dauurica*	Asian Brown Flycatcher	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA + USA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary and secondary forests, mangroves, forest edge, scrub, old plantations, parkland, urban green spaces	South of Mandai Lake Road Zones D, E, F	Central Siberia, Russian Far East, south to NE China, Korea, Japan, South India, South China, SEA, TM, Greater Sundas, Phillipines	The population size is unknown, but the species is described as common to locally common in much of its range
102	Ciconiidae	*Mycteria cinerea*	Milky Stork	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	Native in Cambodia, Indonesia and Malaysia Introduced in Singapore	EN	Endangered A2cd+3cd+4cd ver 3.1	Not listed	Endangered Species (Import and Export) Act, 2008 Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CITES Appendix I	It is a predominantly coastal resident in Indonesia and Malaysia, inhabiting mangroves and adjacent, less saline, swamps. It forages on tidal mudflats, in saline pools, freshwater marshes, fishponds and rice-fields. Birds only occur inland in flooded forest around Tonle Sap lake in Cambodia, from where they disperse in the wet season, possibly to the coast (van Zalinge et al. 2011).	Zones A, D, E, F	-	The global population was previously thought likely to total fewer than 5,000 individuals, roughly equating to 3,300 mature individuals, based on estimates of c.5,000 individuals in Sumatra in the late 1980s (Silvius and Verheugt 1989) and 100-150 individuals in Java (M. Silvius in litt. 2002), plus 10 birds in Malaysia and 20-40 in Cambodia. Recent estimates put the global population far lower, at around 2,200 birds, based on totals of c.1,600 in Sumatra (c.75 individuals in Aceh province, c.500 North Sumatra province, c.350 Riau province, c.100 Jambi province, c.500 South Sumatra province and c.75 Lampung province), c.500 individuals, but possibly fewer, on Java, and <100 birds on the mainland of South-East Asia (Iqbal et al. in prep). This roughly equates to 1,500 mature individuals.
103	Ciconiidae	*Mycteria leucocephala*	Painted Stork	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + IC	NT	Near Threatened ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006		Freshwater marshes, lakes and reservoirs, flooded fields, rice paddies, freshwater swamp forest, river banks, intertidal mudflats and saltpans.	Zone E	-	Perennou et al. (1994) estimated populations of 15,000 individuals in south Asia, and fewer than 10,000 individuals in South-East Asia, thus there are estimated to be a total of 15,000-25,000 individuals in total, roughly equivalent to 10,000-17,000 mature individuals.
104	Nectariniidae	*Nectarinia jugularis*	Olive-backed Sunbird	*Subaraj, R (2014) Vertebrate & Odonate Report* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	-	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Found in diverse habitats	Zones D, E, F	SEA, Australasia	The global population size has not been quantified, but the species is described as common.
105	Nectariniidae	*Nectarinia sperata* (also known as *Leptocoma brasiliana*)	Van Hasselt's Sunbird; Purple-throated Sunbird	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *Mandai Conceptual Masterplan Study Appendix C (2014)* *WRS Data*	O	BO + TM + PH	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forest dependent species (Subaraj, 2007). Primary and secondary forests, old plantations, scrub, mangroves, parkland. Takes nectar from flowers of Morinda elliptica.	North and South of Mandai Lake Road Zones A, D, F, H	Found throughout Singapore and its offshore islands.	The global population size has not been quantified, but the species is reported to be locally common to uncommon
106	Strigidae	*Ninox scutulata*	Brown Hawk Owl	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-			The global population size has not been quantified, but the species is reported to be common to uncommon
107	Accipitridae	*Nisaetus cirrhatus*	Changeable Hawk-Eagle	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	BO + SD + IM	LC	Least Concern ver 3.1	EN	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary forest and cultivated areas.	North and South of Mandai Lake Road Zones A, B, D, E, F, H		The population is suspected to be declining locally owing to ongoing habitat destruction and increased human disturbance (Ferguson-Lees and Christie 2001
108	Ardeidae	*Nycticorax nycticorax*	Black-crowned Night Heron	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA + others	LC	Least Concern ver 3.1	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	An uncommon resident of mangroves, ponds, mudflats, canals and well-vegetated reservoir fringes	Zones A, D, E, F, H	-	-

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109	Oriolidae	*Oriolus chinensis*	Black-naped Oriole	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary forests, mangroves, old plantations, scrub, parkland, urban areas	North and South of Mandai Lake Road; Mandai East Camp; Mandai Firing Range, Lorong Asrama Zones A, B, D, E, F, H	Indian sub-continent, ,much of China north to East Russia and Japan, SEA, Greater and Lesser Sundas, Phillipines and Sulawesi	The global population size has not been quantified, but the species is described as common
110	Sylviidae	*Orthotomus atrogularis*	Dark-necked Tailorbird	*Mandai Conceptual Masterplan Study Appendix C (2014)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + China	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary and secondary forests, forest edge, old plantations, scrub, well-wooded areas.	North and South of Mandai Lake Road; Mandai East Camp; Mandai Firing Range Zones A, B, D, E, F, H	NE India, SEA, TM, Sumatra, Borneo	The global population size has not been quantified, but the species is reported to be locally common
111	Sylviidae	*Orthotomus sericeus*	Rufous-tailed Tailorbird	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + PH + BO	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary and secondary forests, forest edge, scrub and old plantations, swampy forests	Central Catchment Nature Area Zones A, B, D, E, F, H	TM, Sumatra, Borneo, Palawan	The global population size has not been quantified, but the species is reported to be rather scarce and local
112	Sylviidae	*Orthotomus ruficeps*	Ashy Tailorbird	*WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	-	Ashy Tailorbirds eat insects. They are very common in mangroves, energetically foraging in the lower understorey. Although Ashy Tailorbirds are mostly found in mangroves, they also live in adjacent growths such as swampy forest and coastal scrub.	Zone F	Brunei Darussalam; Indonesia; Malaysia; Myanmar; Philippines; Singapore; Thailand	The global population size has not been quantified, but the species is reported to be common
113	Sylviidae	*Orthotomus sutorius*	Common Tailorbird	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + China	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forest edge, old plantations, scrub, parkland, urban areas	North and South of Mandai Lake Road Zones D, E, F	Indian sub-continent, South China, SEA, TM, Java	The global population size has not been quantified, but the species is reported to be common
114	Strigidae	*Otus bakkamoena*	Collared Scops Owl	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forest, orchards, forests near cultivated areas	Zones A, D, F		The global population size has not been quantified, but the species is reported to be widespread and locally common
115	Pandionidae	*Pandion haliaetus*	Osprey	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *WRS Data*	O	IM + EA + others	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Mangroves, coastal mudflats, reservoirswith well-vegetated fringes	Zone F	Kranji Marshes, Seletar Wetlands, Sungei Buloh Wetland Reserves	-
116	Phasianidae	*Pavo cristatus*	Indian peafowl	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Arable Land, Plantations, Subtropical/Tropical Moist Lowland, Subtropical/Tropical Moist Montane, Subtropical/Tropical Dry	Zone F		-

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117	Alcedinidae	*Pelargopsis capensis* (Formally *Halcyon capensis*)	Stork-billed Kingfisher	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	EA + IM + BO + TM + PH	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	In Singapore, mangroves, coastal areas, reservoir edges, ponds, gardens and other inland habitats.	North and South of Mandai Lake Road Zones A, D, E, F	CCNR forest, Changi, Japanese Garden, Kranji, Punggol, Pasir Ris, SBG, SBWR, Serangoon, Sungei Seletar, Sungei Tampines and offshore islands.	Species is reported to be widespread and generally sparse but locally common. Suspected to be in decline owing to ongoing habitat destruction.
118	Campephagidae	*Pericrocotus divaricatus*	Ashy Minivet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	North of Mandai Lake Road Zone D	Russian Far East, East China, Korea, Japan	The global population size has not been quantified
119	Accipitridae	*Pernis ptilorhyncus*	Oriental Honey-Buzzard	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary and secondary forest, forest edge, mangroves, oldplantations, scrub and parkland.	North and South of Mandai Lake Road	-	The global population is estimated to number c.100,000-1,000,000 individuals, while national population estimates include: c.10,000-100,000 breeding pairs and c.1,000-10,000 individuals on migration in China; < c.100 breeding pairs, c.1,000-10,000 individuals on migration and c.50-1,000 wintering individuals in Taiwan; c.10,000-100,000 breeding pairs and c.1,000-10,000 individuals on migration in Korea; c.10,000-100,000 breeding pairs and c.1,000-10,000 individuals on migration in Japan and c.10,000-100,000 breeding pairs and c.1,000-10,000 individuals on migration in Russia.
120	Cuculidae	*Phaenicophaeus sumatranus*	Chestnut-bellied Malkoha	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	SD + TM	NT	Near Threatened ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forest dependent species	Zones B, D, E, F, H	-	The global population size has not been quantified, but the species is described as generrally fairly common, although localy very common to uncomon in Thailand
121	Sylviidae	*Phylloscopus borealis*	Arctic Warbler	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA + Europe (Sweden, Finland) + USA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary and secondary forests, forest edge, mangroves, old plantations, scrub, parkland and urban areas, small islands	Zones D, F	Widespread across Eurasia and Alaska	Estimated global population to number 30,000,000 individuals
122	Phylloscopidae	*Phylloscopus coronatus*	Eastern crowned warbler	*WRS Data*	O	TM + IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007		Wooded areas, mangroves	Zone F	Bidadari, Bukit Timah, CCNR, Changi, Pasir Ris, Sungei Buloh Summar distribution in Russia, China, Korea and Japan; Winter distribution in SEA	Population expected to be stable
123	Picidae	*Picus vittatus*	Laced Woodpecker	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + China	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary forests, scrub, old plantations,mangroves and urban forests Has colonised secondary woodland. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	North and South of Mandai Lake Road Zones B, D, E, F	East India, mainland SEA, TM, Sumatra, Java	The global population size has not been quantified
124	Pittidae	*Pitta megarhyncha*	Mangrove Pitta	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	Bangladesh + TM + Indonesia + India (West Bengal)	NT	Near Threatened ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Coastal mangroves, as well as in mangrove and Nipa palm stands along tidal rivers, and freshwater swamp forest.	Zone A, D, E	Pasir Ris Park, Pulau Ubin, Pulau Tekong, and Sungei Buloh Wetland Reserve.	The population size of this species has not been quantified
125	Pittidae	*Pitta moluccensis*	Blue-winged pitta	*WRS Data*	O	AS + PH + SD + TM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007		Fairly tolerant of habitat alteration and not reliant on primary forest. Survives well in secondary habitats; wooded areas and parks	Zone F	Singapore Botanic Gardens, Bidadari, Bukit Batok, Bukit Timah, CCNR, Jurong Island, Jurong Lake, Poyan, Sembawang, West Coast, Kranji Nature Trail	Decreasing
126	Ploceidae	*Ploceus philippinus*	Baya Weaver	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM + China	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Grassland dependent species	South of Mandai Lake Road; Lorong Asrama Zone D, E	Indian sub-continent, SW China, SEA, Sumatra, Java, Bali	The global population size has not been quantified, but the species is described as locally common to common, although rare in Bhutan
127	Cisticolidae	*Prinia flaviventris*	Yellow-bellied Prinia	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Grassland dependent species	South of Mandai Lake Road Zone D	Himalayan foothills, much of North and East India, South China, SEA, TM, Greater Sundas Lorong Halus Wetlands, Sungei Buloh Wetland Reserves	The global population size has not been quantified, but the species is reported to be locally common
128	Megalaimidae	*Psilopogon haemacephalus* (Previously *Megalaima haemacephala*)	Coppersmith Barbet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *WRS Data*	O	IM + TM + IC	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary scrub, parkland, mangroves , in Singapore has benefited from increase in number of habitat	Lorong Asrama Zone F	Indian sub-continent, South China, mainland SEA, Sumatra, Java, Phillipines	The global population size has not been quantified, but the species is reported to be widespread and common throughout its range

Item	Family	Genus Species	Common Name	Source	Presence#	Current endemicity listing*	IUCN Category	IUCN Status	Local Status (SRDB)	Protected by Local Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
129	Megalaimidae	*Psilopogon lineatus* (Previously *Megalaima lineata*)	Lineated Barbet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM + TM + IC	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary forest, scrub, old plantations, parkland; shows preference for man made and altered habitats; common throughout its range and found in heavily urbanized areas. Has adapted well to scrub. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	Zones D	-	Population trend appears to be increasing.
130	Megalaimidae	*Psilopogon rafflesii* (Previously *Megalaima rafflesii*)	Red-Crowned Barbet	*Subaraj, R (2007) Wildlife and Vegetation Report (Mandai)* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	SD + TM	NT	Near Threatened ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary lowland evergreen forest. Also found in tall secondary forest, poor quality Dipterocarp slope forest and occasionally in rubber plantations.	Zones A, D, E, F		The population size of this species has not been quantified; it is considered scarce to common throughout its range. A moderately rapid population decline is suspected to be on-going as a result of continuing forest loss and degradation across the species's range.
120	Psittaculidae	*Psittacula alexandri*	Red-breasted parakeet	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IC + India + Bangladesh	NT	Near Threatened ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	-	This species uses a variety of forest and wooded habitats, including human-altered areas, usually below 2,000 m. Habitats utilised by the species include dry forest, moist deciduous secondary forest, mangroves, cultivated areas with trees and human settlements. It nests in tree cavities.	Zones D and F	Introduced to Hong Kong and Singapore. Native to Bangladesh; Bhutan; Cambodia; China; India; Indonesia; Lao People's Democratic Republic; Myanmar; Nepal; Thailand; Vietnam	The global population size has not been quantified, but the species is reported to be generally common
132	Psittacidae	*Psittacula krameri*	Rose-ringed Parakeet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	IM + EA + others	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Rural gardens, mangrove, forest, grassland, shrubland, inland wetlands	-	-	The global population size has not been quantified, but the species is reported to be common to abundant throughout its natural range
133	Psittacidae	*Psittacula longicauda*	Long-tailed Parakeet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	NT	Near Threatened ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Coastal and lowland areas, lowland evergreen forest including mangroves, oil-palm plantations and coconut groves. Prefers forest edges including near cultivated areas and will visit parks and gardens. Gregarious.	North and South of Mandai Lake Road Zones A, B, D, E, F, H	-	The global population size has not been quantified, but the species is described as very common and widespread in southern Borneo, locally common in Sumatra and Peninsular Malaysia and common in Brunei, the Andaman islands and the Nicobar islands. Forest destruction in the Sundaic lowlands of Indonesia, and in Thailand and Malaysia has been extensive (Kalimantan lost nearly 25% of its evergreen forest during 1985-1997, and Sumatra lost almost 30% of its 1985 cover), but the species remains numerous in a number of areas due to its capacity to forage away from forested areas and nest communally.
134	Psittacidae	*Psittinus cyanurus*	Blue-rumped Parrot	*NParks (Presentation on 20 August 2015) Biodiversity in Mandai* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	SD + TM	NT	Near Threatened ver 3.1	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary, dry-land evergreen and semi-evergreen lowland forest, both mature and selectively logged, and also visits edge vegetation, cultivated areas and gap-phase growth of forest clearings and occasionally mangroves, up to 1,300 m, although generally below 700 m. Noted to be more readily observed in areas with some logging activity, and to feed on fruits of ornamental plants.	Forested areas within Project Area Zone F	.	The global population size has not been formally quantified, but it is thought to number more than 100,000 individuals. It is suspected to be undergoing a moderately rapid population decline due to forest destruction.
135	Pycnonotidae	*Pycnonotus atriceps*	Black-headed Bulbul	*WRS Data*	O	IM + TM	LC	Least Concern ver 3.1	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forest	Zone F	Bukit Brown, Bukit Timah, Central Catchment, Pasir Ris, Pulau Ubin.	-
136	Pycnonotidae	*Pycnonotus brunneus*	Red-eyed Bulbul	*NParks (2015), Rapid Biodiversity Assessment of Mandai Firing Range* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	SD + TM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forests, shrubland, wetlands, plantations, heavily degraded former forest.	Mandai Firing Range vicinity Zone D, F	-	The global population size has not been quantified, but the species is described as generally fairly common throughout its range. However, the population is suspected to be in decline owing to ongoing and rapid deforestation.
137	Pycnonotidae	*Pycnonotus goiavier*	Yellow-vented Bulbul	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + SD + PH	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Commonly found in a wide variety of open habitats, but not deep forest	North and South of Mandai Lake Road Zones A, B, D, E, F, H	Throughout Thai-Malay peninsula, Sundaic region and the Philippines	The global population size has not been quantified, but the species is described as common throughout its range
138	Pycnonotidae	*Pycnonotus jocosus*	Red-whiskered Bulbul	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	AS + USA + Asia (Singapore, Saudi Arabia)	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Scrub, parklands, secondary forests Introduced, Naturalised Species in Singapore	South of Mandai Lake Road Zones D, E and F	-	The global population size has not been quantified, but the species is described as common in many areas

Item	Family	Genus Species	Common Name	Source	Presence#	Current endemicity listing*	IUCN Category	IUCN Status	Local Status (SRDB)	Protected by Local Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
139	Pycnonotidae	*Pycnonotus plumosus*	Olive-winged Bulbul	*NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + SD	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Commonly found in subtropical or tropical lowland rainforest	North and South of Mandai Lake Road; Mandai Firing Range, Lorong Asrama Zones A, B, D, E, F, H	Throughout Thai-Malay peninsula and Sundaic region	The global population size has not been quantified, but the species is described as generally abundant throughout its range
140	Pycnonotidae	*Pycnonotus simplex*	Cream-vented Bulbul	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + SD	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary and secondary forests, forest edge	Bukit Timah, Central Catchment Nature Reserves Zones A, E, F, H	TM, Sumatra, Borneo, Java	The global population size has not been quantified, but the species is described as fairly common to very common
141	Pycnonotidae	*Pycnonotus zeylanicus*	Straw-headed Bulbul	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	SD + Myanmar	VU	Vulnerable A2cd+3cd+4cd ver 3.1	EN	Endangered Species (Import and Export) Act, 2008 Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CITES Appendix II	It occupies successional habitats bordering rivers, streams, marshes and other wet areas, where seasonal flooding prevents the establishment of climax communities	North and South of Mandai Lake Road Zones A, B, D, E, F, H	-	The population size is preliminarily estimated to fall into the band 10,000-19,999 mature individuals. This equates to 15,000-29,999 individuals in total, rounded here to 15,000-30,000 individuals.
142	Rallidae	*Rallina fasciata*	Red-legged Crake	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + AS	LC	Least Concern ver 3.1	VU	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Seasonally flooded agricultural land, grassland, inland wetlands (rivers, streams, creeks)	Zones D, F	-	The population trend is difficult to determine because of uncertainty over the extent of threats to the species. However, population is not believed to be decreasing rapidly.
143	Rhipidurudae	*Rhipidura javanica*	Pied Fantail	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IC + SD	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Mangroves, old plantations, forest edge, secondary scrub, parklands near waters	Zones E, F	Mainland SEA, TM, Sumatra, Borneo, Java	The global population size has not been quantified, but the species is described as common to very common
144	Muscicapidae	*Rhinomyias brunneata*	Brown-chested Jungle Flycatcher	*WRS Data*	O	IM	VU	Vulnerable C2a (ii) ver 3.1	Not Listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006		Breeds in dense bamboo undergrowth or low bushes in subtropical broadleaved evergreen forsets. Does not utilise logged forest or artificial plantations.	Zone F	Rare passage migrant and winter visitor in Singapore Bidadari, Bukit Batok, Bukit Timah, CCNR, Sungei Buloh, Tuas	2,500-9,999 mature individuals, decreasing
145	Accipitridae	*Spilornis cheela*	Crested Serpent Eagle	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IC + SD + IM + EA + PH + Pakistan	LC	Least Concern ver 3.1	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Arable Land, Plantations, Subtropical/Tropical Heavily Degraded Former Forest, Subtropical/Tropical Mangrove Vegetation Above High Tide Level, Subtropical/Tropical Moist Lowland, Subtropical/Tropical Moist Montane, Estuaries and Dry Grassland	Zone E	Bukit Batok Nature Park, Bukit Timah Nature Reserve, Kent Ridge Park, Pulau Ubin, Pulau Tekong, Sungei Buloh Wetland Reserve	The global population size has not been quantified,
146	Timaliidae	*Stachyris erythroptera*	Chestnut-winged Babbler	*NSS Report on STB Project*	O	TM + IC	LC	Least Concern ver 3.1	EN	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Plantations, mangroves, swamps, lowland forests	-	-	The global population size has not been quantified, but the species is described as generally common. The population is suspected to be in decline owing to ongoing habitat destruction and fragmentation.
147	Columbidae	*Streptopelia chinensis* (Not recognised as a species by BirdLife International)	Spotted Dove	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + AS + IC	Not yet assessed	Not yet assessed	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Grassland and cultivated land; readily colonise newly cleared and agricultural land.	Mandai Firing Range; Lorong Asrama Zones A, B, D, E, F, H	Widespread around Singapore in gardens, parks, cultivated areas, mangroves and urban environments.	-

Item	Family	Genus Species	Common Name	Source	Presence#	Current endemicity listing*	IUCN Category	IUCN Status	Local Status (SRDB)	Protected by Local Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
148	Strigidae	*Strix seloputo*	Spotted Wood Owl	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IC + SD	LC	Least Concern ver 3.1	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Irrigated Land , Plantations, Rural Gardens, Subtropical/Tropical Heavily Degraded Former Forest, Urban Areas, Subtropical/Tropical Mangrove Vegetation Above High Tide Level, Subtropical/Tropical Moist Lowland	Zone F	Bidadari Cemetery, Chinese Garden, Dempsey Road, Khatib Bongsu, Labrador Nature Reserve, Malcolm Park, Pasir Ris Park, Pulau Tekong, Pulau Ubin, Singapore Botanic Gardens, Sentosa, St John's Island, Tyersall Ave.	The global population size has not been quantified,
149	Sturnidae	*Sturnus sturninus*	Purple-backed Starling	*Mandai Conceptual Masterplan Study Appendix C (2014)* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Not protected under the Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	South of Mandai Lake Road Zone F	-	The global population size has not been quantified
150	Sturnidae	*Sturnus sturninus*	Daurian Starling	*NParks (August, 2015), Rapid Biodiversity Assessment of Mandai Firing Range*	O	TM + IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Rural gardens, urban areas	Mandai Firing Range vicinity	-	The global population size has not been quantified, but the species is reported to be reasonably common. The population trend is difficult to determine because of uncertainty over the impacts of habitat modification on population sizes.
151	Cuculidae	*Surniculus lugubris*	Drongo Cuckoo	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	LC	Least Concern ver 3.1	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forests, secondary woodland and forest edges.	Zones A, D, E, F	In Singapore, the species has been recorded at Bidadari, BBNP, BTNR, CCNR, changi, Mount Faber, Poyan, P. Ubin, offshore islands and SBWR.	The population size has not been quantified owing to recent taxonomic splits but is suspected to be in decline owing to ongoing habitat destruction.
152	Alcedinidae	*Todiramphus chloris*	Collared Kingfisher	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Formerly mostly found along coasts and mangroves in Singapore but have now moved inland to hunt along freshwater wetlands, cultivated lands, gardens and parks. Usually avoid forests. Benefited from increase in number of habitat. *Yong et al (2013) A Naturalist Guide to the Birds of Singapore*	Mandai East camp, Mandai Firing Range, Lorong Asrama Zones D, E, F	Resident throughout singapore mainland, and N and S offshore islands.	The global population size has not been quantified, but the species is reported to be very widespread and common to abundant
153	Columbidae	*Treron curvirostra*	Thick-billed Green Pigeon	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	LC	Least Concern ver 3.1	EN	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forest dependent species	North and South of Mandai Lake Road Zones A, D, E, F	-	The global population size has not been quantified, but the species is described as generally common to abundant.
154	Columbidae	*Treron vernans*	Pink-necked Green Pigeon	*NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *NParks (2015) Rapid Biodiversity Assessment of Mandai Firing Range* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Commonly found outside primary forest, preferring habitats with trees that provide fruits and a safe perch including mangroves, scrub, secondary forest, forest edge.	North and South of Mandai Lake Road, Mandai East Camp, Mandai Firing Range, Lorong Asrama Zones A, B, D, E, F	Common resident thoughout Singapore at suitable habitats and offshore islands.	The global population size has not been quantified, but the species is described as generally common to abundant
155	Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	Indonesia + Oceania	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	-	-	The global population size has not been quantified, but the species is described as common to abundant on New Guinea and surrounding islands
156	Zosteropidae	*Zosterops japonicus*	Japanese White-eye	*WRS Data*	O	IC + Japan	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	-	Zosterops japonicus are arboreal and are found in the foliage of trees and shrubs searching for food. They can be found from sea level to the tree lines of areas with less than 25cm of annual rainfall and in rainforests with more than 760cm of annual rainfall. They will inhabit open forest, forest edge, mangrove thickets, plantations, gardens and parks in urban areas	Zone F	This species has an extremely large range across Asia, and the Australasia-Pacific Region	The global population size has not been quantified, but the species is described as common.
157	Zosteropidae	*Zosterops palpebrosus*	Oriental White-eye	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Secondary forests, forest edge, old plantations, scrub, mangroves , parklands	Zones E, F, H	Indian sub-continent, SEA, TM, Greater Sundas	The global population size has not been quantified, but the species is described as common

* Endemicity definitions:
PH = Philippines only
BO = Borneo Island, which includes only Brunei, Sabah, Sarawak and Kalimantan

# Presence definitions:
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O/A = Observed always

Item	Family	Genus Species	Common Name	Source	Presence#	Current endemicity listing*	IUCN Category	IUCN Status	Local Status (SRDB)	Protected by Local Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status

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AS = Australasia region, which includes Australia, New Zealand, New Guinea Island and neighbouring islands in Pacific Ocean

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Item	Family	Genus species	Common Name	Source	Presence#	Current endemicity listing*	Native to Singapore (Yes, No)	IUCN Category	IUCN Status	Local Status (SRDB)	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
1	Channidae	*Channa striata*	Common Snakehead	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai* *Tan HH, Lim LKP (2015) Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area* *WRS Data*	O	IM + EA	Yes	LC	Least Concern ver 3.1	Not listed; understood to be widespread and common	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Inhabits swamps, freshwater ponds, streams and tanks in the plains; prefers stagnant muddy waters and grassy tanks. In Singapore, can also be found in reservoirs and concretised waterways.	Upper Seletar Reservoir inlet stream (shallow creek, surrounded by mature secondary forest); Zones A, F, H	In Singapore, widespread and common.	-
5	Cyprinidae	*Rasbora einthovenii*	Einthoven's Rasbora	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai* *Tan HH, Lim LKP (2015) Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area* *WRS Data*	O	SD	Yes	Not yet assessed	Not yet assessed	Not listed; understood to be restricted but common	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Gregarious, omnivorous species which inhabits the upper and middle water levels in shallow, slow-flowing and shaded streams.	Upper Seletar Reservoir inlet stream (shallow creek, surrounded by mature secondary forest); Zone A, Zone F, Zone H	In Singapore, occurs in the CCNR, Western Catchment Area and Pulau Tekong.	-
8	Eleotridae	*Oxyeleotris marmorata*	Marbled Gudgeon	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai* *NParks (2015) Rapid Biodiversity Assessment of Mandai East Camp* *Tan HH, Lim LKP (2015) Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area*	O	IM + EA	Yes	LC	Least Concern ver 3.1	Not listed; understood to be widespread and common	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Occurs in various wetlands, including rivers, ponds, reservoirs, canals, swamps and flooded forests. It generally prefers areas of little or no water movement. Mainly found in freshwater but is also found in brackish environments.	Upper Seletar Reservoir inlet stream (shallow creek, surrounded by mature secondary forest); Zone A	In Singapore, the CCNR, Lower Seletar Reservoir, and reservoirs in the Western catchment area.	Little information is available.
10	Gobionellidae	*Eugnathogobius siamensis*	Siam Stream Goby	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai*	O	TM + BO + EA	Yes	LC	Least Concern ver 3.1	None; understood to be restricted and rare	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Inhabits streams and lower reach rivers and estuaries.	Upper Seletar Reservoir inlet stream (shallow creek, surrounded by mature secondary forest); Zone A	-	Common to locally uncommon in its range. Was common around Bangkok in Thailand but disappeared recently, but common elsewhere.
13	Osphronemidae	*Trichopsis vittata*	Croaking Gouramy	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Tan HH, Lim LKP (2015) Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area* *WRS Data*	O	SD + IC	Yes	LC	Least Concern ver 3.1	Not listed, understood to be widespread but uncommon	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	In Singapore, occurs in streams and ponds with dense vegetation in scrub and rural areas.	Upper Seletar Reservoir inlet stream (shallow creek, surrounded by mature secondary forest); Unnamed Stream Parallel to the Project Western Boundary (artificial bank waterway flowing through secondary forest); Zones A, D, F and Lorong Asrama	Indochina, Malay Peninsula, Sumatra, Borneo and Java	Inhabits marshlands, floodplain and swamps, occurs in shallow sluggish or standing water habitats with a lot of vegetation. Feeds on zooplankton, crustaceans and insect larvae. Often found in disturbed habitats such as paddy fields and ditches.
16	Zenarchopteridae	*Dermogenys collettei*	Sunda Pygmy Halfbeak/ Malayan Pygmy Halfbeak	*Tan Heok Hui, Kelvin Lim Kok Peng (2014). Survey of freshwater fishes at Mandai* *Tan HH, Lim LKP (2015) Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area*	O	Asia	Yes	Not yet assessed	Not yet assessed	Not listed, understood to be widespread and common	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Ponds, small streams in both forest and exposed areas. In freshwater and brackish water.	Upper Seletar Reservoir inlet stream (shallow creek, surrounded by mature secondary forest); Zones A, F	In Singapore, land-locked populations found in the CCNR and western catchment area.	-

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Item	Family	Genus species	Common Name	Source	O	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
Amphibian Species															
1	Bufonidae	*Bufo melanostictus (Duttaphrynus melanostictus)*	Asian Toad	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	It is mainly a species of disturbed lowland habitats, from upper beaches and riverbanks to human-dominated agricultural and urban areas. It is uncommon in closed forests. It breeds in still and slow-flowing rivers and temporary and permanent ponds and pools. Adults are terrestrial and may be found under ground cover (eg. rocks, leaf-litter, logs), and are also associated with human habitations. The larvae are found in still and slow-moving waterbodies.	North and South of Mandai Lake Road Zones D & F	-	It is an abundant species throughout its range that is probably increasing in many areas.
2	Dicroglossidae	*Fejervarya cancrivorus*	Crab-eating Frog	*WRS Data*	O	IC+TM + BO+ PH	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	Not listed	-	The Crab-eating Frog has the rare ability among amphibians to tolerate brackish water, and can be found in mangroves, scrubland, as well as canals and parks in urban areas along the coast. The adult is nocturnal and semi-aquatic.	Zone F	Locally it can be found at Pulau Semakau, Sungei Buloh Wetland Reserve and East Coast Park	This species ranges from Indochina, Thailand, Peninsular Malaysia, Singapore to Sumatra, Java, Borneo and the Philippines.
3	Dicroglossidae	*Fejervarya limnocharis*	Field Frog	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	It inhabits most open wet habitat types, including river floodplains, wet agriculture areas such as rice fields, ditches, marshes, parks, gardens and other habitats and in closed-canopy forest (although this is rare in some regions).	North of Mandai Lake Road Zones D, E & F	-	Frogs of this complex are generally common and abundant in suitable habitat
4	Ranidae	*Hylarana baramica*	Golden-eared Rough-sided Frog	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	SD	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	VU	-	It is known from a variety of lowland floodplain situations, including peat swamp forest and swampy flatland primary forest at low elevations, usually in swampy areas	Zone A	-	It is considered uncommon in Singapore
5	Ranidae	*Hylarana erythraea*	Common Greenback	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	It is characteristic of vegetated floodplain ponds and is also frequently associated with rice fields.	Zones D & E	-	It is abundant in appropriate habitats.
6	Ranidae	*Hylarana labialis* (Formerly confused with *Rana chalconota*)	Copper-cheeked Frog	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + BO	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Shallow streams in lowland primary forest, adjacent secondary forest, and freshwater swamp forest. Adults generally perch low down on streamside branches or fallen forest debris.	North and South of Mandai Lake Road Zones A, D and F	Southern Thailand through Peninsular Malaysia and Singapore, to islands of Borneo, Sumatra, Java, Bali and Sulawesi.	-
7	Ranidae	*Hylarana laterimaculata*	Masked Rough-sided Frog	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	IM	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	The species is predominantly an inhabitant of lowland freshwater and peat swamp forests	-	-	It is locally abundant where suitable habitat exists. Healthy populations have been recorded within the inland swamp forests of Singapore. It is considered uncommon in Thailand.
8	Bufonidae	*Ingerophrynus quadriporcatus*	Four-ridged Toad	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	LC	Least Concern ver 3.2	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	Not listed	-	Swamp forests are the primary habitat for this toad. It is known to breed in standing water. It has been recorded from rubber plantations, presumably close to primary forest.	Zone B	Occurs in Peninsula Malaysia, Singapore, Indonesia (Sumatra, Natuna Besar and Pulau Bintan), and Borneo.	There are no estimates of the size of subpopulations in Borneo, but it appears to be common but not abundant in intact swamp forests. It is uncommon in Sumatra and Singapore, and presumably localized or uncommon in Peninsular Malaysia.
9	Microhylidae	*Kalophrynus limbooliati*	Lim's Black-spotted Sticky Frog (Formerly confused with *K. pleurostigma*)	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	Malay Peninsula	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed (VU after consultation with Subaraj)	-	-	Zone A	-	Southern Malay Peninsula
10	Microhylidae	*Kalophrynus pleurostigma*	Black-spotted Sticky Frog	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	PH + SD + Thailand	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	VU	-	-	Zones D & F	-	Leaf-litter of lowland and hill forests and occasionally in disturbed forests. It breeds in small pools of water.
11	Microhylidae	*Kaloula pulchra*	Banded Bull Frog	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + TM + SD + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Can survive in disturbed habitats including flooded grassland, roadside puddles and urban storm drains. By day hides in holes in the ground, under leaf litter or in the crevices of walls or buildings.	South of Mandai Lake Road Zone F	-	-
12	Megophyridae	*Leptobrachium nigrops*	Black-eyed Litter Frog	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	SD	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	It inhabits lowland rainforest, including regenerating forest. Adults and juveniles range widely in swampy forest; nocturnal, solitary insectivore adult lives among leaf litter on the forest floor.	Zone A	-	Population is believed to be decreasing. In Malaysia and Singapore the species is common, but nothing is known about its abundance in Borneo.
13	Dicroglossidae	*Limnonectes blythii*	Malayan Giant Frog	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + IC	NT	Near Threatened ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	It inhabits streams with gravel and boulders in primary and secondary evergreen forest.	Zones A, B, D, E, F	-	The population status of this species is locally variable, ranging from uncommon in western Thailand to very common in areas where harvesting does not occur in Peninsular Malaysia
14	Dicroglossidae	*Limnonectes malesianus*	Malesian Frog	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + Indonesia	NT	Near Threatened ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A and F	Western Catchment Area	shallow, gentle streams and nearby swampy areas including peat swamps, very flat alluvial forests (both primary forest and mature secondary growth), and overgrown plantations. Lay eggs in sandy streambeds but no nest is constructed (Kiew 1984c).
15	Ranidae	*Lithobates catesbeianus*	American Bullfrog	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	IM + EA + others	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	This species inhabits ponds, swamps, lakes, reservoirs, marshes, brackish ponds (in Hawaii), stream margins and irrigation ditches. It is sometimes found in temporary waters hundreds of metres from permanent water.	-	-	There are thousands of occurrences of this species. It is highly abundant and its global population is increasing
16	Microhylidae	*Microhyla butleri*	Painted Chorus Frog	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	A species of the forest edge, occasionally encountered on the forest floor of primary forest, but most often heard in massive choruses at forest edge puddles and pools. It is also known occasionally from plantations, tall shrublands and cultivated fields. It breeds in relatively permanent still waters, such as grassy pools, marshes, ponds and paddy fields in hilly areas.	South of Mandai Lake Road Zones B & F	-	It is generally abundant in appropriate habitat in Southeast Asia. It is regarded as a rare species in Taiwan, Province of China. The distribution in China is fragmented.
17	Microhylidae	*Microhyla heymonsi*	Dark-sided Chorus Frog	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	It inhabits disturbed areas such as riverbanks, gardens, fire-maintained grassy areas, paddy fields and savannah forest as well as secondary vegetation. It breeds in temporary rain puddles, paddy fields, ditches, marshes and slow-flowing streams.	South of Mandai Lake Road Zones A, B, D, E, F	-	It is generally abundant in appropriate habitats.
18	Rhacophoridae	*Nyctixalus pictus*	Spotted Tree Frog	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	SD + Thailand + PH	NT	Near Threatened ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	VU	-	-	Zone B	-	It is widespread but nowhere is it common
19	Rhacophoridae	*Polypedates leucomystax*	Common Tree Frog	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + SD + PH + IC	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, D & F	Chinese Garden, Hindhede Nature Park, Lower Pierce Reservoir, Nee Soon Swamp Forest, Singapore Botanic Gardens, Sungei Buloh Wetland Reserve, Upper Seletar Reservoir Park, Western Catchment, Sentosa, Pulau Semakau, Pulau Tekong and Pulau Ubin.	It is abundant and common throughout its range.

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Reptile Species															
1	Colubridae	*Ahaetulla prasina*	Oriental Whip Snake	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM + China	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	This species inhabits both primary lowland and montane moist forests, secondary forests, dry and open forests, scrublands, plantations, gardens, monsoon forest, cultivated land, roadsides, and city gardens	South of Mandai Lake Road Zone D & F	-	This species is "fairly common" in India and in Sumatra. The snake is common and widespread in the Philippines. It is common in forested areas of Indochina, and near villages where there is forested habitat nearby
2	Trionychidae	*Amyda ornata (listed in IUCN as Amyda cartilaginea)*	Asian softshell turtle	*Tan HH, Lim LKP (2015) Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area*	O	SD + TM	VU	Vulnerable A1cd+2cd ver 2.3	Native; understood to be restricted and uncommon	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	II	Lowland forest streams in forested areas.	Zone D	CCNR	-
3	Colubridae	*Boiga dendrophila*	Gold-ringed Cat Snake	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM	DD	Data Deficient ver 3.1	VU	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	This nocturnal species is found in undisturbed tropical moist forests, and snakes have been seen on the forest floor near freshwater bodies	Zone E	-	-
4	Pythonidae	*Broghammerus reticulatus*	Reticulated Python	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	NE	Not yet assessed	Not listed	Endangered Species (Import and Export) Act Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CITES Appendix II	Generally found rainforests, woodlands, and nearby grasslands associated with rivers	South of Mandai Lake Road Zone F	Large distribution range extending from India in South Asia eastward through entire Southeast Asia	A reliable population estimate is lacking
5	Agamidae	*Bronchocela cristatella*	Green-crested Lizard	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + Indonesia	NE	Not yet assessed	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forest, Terrestrial, Urban, Parks & Gardens	Zone F	Sungei Buloh Wetland Reserve, Kent Ridge Park	Only in South East Asia region
6	Elapidae	*Calliophis bivirgatus*	Blue Coral Snake / Blue Malayan Coral Snake	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	SD	NE	Not yet assessed	VU	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Terrestrial, Forest	Zone F	Western Catchment Area	Only in South East Asia region
7	Elapidae	*Calliophis intestinalis*	Banded Malaysian coral snake	*WRS Data*	O	IM	LC	Least Concern ver 3.1	VU	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	-	This species has been recorded from primary and secondary tropical moist forest, as well as from town gardens and agricultural fields.	Zone F	Bukit Timah Nature Reserve, Central Catchment Nature Reserve, Kent Ridge Park, Nee Soon Swamp Forest, Upper Seletar Reservoir Park, Pulau Tekong	This species occurs from southern Thailand to the Philippines and Sulawesi, Indonesia
8	Agamidae	*Calotes versicolor*	Changeable Lizard	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IC + SD, Iran to India	Not yet assessed	Not yet assessed	Not listed	Introduced, naturalised in Singapore	-	Open areas such as scrubland and parkland, sometimes forest clearings.	South of Mandai Lake Road Zone B, D, E & F	In Singapore, common in urban parks and housing estates.	-
9	Colubridae	*Chrysopelea paradisi*	Paradise Tree Snake	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	TM + SD + PH + India	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	This diurnal, arboreal species is found in both primary and secondary tropical moist forest up to 1,500 m elevation (Cox et al. 1998). It has been recorded from coconut plantations adjacent to forests, rural villages, tree-shaded gardens, and within the attics of old houses (Stuebing and Inger 1999; A. Diesmos pers. comm.).	Zone E & F	Pasir Ris Park, Pulau Ubin, Rifle Range Road, and Sungei Buloh Wetland Reserve.	This species is fairly common throughout its range.
10	Colubridae	*Chrysopelea pelias*	Twin-barred Tree Snake	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	SD + Thailand	LC	Least Concern ver 3.1	VU	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	This species inhabits lowland moist forests and plantations (David and Vogel 1996), and was recorded recently in the outskirts of Kuala Lumpar (Ismail et al. 2010). This snake is diurnal and predominantly arboreal, however, it can also be found active among bushes, and on the ground in thick vegetation.	Zone F	Pulau Ubin	David and Vogel (1996) state that this species is rare throughout its range. In Singapore it is considered Vulnerable, and it is considered likely to move into the Endangered threat category if current threats continue (Ng and Lee 1994), as it is becoming increasingly difficult to find (L. Grismer pers. comm. October 2011). Cox (1991) records that it is the rarest member of the genus. This is, however, a secretive species, and its arboreal lifestyle which could mean it is easily missed by surveys. For example, the first record for this species in Kalimantan was reported only in 2006 (Auliya 2006).
11	Colubridae	*Coelognathus flavolineatus*	Malayan Racer	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IC + SD	LC	Least Concern ver 3.1	EN	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	This species occurs in forest clearings and edges, savannas, scrub, grasslands, cultivated areas, rice fields, and suburban areas from sea level to 900 m elevation (David and Vogel 1996). It is often found near human habitation (David and Vogel 1996).	Zone A	-	This species is common and abundant in Sumatra (David and Vogel 1996). It is rare in the northeastern part of its range (Cambodia and Viet Nam).
12	Geoemydidae	*Cuora amboinensis*	Malayan Box Terrapin	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	VU	Vulnerable A1d+2d ver 2.3	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Juveniles fully aquatic (marshes, swamps, ponds, pools, rice paddies); adults semi-aquatic.	South of Mandai Lake Road Zone B & F	-	-
13	Gekkonidae	*Cyrtodactylus majulah*	Singapore Bent-toed Gecko	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	-	Not yet assessed	Not yet assessed	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	-	-	-
14	Gekkonidae	*Cyrtodactylus quadrivirgatus*	Marbled Forest Gecko	*Nature Society Singapore (nd) Report on the STB Project at Mandai*	O	SD + TM	Not yet assessed	Not yet assessed	VU	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Lowland primary or tall secondary rainforest, freswhater swamp forest and lower montane forest up to at least 1,100 m. Generally found clinging to low vegetation and occasionally on boulders or rock outcrops.	Specific area unclear; recent research (Grismer et al 2012) suggest that the species is unlikely to occur in Singapore and is now recognised as two different species (*Cyrtodactylus majulah* and *Cyrtodactylus semenanjungensis*).	Southern Thailand and Peninsular Malaysia. Also listed as occurring in North Sumatra and North-Western Borneo.	
15	Colubridae	*Dendrelaphis caudolineatus*	Striped Bronzeback	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	SD + PH	NE	Not yet assessed	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Arboreal, Forest, Parks & Gardens	Zone A, F	Dairy Farm Nature Park	
16	Colubridae	*Dendrelaphis kopsteini*	Red-necked Bronzeback	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	SD + TM	LC	Least Concern ver 3.1	VU	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	In common with some other species in the genus, this snake is commonly found in primary and secondary lowland forest but can also be encountered in gardens in villages	-	-	The species appears to be common, as images were included in several books before it was even described

Item	Family	Genus species	Common Name	Source	Presence#	Current endemicity listing*	IUCN Category	IUCN Status	Local Status (SRDB)	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
17	Colubridae	*Dendrelaphis pictus*	Painted Bronzeback	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IC + SD + BO + PH	Not yet assessed	Not yet assessed	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forest, scrubland and gardens. In Singapore also common in suburban, rural areas and on surrounding islands.	South of Mandai Lake Road Zone D, E & F	Southern China, Malay Peninsula, Borneo, Sumatra, Java, Sulawesi, to Timor and the Philippines.	-
18	Agamidae	*Draco melanopogon*	Black Bearded Flying Dragon	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	TM	NE	Not yet assessed	VU	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	-	They inhabit lowland forests. They are often seen on the tree trunk at eye level but will also inhabit the canopy.	Zone A	Common in lowland primary and secondary rainforests, and its range encompasses Southern Thailand, Peninsular Malaysia, and Sumatra, Borneo and other Indonesian Islands. In Singapore it is restricted to the primary forests of Bukit Timah and the mainly secondary forests of the Central Catchment Area.	-
19	Agamidae	*Draco sumatranus*	Common Malayan Flying Dragon	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	BO + TM	Not yet assessed	Not yet assessed	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Disturbed or man-made habitats such as parks, gardens or wayside trees, where abundant sunlight is the norm. Rarely found in the shade of primary or mature secondary forests, preferring to keep to the forest edge.	North and South of Mandai Lake Road Zone F	In Singapore widespread and common, including offshore islands. Distributed in the Malay Peninsula, Sumatra, Borneo and Palawan.	-
20	Scincidae	*Eutropis multifasciatus*	Common Sun Skink	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	EA + PH + IC + SD + India	NE	Not yet assessed	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forest, Mangroves, Parks & Gardens, Terrestrial	North of Mandai Lake Road Zone A, D, E, F & H	Pasir Ris Park, Singapore Botanic Garden	They are distributed mostly in the South East Asia region, India, East Asia. They are also introduced to Florida.
21	Scincidae	*Eutropis rugiferus*	Striped Sun Skink	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	-	NE	Not yet assessed	EN	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	-	Primary lowland dipterocarp forest	Zone A	Seems to be confined to the Bukit Timah Nature Reserve and the Central Catchment Nature Reserve	-
22	Gekkonidae	*Gecko gekko*	Tokay Gecko	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	SD + PH + TM + India + Bangladesh	NE	Not yet assessed	CR	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Tropical rainforests, on cliffs and trees	Zone F	-	Mostly from northeast India to the Indo-Australian Archipelago
23	Gekkonidae	*Gehyra mutilata*	Four-clawed Gecko	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	SD + IC + EA + PH + Oceania	NE	Not yet assessed	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forests and urban areas such as ceiling and roofs	Zone F	-	Southeast Asia. Its distribution also extends across the Pacific to Mexico and Hawaii
24	Gekkonidae	*Gekko monarchus*	Spotted House Gecko	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	-	Not yet assessed	Not yet assessed	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary lowland rainforests, sometimes venturing to the walls of buildings adjacent to the forest.	Zone D, F	-	-
25	Colubridae	*Gonyosoma oxycephalum*	Red-tailed Racer	*WRS Data*	O	IC + PH	LC	Least Concern ver 3.1	EN	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	-	This is a diurnal, arboreal snake that occurs in primary forest, but appears to prefer edge habitats, secondary growth, plantations and rural gardens.	Zone F	Bukit Timah Nature Reserve, Central Catchment Nature Reserve and Pulau Tekong.	This species ranges from Myanmar eastward to central Viet Nam, southward through the Malay Peninsula and in island Southeast Asia (including both the Andaman and Nicobar Islands) as far east as the Philippines and Lombok, Indonesia; Population trend is decreasing.
26	Gekkonidae	*Hemidactylus frenatus*	Spiny-tailed House Gecko	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	This nocturnal species is found on boulders, beneath rocks or rotting logs, and on trees, however, it most commonly found on buildings. This species is found in both villages and large urban areas, it is usually found close to electric lights at dusk. In addition, this species also occurs in a diverse range of habitats, including rain forests, savannas, and deserts.	Zone A, B, F	-	This species is common throughout most of its range.
27	Gekkonidae	*Hemidactylus platyurus*	Flat-tailed house gecko	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + IC + IM + Papua New Guinea + Philippine Islands	NE	Not yet assessed	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forests and agriculture areas.	Zone F	-	Southeast Asia, Papua New Guinea, Florida (Introduced) + Indomalaya Ecozone
28	Gekkonidae	*Hemiphyllodactylus typus*	Lowland Dwarf Gecko	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	EA + SD + TM + PH + India + Sri Lanka	NE	Not yet assessed	VU	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Warm regions with tropical or subtropical climates. Usually located in humid microclimate such as under loose bark, in leaf axils of ferns or bromeliads and other herbaceous plants	Zone D	-	South Asia, islands in both the Indian Ocean and Pacific Oceans, Papua New Guinea and Indian Subcontinent
29	Geoemydidae	*Heosemys grandis*	Giant Leaf Terrapin	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IC + SD	VU	Vulnerable A2acd ver 3.1	Not listed	Endangered Species (Import and Export) Act Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CITES Appendix II	Semi-aquatic habitats such as ponds, lakes and slow-flowing pools in freshwater swamp forest	Zone D	-	Distributed in the Malay Peninsula, Sumatra, Borneo and Mindanao
30	Gekkonidae	*Lepidodactylus lugubris*	Maritime Gecko	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	IM + New Guinea	NE	Not Evaluated	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Inhabits mangroves, back-beach and rocky shorelines. Eggs are laid either in the soil, or adhered to the foliage of mangrove species, coconut trees, Pandanus and Banana.	Zone F	Well distributed throughout much of Southeast Asia, including Burma, West Malaysia, Singapore, the Indonesian islands of Borneo, Lombok, Sulawesi, Halmahera and Ambon, the Philippines and New Guinea.	-

Item	Family	Genus species	Common Name	Source	Presence#	Current endemicity listing*	IUCN Category	IUCN Status	Local Status (SRDB)	Protected by Law	CITES (I, II, III)	Habitat Requirements	Expected range within and outside Project Area	Predicted range outside Project Area	Estimated global population size/status
31	Scincidae	*Lipinia vittigera*	Yellow-striped Tree Skink	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	TM + BO	NE	Not Evaluated	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	-	Inhabits tree trunks in lowland primary and secondary forest up to 1600 metres elevation, mature forests and relatively open areas. It is diurnal and is often found on tree trunks and buttresses, hiding under exfoliating tree bark.	Zone F	Ranges from Burma, Thailand and Vietnam to Peninsular Malaysia, Singapore and Borneo.	-
32	Natricidae	*Macropisthodon rhodomelas*	Blue-necked Keelback	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)*	O	SD + TM	LC	Least Concern ver 3.1	EN	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2008	-	This species is only known from lowland forest near riparian areas. In Peninsular Malaysia it is found in low-lying wet areas up to 200 m asl.	-	-	The species is uncommon in much of its range
33	Elapidae	*Naja sumatrana*	Black Spitting Cobra	*Subaraj, R (2015) Mandai Terrestrial Fauna Report*	O	TM + BO + Philippines	LC	Least Concern ver 3.2	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2009	-	It is primarily a forest species, but can also be found in second growth, gardens, parks, rice fields, plantations and house compounds (Steubing and Inger 1999). It is oviparous, laying clutches of between 6 and 23 eggs.	Zones B and F	This widespread species is present in southern Thailand, Peninsular Malaysia, Sumatra (Indonesia), the island of Borneo (Brunei, Indonesia and Malaysia), and the Philippine.	There is little information available on the population abundance of this species. On Sumatra and Kalimantan the species is considered as uncommon, but can be common in some areas, especially rice fields. In Peninsular Malaysia it is extremely common in oil palm plantations. In Thailand it is common in hilly forests and in rubber plantations in hilly areas.
34	Geoemydidae	*Notochelys platynota*	Malayan Flat-shelled Turtle	*Mandai Conceptual Masterplan Study Appendix C (2014)* *WRS Data*	O	TM + SD	VU	Vulnerable A1cd + 2cd ver 2.3	EN	Endangered Species (Import and Export) Act Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CITES Appendix II	Inhabits freshwater, especially mangroves and low lying peat swamp forests	North of Mandai Lake Road Zone F	Throughout Thai-Malay peninsula and Sundaic region	A reliable population estimate is lacking
35	Colubridae	*Oligodon octolineatus*	Striped Kukri	Subaraj, R (2015) Mandai Terrestrial Fauna Report	O	SD	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2009	-	This species occurs in lowland wet areas to dipterocarp forest. It is sometimes found around human habitat up to forested area.	Zones B and F	The species is widely distributed in the Sundaland, Brunei, East and West Malaysia, and Singapore.	The species is considered as uncommon in Peninsular Malaysia.
36	Elapidae	*Ophiophagus hannah*	King Cobra	Subaraj, R (2015) Mandai Terrestrial Fauna Report	O	IM + EA + IC + SD + PH	VU	Vulnerable A2acd ver 3.1	EN	Endangered Species (Import and Export) Act Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CITES Appendix II	Pristine forests, but it can also be found in degraded forest, mangrove swamps and even agricultural areas with remnants of woodland. It has also been found swimming in rivers in non-forested land and probably occurs in palm oil plantations	Zone F	Pulau Tekong, Sungei Buloh Wetland Reserve, Kranji and Sentosa	Large range, extending from India, east to Bangladesh, Myanmar, Cambodia, southern China, Laos, Thailand, Vietnam, Malaysia, Indonesia and the Philippines
37	Geoemydidae	*Orlitia borneensis*	Bornean Giant River Terrapin	Subaraj, R (2015) Mandai Terrestrial Fauna Report WRS Data	O	BO + TM	EN	Endangered ver 3.1	Not listed	Endangered Species (Import and Export) Act Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	CITES Appendix II	Semi-aquatic, inhabiting large lakes, swamps and slow-flowing rivers.	Zone F	Indonesia; Malaysia	This uncommon to rare species occurs in southern Thailand, Peninsular Malaysia, Sumatra and Borneo.
38	Lamprophiidae	*Pareas margaritophorus*	White-spotted Slug Snake	Subaraj, R (2015) Mandai Terrestrial Fauna Report	O	EA + IC + TM	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Arboreal in montane forest (Orlov et al. 2000), and in lowland forest in Peninsular Malaysia (L. Grismer pers. comm. August 2011).	Zone F	Open scrubland of Mandai, Khatib Bongsu Park Connector, Lim Chu Kang, and Sungei Buloh Wetland Reserve	Southern China, Indochina and the northern parts of the Malay Peninsula.
39	Typhlopidae	*Ramphotyphlops braminus*	Brahminy Blind Snake	Subaraj, R (2015) Mandai Terrestrial Fauna Report	O	-	NE	Not yet assessed	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2009	-	Spends much of its time burrowing in soil and leaf litter. They may be encountered when digging in soil, when turning over logs or rocks or after a heavy downpour when they are forced to the ground surface.	Zone A	Species ranges throughout Southeast Asia, and has populated other parts of the world including the Middle East, Africa and the U.S.	-
40	Geoemydidae	*Siebenrockiella crassicollis*	Black Marsh Terrapin	Subaraj, R (2014) Vertebrate & Odonate Report (Mandai) NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama Tan HH, Lim LKP (2015) Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area	O	TM + IC + BO	VU	Vulnerable A1cd+2cd ver 2.3	Not listed; Non-native	Endangered Species (Import and Export) Act Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CITES Appendix II	Vegetated shallow margins of quiet streams, canals, ponds, lakes and reservoirs.	Lorong Asrama	Burma, Thailand and Indochina through Peninsular Malaysia and Singapore to Borneo, Sumatra and Java	No information available however heavily exploited for trade and threated by habitat conversion and loss.
41	Emydidae	*Trachemys scripta*	Red-eared Slider	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Tan HH, Lim LKP (2015) Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	America	LC	Least Concern ver 3.1	Not listed; Non-native	Introduced, naturalised in Singapore	-	In its native range, *Trachemys scripta* is an inhabitant of a wide variety of waterbodies, and is most abundant in soft-bottomed shallow habitats with minimal flow, abundant access to sunlight and extensive vegetation. In Mexico, it is primarily a riverine species. In Europe, the species is an opportunistic inhabitant of freshwater habitats, generally in close proximity to human habitation and/or recreation centres.	South of Mandai Lake Road; Zones A and H (Less than 10 individuals) Zone A & F	-	United States: A widespread species that is common in its native range, and has established populations beyond its native range. Mexico: locally common within its native range, and has established feral populations throughout the country. In Europe it is becoming increasingly abundant, especially in Portugal, Spain and France.
42	Varanidae	*Varanus nebulosus*	Clouded Monitor	*Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	SD + IC	Not yet assessed	Not yet assessed	Not listed	Endangered Species (Import and Export) Act Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CITES Appendix I	Primary and Secondary forests, parks and gardens	Zone F	Bukit Batok Nature Park, Bukit Timah Nature Reserve, Central Catchment Nature Reserve, Pulau Tekong and Pulau Ubin	-
43	Varanidae	*Varanus salvator*	Common Water Monitor Lizard	*NParks (2008) A Rapid Biodiversity Assessment of Lorong Asrama* *Tan HH, Lim LKP (2015) Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area* *Subaraj, R (2015) Mandai Terrestrial Fauna Report* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Not listed; native; widespread and common	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Semi-aquatic and opportunistic, inhabits a variety of natural habitats, such as primary forests and mangrove swamps	South of Mandai Lake Road; Zone D (Less than 10 individuals); Zones A and F	Large distribution range extending from India in South Asia eastward through entire Southeast Asia	This species group is thought to be abundant in many places
44	Xenopeltidae	*Xenopeltis unicolor*	Sunbeam Snake	Subaraj, R (2015) Mandai Terrestrial Fauna Report		SD + IC + China + India	LC	Least Concern ver 3.1	Not listed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Forests, marshes and scrublands. The species can be found in both disturbed and undisturbed areas, including urban environments, rice paddy fields and other agricultural areas as well as rainforest. They also appear in forested mountain valleys, with rocky areas close to streams	Zone F	Pulau Tekong, Pulau Ubin	-

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45	Gekkonidae	*Cnemaspis peninsularis*	Peninsular Rock Gecko	Subaraj, R (2015) Mandai Terrestrial Fauna Report	PP	Peninsular Malaysia and Singapore	Not yet assessed	Not yet assessed	VU (as *Cnemaspis kendallii*)	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	Primary or secondary forest up to 1500 m, preferring damp cave entrances or rocky outcrops but also nearby tree trunks. Largely nocturnal but can be active on dull afternoons.	-	Bukit Timah, Venus Drive, Thomson Ridge, Taman Negara (Malaysia)	-

* Endemicity definitions:
PH = Philippines only
BO = Borneo Island, which includes only Brunei, Sabah, Sarawak and Kalimantan
TM = Thai-Malay Peninsula, which includes only Myanmar, Thailand, Singapore and Peninsular Malaysia
IC = Indochinese Region, which includes only Cambodia, Laos, Vietnam, Myanmar, Thailand and Southern China
SD = Sundaland, which includes only Borneo, Peninsular Malaysia, Singapore and Indonesia
IM = Indomalaya Ecozone, which includes South Asian countries, Southeast Asian countries, Southern China and parts of East Asia
EA = East Asia region, which includes from Sakhalin to the north, Japan, Korean Peninsula, mainland China, and Taiwan

# Presence definitions:
O = Reportedly observed
O/A = Observed always
O/S = Observed sometimes
O/R = Rarely observed
O/N = Never observed
PP = Potentially present

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence[#]	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
Invertebrate Species																
Locations of Species follow map zones provided in John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area																
Hymenoptera																
1	Apidae	Apinae; Apini	*Apis cerana*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,C,D, E, F	-	-
2	Apidae	Apinae; Meliponini	*Trigona cf laeviceps*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B,D	-	-
3	Apidae	Apinae; Anthoporini	*Amegilla cf zonata*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	C	-	-
4	Apidae	Xylocopinae; Xylocopini	*Xylocopa latipes*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,D,E,F	-	-
5	Apidae	Xylocopinae; Ceratinini	*Ceratina unimaculata*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B,D,E	-	-
6	Apidae	Xylocopinae; Ceratinini	*Ceratina " sp. 1"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B	-	-
7	Apidae	Xylocopinae; Ceratinini	*Ceratina " sp. 2"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B	-	-
8	Apidae	Xylocopinae; Ceratinini	*Ceratina " sp. 3"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B	-	-
9	Apidae	Apinae; Anthoporini	*Amegillainsularis*		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A	-	-
10	Apidae	Apinae; Anthoporini	*Amegilla andrewsi*		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Usually forages at forest edges and open habitats, seen to often visit Xylocopa-pollinated flowers but not dominant there.	-	-	-
11	Apidae	Apinae; Anthoporini	*Amegilla korotonensis*		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,F	-	-
12	Apidae	Apinae; Apini	*Apis andreniformis*	Black dwarf honeybee	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	Widely distributed in tropical SEA, as well as parts of Nepal, Sri Lanka and China	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Nest built in trees and shrubs and can be anywhere between 1 foot and 20 feet above ground level (3 feet to 10 feet being more usual). Nests built on brances and never cavities, exposed and hung on trees with no outer covering or envelope or any sort. Combs protected by layers of bees. Can be seen foraging from a wide variety of flowers, and during hot weather frequently land on wet patches on the ground to collect water.	A,B,F	-	-
13	Apidae	Apinae; Apini	*Apis dorsata*	Giant Honeybee	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Nest are usually very high in trees in Singapore, combs exposed and hung on trees and are protected by layers of bees. Believed to be native to Singapore and can be found almost every time of the year, being especially numerous in August and September. Can be seen foraging from a wide variety of flowers, and frequently land on wet patches on the ground to collect water during hot weather. Forages at night as well as in the day.	D,F	-	-
14	Apidae	Apinae; Melectini	*Thyreus ceylonicus*		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,D,F	-	-
15	Apidae	Apinae; Melectini	*Thyreus himalayensis*	Cuckoo Bee	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D	-	-
16	Apidae	Apinae; Meliponini	*Heterotrigona itama*		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	SD + TM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Lowland dipterocarp forests; nest mostly in trunk hollows of living trees, between tree roots, or in the nest of other invertebrates such as ants and termintes. Needs forest with a number of large diameter trees in which hollows can form.	D,F	Singapore Botanic Gardens, Orchard, CCNR.	-
17	Apidae	Apinae; Meliponini	*Tetragonula laeviceps*		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,F	-	-
18	Apidae	Xylocopinae: Allodapini	*Braunsapis cupulifera*		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B,D,F	-	-
19	Apidae	Xylocopinae: Allodapini	*Braunsapis* sp.		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A	-	-
20	Apidae	Xylocopinae; Ceratinini	*Ceratina collusor*		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D,E,F	-	-
21	Apidae	Xylocopinae; Ceratinini	*Ceratina lieftincki*		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	E	-	-
22	Apidae	Xylocopinae; Ceratinini	*Ceratina nigrolateralis*		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,D,E,F	-	-
23	Apidae	Xylocopinae; Ceratinini	*Ceratina perforatrix*	Small carpenter bee	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	SEA	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Once thought to be restricted to primary forests in SEA< but now recorded in parks and gardens in Singapore	B	-	-
24	Apidae	Xylocopinae; Ceratinini	*Ceratina ridleyi*		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B	-	-
25	Apidae	Xylocopinae; Xylocopini	*Xylocopa aestuans*		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	SEA	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Can be found in parks and gardens. Males are territorial. Versatile in choice of nesting sites: on man-made structures, tree stumps and fallen logs.	D,E,F	-	-
26	Apidae	Xylocopinae; Xylocopini	*Xylocopa caerulea*		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	SEA, India and China (Yunnan, Guangxi, Hainan)	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Widespread in areas with a reasonably good amount of at least secondary forest; nests observed in tree stumps and woody stem of a hanging vine inside the forest. Species can be seen visiting flowers of *Melastoma malabathricum* , and *Adinandra dumosa* .	B	Pulau Ubin, Sentosa, CCNR, Telok Blangah, Kent Ridge	-
27	Apidae	Xylocopinae; Xylocopini	*Xylocopa dejeani*		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D	-	-
28	Apidae	Xylocopinae; Xylocopini	*Xylocopa flavonigrescens*		*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D,E,F	-	-
29	Colletidae	-	*Hylaeus sp.*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	C	-	-
30	Colletidae	-	*Hyalaeus sp.*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B	-	-
31	Crabronidae	Larrinae	*Liris " sp. 1"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,C,D	-	-
32	Crabronidae	Larrinae	*Liris " sp. 2"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B	-	-

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence[#]	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
33	Crabronidae	Larrinae	*Larrinae undet. (small)*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	C	-	-
34	Crabronidae	Crabroninae; Trypoxylini	*Trypoxylon* "*sp. 1*"	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,D,E,F	-	-
35	Crabronidae	Crabroninae; Trypoxylini	*Trypoxylon* "*sp. 2*"	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A	-	-
36	Crabronidae	Crabroninae; Crabronini	*Crabronidae undet.*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A	-	-
37	Crabronidae	Bembicinae (Stizini)	*Bembicinus* sp.	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D	-	-
38	Crabronidae	Larrinae	*Larrinae* sp. 1	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A	-	-
39	Crabronidae	Larrinae	*Larrinae* sp. 2	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D	-	-
40	Crabronidae	Larrinae	*Larrinae* sp. 3	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D	-	-
41	Crabronidae	Larrinae	*Larrinae* sp. 4	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	G	-	-
42	Crabronidae	Larrinae	*Larrinae* sp. 5	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	G	-	-
43	Crabronidae	Larrinae	*Larrinae* sp. 6	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	G	-	-
44	Crabronidae	Larrinae	*Larrinae* sp. 7	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	G	-	-
45	Crabronidae	Larrinae	*Larrinae* sp. 8	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	G	-	-
46	Halictidae	-	*Nomia strigata*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,C,D, E,F	-	-
47	Halictidae	-	*Nomia (Maculonomia) apicalis*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	C	-	-
48	Halictidae	-	*Nomia (Maculonomia) terminata*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,D,F	-	-
49	Halictidae	-	*Lipotriches ceratina*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,D,E	-	-
50	Halictidae	-	*Halictidae undet. 1*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B,C	-	-
51	Halictidae	-	*Halictidae undet. 2*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B	-	-
52	Halictidae	Halictinae	*Lasioglossum albescens*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D	-	-
53	Halictidae	Halictinae	*Patellapis (Pachyhalictus) sp.*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A	-	-
54	Halictidae	Halictinae	*Halictidae* undet. 1	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B	-	-
55	Halictidae	Nomiinae	*Nomia (Acunomia) iridescens*	Sweat bee	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	India, Borneo, Peninsular Malaysia, Philippines	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D,E	-	-
56	Halictidae	Nomiinae	*Nomia (Hoplonomia) incerta*	Sweat bee	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	E	-	-
57	Halictidae	Nomiinae	*Nomia (Maculonomia) apicalis*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,D,E	-	-
58	Halictidae	Nomiinae	*Pseudapis siamensis*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D	-	-
59	Megachilidae	-	*Coelioxys sp. nr. confusus*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B	-	-
60	Megachilidae	-	*Megachile disjuncta*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D,E	-	-
61	Megachilidae	-	*Megachile subrixator*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B	-	-
62	Megachilidae	-	*Megachile laticeps*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D,E	-	-

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63	Megachilidae	-	*Megachile sp.*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B	-	-
64	Megachilidae	-	*Heriades sp.*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D,F	-	-
65	Megachilidae	-	*Coelioxys confusa*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D	-	-
66	Megachilidae	-	*Megachile atrata*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D	-	-
67	Megachilidae	-	*Megachile stulta*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B	-	-
68	Megachilidae	-	*Megachile subrixator*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,D	-	-
69	Pompilidae	-	*Pompilidae "sp. 1"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,D	-	-
70	Pompilidae	-	*Pompilidae "sp. 2"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,F	-	-
71	Pompilidae	-	*Pompilidae "sp. 3"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,F	-	-
72	Pompilidae	-	*Pompilidae "sp. 4"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,D,F	-	-
73	Pompilidae	-	*Auplopus "sp. 1"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,F	-	-
74	Pompilidae	-	*Pompilidae "sp. 5"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A	-	-
75	Pompilidae	-	*Pompilidae "sp. 6"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A	-	-
76	Pompilidae	-	*Pompilidae "sp. 7"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D	-	-
77	Pompilidae	-	*Tachypompilus analis*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D	-	-
78	Pompilidae	-	*Pompilidae* sp. 8	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D	-	-
79	Scoliidae	-	*Campsomeris* sp.	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	G	-	-
80	Scoliidae	-	*Scolia* sp.	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	E	-	-
81	Sphecidae	Sphecinae	*Sphex sericeus*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B,D,E	-	-
82	Sphecidae	Sphecinae	*Isodontia sp. nr. diodon*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,D,F	-	-
83	Sphecidae	Sphecinae	*Isodontia sp.*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,E	-	-
84	Sphecidae	Sceliphrinae	*Sceliphron javanum*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,F	-	-
85	Sphecidae	Sceliphrinae	*Sceliphron madraspatanum*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D	-	-
86	Sphecidae	Sceliphrinae	*Chalybion* sp. nr. *bengalense*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed		Appear to prefer pre-existing cavities over empty mudnests for nest sites.	F	-	-

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87	Sphecidae	Sceliphrinae	*Chalybion (Hemichalybion) sumatranum*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed		-	F	-	-
88	Sphecidae	Sceliphrinae	*Sphex argentatus*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed		-	D	-	-
89	Sphecidae	Sceliphrinae	*Sphex* sp. nr. *diabolicus*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed		-	D	-	-
90	Sphecidae	Sceliphrinae	*Sphex subtruncatus*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed		-	D	-	-
91	Vespidae	Vespinae	*Vespa tropica*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,D,E,F	-	-
92	Vespidae	Vespinae	*Vespa analis*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D,F	-	-
93	Vespidae	Polistinae	*Ropalidia "sp. 1"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,C,D	-	-
94	Vespidae	Polistinae	*Ropalidia "sp. 2"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B	-	-
95	Vespidae	Polistinae	*Ropalidia erythrospila*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	C	-	-
96	Vespidae	Polistinae	*Ropalidia marginata*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B	-	-
97	Vespidae	Polistinae	*Polistes meadeanus*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B	-	-
98	Vespidae	Polistinae	*Polistes stigma*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,F	-	-
99	Vespidae	Eumeninae	*Delta pyriforme*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,D,E,F	-	-
100	Vespidae	Eumeninae	*Phimenes sp.*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D	-	-
101	Vespidae	Eumeninae	*Rhynchium haemorrhoidale*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	E,F	-	-
102	Vespidae	Eumeninae	*Eumenes "sp. 1"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,D,E,F,G	-	-
103	Vespidae	Eumeninae	*Eumenes "sp. 2"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,D,E,F,G	-	-
104	Vespidae	Eumeninae	*Eumenes "sp. 3"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,C,D	-	-
105	Vespidae	Eumeninae	*Eumenes "sp. 4"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	C	-	-
106	Vespidae	Eumeninae	*Eumenes "sp. 5"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	C	-	-
107	Vespidae	Eumeninae	*Eumenes "sp. 6"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	C	-	-
108	Vespidae	Eumeninae	*Eumenes "sp. 7"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B,C	-	-
109	Vespidae	Eumeninae	*Allorhynchium argentatum*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,D,E,F	-	-
110	Vespidae	Stenogastrinae	*Eustenogaster "sp. 1"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	C	-	-
111	Vespidae	Stenogastrinae	*Eustenogaster "sp. 2"*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	C,D	-	-
112	Vespidae	Stenogastrinae	*Liostenogaster sp.*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	C,D	-	-
113	Vespidae	Stenogastrinae	*Parischnogaster sp. nr. nigricans*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,F	-	-

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114	Vespidae	Stenogastrinae	*Parischnogaster sp. nr. mellyi*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area* *John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,D,E,F	-	-
115	Vespidae	Stenogastrinae	*Parischnogaster ° sp. 2°*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	C	-	-
116	Vespidae	Stenogastrinae	*Metischnogaster sp.*	-	*John X. Q. Lee (2014) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	C	-	-
117	Vespidae	Eumeninae	*Phimenes flavopictus*	Potter wasp	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	IC + TM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Can be seen feeding on flowers of the mango tree or building its round nests under roofs, eaves, and other parts of buildings.	A	-	-
118	Vespidae	Eumeninae	*Eumeninae* sp.1	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,D,E,F	-	-
119	Vespidae	Eumeninae	*Eumeninae* sp.2	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	F	-	-
120	Vespidae	Eumeninae	*Eumeninae* sp.3	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,F	-	-
121	Vespidae	Eumeninae	*Eumeninae* sp.4	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,D,F	-	-
122	Vespidae	Eumeninae	*Eumeninae* sp.5	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B	-	-
123	Vespidae	Eumeninae	*Eumeninae* sp.6	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,D	-	-
124	Vespidae	Eumeninae	*Eumeninae* sp.7	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A	-	-
125	Vespidae	Eumeninae	*Eumeninae* sp.8	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A	-	-
126	Vespidae	Eumeninae	*Eumeninae* sp.9	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,D	-	-
127	Vespidae	Eumeninae	*Eumeninae* sp.10	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,D	-	-
128	Vespidae	Polistinae	*Polistes sagittarius*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	Wide distribution in tropical Asia, recorded from IC, Malaysia, Singapore.	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Nests often built under large, broad leaves of in the dense foliage of bushes, shrubs and trees of all heights, concealed by leaves. Inclined to building nests in urban buildings and man-made shelters. Colony size seldom gets very large, males are territorial. Can nest in ornamental plants.	F	-	-
129	Vespidae	Polistinae	*Polistes sp. nr. stigma*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	Wide distribution in various parts of Asia, including Hong Kong	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Nests in tall trees, small trees and ornamental plants. Appear to prey mainly on caterpillars. Can be found in mangroves.	A,F	-	-
130	Vespidae	Polistinae	*Ropalidia erythrospila*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed		-	A,B,F	-	-
131	Vespidae	Polistinae	*Ropalidia flavopicta*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	F	-	-
132	Vespidae	Polistinae	*Ropalidia marginata*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D,E	-	-
133	Vespidae	Polistinae	*Ropalidia stigma*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,F	-	-
134	Vespidae	Polistinae	*Ropalidia sumatrae*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	B,E,F	-	-
135	Vespidae	Polistinae	*Ropalidia timida*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D,F	-	-
136	Vespidae	Polistinae	*Ropalidia* sp. 1	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	D	-	-
137	Vespidae	Stenogastrinae	*Eustenogaster hauxwelli*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A	-	-
138	Vespidae	Stenogastrinae	*Eustenogaster micans*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,B,D	-	-
139	Vespidae	Stenogastrinae	*Liostenogaster nitidipennis*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,F	-	-
140	Vespidae	Stenogastrinae	*Liostenogaster variipicta*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A,F	-	-
141	Vespidae	Stenogastrinae	*Metischnogaster dreuseni*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	Oriental Region; Malay Peninsula	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Nests can be found under earth banks, hanging from vegetation below 2 m, and under vegetation.	A	-	-
142	Vespidae	Stenogastrinae	*Parischnogaster unicuspata*	-	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	A	-	-
143	Vespidae	Vespinae	*Vespa affinis*	Lesser banded hornet	*John X. Q. Lee (2015) Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area (Apr-Oct 2015)*	O	Widespread throughout Asia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Forages close to the ground in grassy areas, forests and wasteland. Seems to prey heavily on flies. Can be found on the beach in Singapore. Also feed on nectar from flowers of the coconut tree. Nests built high in trees but also commonly found lower in small trees, i n and round houses.	B,D,E,F	-	-
Odonates																
1	Coenagrionidae	-	*Ceriagrion cerinorubellum*	Ornate Coraltail	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *NParks (2008) A Rapid Biodiversity Assessment of Lorong Asrama.* *Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	This species breeds in a wide variety of standing water habitats, from drains in town and cities to marshes and swamp forest, and even the landward margins of mangrove swamp.	Lorong Asrama; Zones A, D, F and H	-	This is a common species across most of its range.

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2	Coenagrionidae	-	*Pseudagrion microcephalum*	Common Blue Sprite	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Habitat preferences include ponds, lakes and streams	South of Mandai Lake Road; Zones A, D, E F and H	-	A widespread and common species lacking in detailed population numbers or trend.
3	Platycnemididae	-	*Copera marginipes*	Yellow Featherlegs	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Yeo SH (2015) Odonata Survey at Mandai*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Found in ponds, puddles, canals and streams.	Zone D	-	This is a very common species over much of its range.
4	Aeshnidae	-	*Gynacantha basiguttata*	Spoon-tailed Duskhawker	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Yeo SH (2015) Odonata Survey at Mandai*	O	IM	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	This is a species of lowland forest, especially swamp forest. It breeds in forest pools and appears tolerant of disturbance, occurring in logged forest.	Zone B	-	This species is probably quite common over much of its range, but under-recorded because of its crepuscular habits.
5	Gomphidae	-	*Ictinogomphus decoratus*	Common Flangetail	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	This is a lentic species, breeding in ponds, lakes and slow flowing streams.	Zones A, D, F and H	-	This species is common across much of its range.
6	Libellulidae	-	*Agrionoptera insignis*	Grenadier	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Usually found in swampy lowland forest, and is tolerant of some disturbance.	Zones B, D, E and F	-	This species is fairly common where it occurs over much of its range, becoming less common towards the edges of its distribution.
7	Libellulidae	-	*Agrionoptera sexlineata*	Handsome Grenadier	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Yeo SH (2015) Odonata Survey at Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CR	-	-	Zones B, E and F	-	
8	Libellulidae	-	*Camacinia gigantea*	Sultan	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Yeo SH (2015) Odonata Survey at Mandai*	O	IM	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CR	-	This species breeds in shallow stagnant waters. It is mainly found near the coast, at lagoons and shallow ponds, and at the rearward edges of mangrove, although it is also sometimes encountered far inland (e.g. Chiang Mai in Thailand). In Sarawak numbers of this species have been reported on shallow coastal pools that dry up after a few days without rain.	Zone F	-	This species appears to be somewhat local but can be common where it occurs.
9	Libellulidae	-	*Cratilla lineata*	Line Forest-skimmer, or Pale-faced Forest-skimmer	*WRS Data*	O	IC + India	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	CR	-	Occurs in forested areas in lowland and montane regions. Prefers shaded muddy forest pools but will occur in a wide range of lentic forest habitat.	Zone F	-	*Cratilla lineata* is an abundant and widespread species ranging from the west coast of India through Indo-China, southern China including Taiwan and Hainan to the Philippines and Indonesia.
10	Libellulidae	-	*Cratilla metallica*	Dark-tipped Forest-skimmer	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	The species breeds in forest pools, and occurs in secondary forest.	Zones A, B, E and F	-	Cratilla metallica is a common species in forest across much of its range.
11	Libellulidae	-	*Orchithemis pulcherrima*	Varilable Sentinel	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Yeo SH (2015) Odonata Survey at Mandai*	O	IM	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	This species occupies a broad range of swamp and swampy forest habitats. It is most common at low altitudes but it has been found at above 1,000 m in the Tama Abu Range in Sarawak. It occurs in highly disturbed forest and it has been found on a stream in mature oil palm in eastern Kalimantan and in Peninsular Malaysia.	Zone H	-	This is a very common species in swampy lowland forest across much of its range.
12	Libellulidae	-	*Orthetrum chrysis*	Spine-tufted Skimmer	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Common in marshes, ponds, lakes, sluggish streams and irregation canals.	Zone F	-	This species is common over much of its range.
13	Libellulidae	-	*Orthetrum glaucum*	Common Blue Skimmer	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Yeo SH (2015) Odonata Survey at Mandai*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	This species breeds in ponds, drains, ditches and other open lentic habitats.	Zones B, D, E and F	-	This species is common across much of its large range.
14	Libellulidae	-	*Orthetrum sabina*	Variegated Green Skimmer	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Yeo SH (2015) Odonata Survey at Mandai*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	This species occupies a broad range of slow flowing and still water habitats, from ponds and lakes to wet rice fields, irrigation ditch and marshes. It is very tolerant of high salt contents and to habitat disturbance.	Zones E and F	-	This is a very common species over much of its huge range.
15	Libellulidae	-	*Lathrecista asiatica*	Scarlet Grenadier	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Yeo SH (2015) Odonata Survey at Mandai*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	This species breeds in ponds, marshes, swamp forest and shallow forest pools. It has been found in Kalimantan on small pools in oil palm plantations where agrochemicals are heavily used, so it is tolerant of disturbance and pollution.	Zones A, B, D and F	-	This is a common species over much of its range.
16	Libellulidae	-	*Tholymis tillarga*	White-barred Duskhawk	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	IM + EA + Oceania	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Tholymis tillarga is a migrant with permanent presence in the humid parts of the tropics. Migrants enter the desert areas and can potentially be found anywhere. The species is a very ubiquitous and opportunistic one and breeds in pools, ponds, marshes on sides of large lakes, and swamps in bush, woodland and forest as well as in river backwaters and man-made sewage lagoons, pools, ponds and water tanks	Zones B and F	-	Population size is unknown but the species is very common across much of southeast Asia and locally very common in Africa.
17	Libellulidae	-	*Tramea transmarina*	Saddlebag Glider	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	The species is widespread throughout tropical Asia occurring in well vegetated lakes, ponds and drains from sea level to 2,000 m; it occurs everywhere throughout Malaysia in the lowlands, is salt tolerant, wanders far from its breeding places upon emergence, frequently soars to altitudes of over 2,000 m, soaring high above mountain plateaux and jungle clearings, and is migratory	Zones D, E and F	-	The species and its various subspecies are common and widespread throughout the tropical Indomalayan and Oceania zoogeographical regions.
18	Libellulidae	-	*Urothemis signata*	Scarlet Basker	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	This species breeds in ponds and slow flowing rivers, typically in lowland areas.	Zones A, B,F and H	-	This is a common species over much of its range
19	Libellulidae	-	*Zyxomma petiolatum*	Long-tailed Dusk-darter	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	The species breeds in small stagnant pools, ponds, swamp forest and slow flowing rivers.	South of Mandai Lake Road	-	This species is under-recorded in many areas because of its crepuscular habits and swift flight, but it is very common over much of its range.
20	Libellulidae	-	*Trithemis festiva*	Indogo Dropwing	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Yeo SH (2015) Odonata Survey at Mandai*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Breeds in streams and rivers.	North and South of Mandai Lake Road; Zones D and F	-	This is a common species over much of its large range.
21	Libellulidae	-	*Trithemis aurora*	Dawn Dropwing	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	The species uses diverse wetland habitats such as ponds, lakes, marshes, wet paddy fields, streams, rivers, and irrigation canals	South of Mandai Lake Road; Zones A, B, D, E and F	-	This species is very common throughout its range.
22	Libellulidae	-	*Rhyothemis phyllis*	Yellow-striped Flutterer	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	In Malaysia, the species is commonly found at open pond/ marsh and from swamp forest.	North and South of Mandai Lake Road; Zones B, D, E, F, and H	-	No information available.

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence[#]	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
23	Libellulidae	-	*Pseudothemis jorina*	Asian Pied Dragonfly; Banded Skimmer	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	SD + IC	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CR	-	It occurs in lentic bodies and slow flowing rivers.	North and South of Mandai Lake Road; Zones A, B, D, E, F and H	-	This is a locally common species over much of its range, becoming scarcer in Borneo.
24	Libellulidae	-	*Pantala flavescens*	Globe Skimmer	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	Asia + Africa + Oceania	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	It used commonly temporary pools and ponds watered by monsoon rainfalls but may occasionally breed in permanent water.	North and South of Mandai Lake Road; Zones B, D, E and F	-	The species is common in very huge numbers throughout its tropical range.
25	Libellulidae	-	*Orthetrum testaceum*	Red-nosed Skimmer	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	It occurs in a wide variety of standing water and stream habitats, including mildly organically polluted streams.	North and South of Mandai Lake Road; Zones B, D, E, F and H	-	Over much of its range it is very common.
26	Libellulidae	-	*Orthetrum luzonicum*	Marsh Skimmer; Slender Blue Skimmer	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Yeo SH (2015) Odonata Survey at Mandai*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	This species breeds in habitats such as marshes, boggy areas and wet abandoned rice fields.	North and South of Mandai Lake Road; Zone D	-	This is a common species across much of its range.
27	Libellulidae	-	*Neurothemis fluctuans*	Common Parasol	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	IM	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	This species is found at ponds, marshes, swamps and other stagnant waters.	North and South of Mandai Lake Road; Zones A, B, D, E, F and H	-	This is a common species over much of its range.
28	Libellulidae	-	*Brachydiplax chalybea*	Powder Blue Dwarf/ Blue Dasher	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	IM + EA	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	This species is found in marshes and weedy ponds, may be able to tolerate brackish water, and is tolerant of disturbance.	South of Mandai Lake Road; Zones D, E, F and H	-	This is a very common species across most of its range.
29	Protoneurida	-	*Prodasineura humeralis*	Orange-striped Threadtail	*Subaraj, R (2014) Vertebrate & Odonate Report (Mandai)* *Yeo SH (2015) Odonata Survey at Mandai*	O	Widespread in tropica Asia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Associated with shaded forest streams with fast flowing water.	Zones A, D, E and F	Recorded elsewhere near Chestnut Drive and in Mandai Forest.	-
30	Libellulidae	-	*Lathrecista asiatica*	Australian Slimwing	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	EA + BO + TM + IM	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	This species breeds in ponds, marshes, swamp forest and shallow forest pools. It has been found in Kalimantan on small pools in oil palm plantations where agrochemicals are heavily used, so it is tolerant of disturbance and pollution	North of Mandai Lake Road	CCNR, BTNR, Tanah Merah reclaimed land, Marina South, Jurong Lake, Lorong Halus and Mandai mangroves	Widespread species without any known major widespread threats
31	-	-	*Tramea* sp.		*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
32	Libellulidae	-	*Orthetrum chrysis*	Black-backed Skimmer	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Yeo SH (2015) Odonata Survey at Mandai*	O	BO + IC + TM + SD	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Common in ponds and along streams with trees nearby, including disturbed areas	North and South of Mandai Lake Road; Zones A, B, D, E, F and H	CCNR, and in ordinary parks with a suitable habitat,	-
33	Calopterygidae	-	*Vestalis amethystina*	Common Flashwing	*Yeo SH (2015) Odonata Survey at Mandai*	O	SD + TM	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Breeds in small lowland forest streams	Zone D	Frequently encountered along the trails in the CCNR and BTNR, and in the vicinity of clear forest streams.	Appears to be locally common in Peninsular Malaysia and Singapore, becoming less common in Southern Thailand.
34	Coenagrionidae	-	*Pseudagrion pruinosum*	Grey Sprite	*Yeo SH (2015) Odonata Survey at Mandai*	O	IC + SD	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CR	-	Lives near open clean and slow water streams, is tolerant of mild organic stream pollutants; in Singapore, encountered on grassy banks of streams with fast flowing water	Zones D and H	Found only in Mandai, Tuas and Nee Soon Swamp Forest	-
35	Platycnemididae	-	*Coeliccia octogesima*	Telephone Sylvan	*Yeo SH (2015) Odonata Survey at Mandai*	O	SD	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Found on low vegetation along shady and sluggish, often muddy forest streams.	Zone A	Confined to the CCNR	-
36	Gomphidae	-	*Macrogomphus quadratus*	Forktail	*Yeo SH (2015) Odonata Survey at Mandai*	O	SD	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Frequents sluggish forest streams in the CCNR and BTNR	Zone H	CCNR and BTNR	-
37	Libellulidae	-	*Aethriamanta gracilis*	Pond Adjutant	*Yeo SH (2015) Odonata Survey at Mandai*	O	SD, Thailand, Sulu Islands and the Moluccas	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Not a forest species; occurs around open grassy water bodies and some reservoir inlets	Zone H	Common and widespread in areas outside the nature reserves in Singapore	-
38	Libellulidae	-	*Acisoma panorpoides*	Trumpet Tail	*Yeo SH (2015) Odonata Survey at Mandai*	O	Tropical Asia and Africa	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Disturbed habitats and grassy swamps throughout open country in Singapore. Open areas and freshwater ponds.	Zone D	Open areas in the CCNR and BTNR, and freshwater ponds in SBWR	-
39	Macromiidae	-	*Epophthalmia vittigera*	Pond Cruiser	*Yeo SH (2015) Odonata Survey at Mandai*	O	SD + PH + IM	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Ponds and wet rice fields, to lakes and reservoirs and to open sections of slow flowing rivers. It is disturbance tolerant. In Singapore, open lakes and marshes	Zone G	Swamp forests in the CCNR and BTNR	-
40	Libellulidae	-	*Crocothemis servilia*	Common Scarlet or Scarlet Skimmer	*Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	Ranges from Middle East throughout tropical and subtropical Asia to New guinea in the east Accidentally introduced into Hawaii and Florida.	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	In Singapore, disturbed open habitats and grassy water bodies with still water. Sun-loving species.	Zones D and F	Widespread in Singapore	-
41	Libellulidae	-	*Diplacodes trivialis*	Chalky Percher	*Yeo SH (2015) Odonata Survey at Mandai*	O	From India to China and Japan and southwards to New Guinea and Australia	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	In Singapore, common in many open marshes in disturbed areas and sometimes found far away from water sources.	Zone G	Widespread in Singapore	-
42	Libellulidae	-	*Hydrobasileus croceus*	Water Monarch	*Yeo SH (2015) Odonata Survey at Mandai*	O	SD + TM + IC	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	In Singapore, well-vegetated ponds in open country and open areas in the forested reservoirs.	Zones G and H	Marina East, Tuas, East Coast Parkway, Mandai and mature gardens such as Bishan Park.	-
43	Libellulidae	-	*Macrodiplax cora*	Coastal Glider	*Yeo SH (2015) Odonata Survey at Mandai*	O	Huge range in tropical and subtropical Africa and Asia, Australia and the Pacific Islands	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Reclaimed land, reservoirs and coastal areas. Species is migratory and sometimes flies high over forest canopy but never descends into the understorey.	Zones D and F	Poyan Reservoir, Tuas, Sembawang and Pulau Semakau.	Stable
44	Libellulidae	-	*Nannophya pygmaea*	Scarlet Pygmy	*Yeo SH (2015) Odonata Survey at Mandai*	O	Widespread, but local, in tropical and subtropical Asia from Nepal and North-east India in the west of Japan and New Guinea in the east.	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Open grassy swamps and inlets of reservoirs; standing waters	Zone H	CCNR, reclaimed sites in Tuas and Marina East	Stable
45	Libellulidae	-	*Potamarcha congener*	Common Chaser	*Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	Widespread, occurring from India to China and Taiwan and south to Australia and New Guinea.	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Open ponds and disturbed habitats in standing and slowly flowing water	Zone F	Widespread in Singapore	
46	Libellulidae	-	*Rhodothemis rufa*	Common Redbolt	*Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	Widespread in tropical Asia, ranging from the western India and Sri Lanka to the Solomon Islands in the east.	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Well-vegetated ditches, ponds and other grassy water bodies, including reservoirs; not a forest species	Zones A, F and H	CCNR and BTNR	
47	Libellulidae	-	*Rhyothemis obsolence*	Bronze Flutterer	*Yeo SH (2015) Odonata Survey at Mandai* *WRS Data*	O	-	Not yet assessed	Not yet assessed	-	CR	-		Zones E, F and H		

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence[#]	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
48	Libellulidae	-	*Rhyothemis triangularis*	Sapphire Flutterer	*Yeo SH (2015) Odonata Survey at Mandai*	O	IC + SD	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Breeds in well vegetated ponds and similar habitats (e.g. drains). It is tolerant of disturbance.	Zone B	Ang Mo Kio Town Garden West, Bishan Park, MacRitchie Reservoir, at the forest edge of BTNR, Marina East and Marina South	
49	Coenagrionidae.	-	*Agriocnemis femina*	-	*WRS Data*	O	EA + AS + India	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2007	Not listed	-	This species breeds in a variety of shallow weedy habitats, from marshes and the margins of lakes to water filled wheel ruts. It has been reported in polluted drains and ditches inside cities, and it is possibly more common in the lowlands but it has been recorded from above 1,000 m in Borneo.	Zone F	Old Upper Thomson Rd, Jurong, Lower Pierce Reservoir forest, MacRitchie Reservoir, Nee Soon.	*Agriocnemis femina* is very widely distributed, from India to China, Japan, Australia and islands in the Pacific Ocean.
Spiders																
1	Araneidae	-	*Acusilas coccineus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	EA + Indonesia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
2	Araneidae	-	*Arachnura sp. BB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
3	Araneidae	-	*Araneus sp. MB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
4	Araneidae	-	*Argiope aemula*	-	*Joseph K H Koh et.al (2014) Mandai Spiders* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
5	Araneidae	-	*Argiope sp. NM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
6	Araneidae	-	*Argiope versicolor*	-	*Joseph K H Koh et.al (2014) Mandai Spiders* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	BO + IC	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
7	Araneidae	-	*Caerostris sp. MG*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
8	Araneidae	-	*Cyclosa bifida*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road/ South of Mandai Lake Road	-	-
9	Araneidae	-	*Cyphalonotus sp. MF*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
10	Araneidae	-	*Cyrtophora unicolor*	-	*Joseph K H Koh et.al (2014) Mandai Spiders* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	SD	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
11	Araneidae	-	*Eriovixia excelsa*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Indonesia + PH	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-		Found only in Mandai, previously not collected elsewhere in Singapore	-
12	Araneidae	-	*Eriovixia laglaizei*	-	*Joseph K H Koh et.al (2014) Mandai Spiders* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	SD + PH + Myanmar	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road/ South of Mandai Lake Road	-	-
13	Araneidae	-	*Eriovixia pseudocentrodes*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM + EA	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
14	Araneidae	-	*Gasteracantha hasselti*	-	*Joseph K H Koh et.al (2014) Mandai Spiders* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
15	Araneidae	-	*Gasteracantha kuhli*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road/ South of Mandai Lake Road	-	-
16	Araneidae	-	*Gasteracantha sp. SM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
17	Araneidae	-	*Gea spinipes*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	TM + SD	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road/ South of Mandai Lake Road	-	-
18	Araneidae	-	*Liprocea fusiformis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
19	Araneidae	-	*Neoscona bengalensis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Indonesia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
20	Araneidae	-	*Neoscona punctigera*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
21	Araneidae	-	*Neoscona vigilans*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
22	Araneidae	-	*Parawixia dehaani*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road/ South of Mandai Lake Road	-	-
23	Araneidae	-	*Poltys illepidus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
24	Araneidae	-	*Singa perpolita*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
25	Araneidae	-	*Unidentified sp. AM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
26	Clubionidae	-	*Cheiracanthium sp. 4F*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
27	Clubionidae	-	*Cheiracanthium sp. WE*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
28	Clubionidae	-	*Clubiona sp. JB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
29	Clubionidae	-	*Nusatisdia sp. JB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
30	Corinnidae	-	*Corinnomma severum*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	PH + BO + TM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North and South of Mandai Lake Road	-	-
31	Corinnidae	-	*Corinnomma thorelli*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
32	Corinnidae	-	*Oedignatha scrobiculata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
33	Corinnidae	-	*Serendib muadai*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
34	Ctenidae	-	*Ctenus sp. BR*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
35	Ctenidae	-	*Ctenus sp. SH*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
36	Ctenidae	-	*Unidentified Ctenus sp.*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
37	Hersiliidae	-	*Hersilia savignyi*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM + EA	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
38	Hersiliidae	-	*Hersilia deelemanae*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + Indonesia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
39	Linyphiidae	-	*Nasoona chrysanthusi*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
40	Linyphiidae	-	*Nasoona prominula*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	TM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
41	Linyphiidae	-	*Paramaioneta spicata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	TM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
42	Linyphiidae	-	*Unidentified sp. DB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
43	Linyphiidae	-	*Unidentified sp. 8B*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence[#]	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
44	Liocranidae	-	*Sphingius vivax*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IC + PH	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
45	Liocranidae	-	*Sphingius sp. AV*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
46	Lycosidae	-	*Hippasa holmerae*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM + EA	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
47	Lycosidae	-	*Pardosa pusiola*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	SD + Myanmar	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
48	Lycosidae	-	*Pardosa sumatrana*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
49	Lycosidae	-	*Pardosa sp. AS*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
50	Lycosidae	-	*Venonia coruscans*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
51	Mysmenidae	-	*Unidentified sp. PO*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
52	Nephiliidae	-	*Herennia multipuncta*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM + Oceania	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
53	Nephiliidae	-	*Nephila pilipes*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
54	Nesticidae	-	*Unidentified sp. LE*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
55	Ochyroceratidae	-	*Unidentified sp. SA*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
56	Oonopidae	-	*"Opopaea" sp. 4S*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
57	Oonopidae	-	*"Opopaea" sp. BB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
58	Oonopidae	-	*"Opopaea" sp. LR*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
59	Oonopidae	-	*"Opopaea" sp. PO*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
60	Oonopidae	-	*Ischnothyreus sp. BS*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road/ South of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
61	Oonopidae	-	*Ischnothyreus sp. WR*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road/ South of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
62	Oonopidae	-	*Ischnothyreus sp. LM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
63	Oxyopidae	-	*Hamataliwa incompta*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	PH + BO	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
64	Oxyopidae	-	*Hamataliwa sp. AB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
65	Oxyopidae	-	*Oxyopes auratus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
66	Oxyopidae	-	*Oxyopes javanus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
67	Oxyopidae	-	*Oxyopes lineatipes*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
68	Oxyopidae	-	*Oxyopes sp. IM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
69	Pholcidae	-	*Pholcus gracillimus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Indonesia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
70	Pholcidae	-	*Spermophora sp. CK*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road/ South of Mandai Lake Road	-	-
71	Pholcidae	-	*Unidentified Spermophora sp.*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
72	Pisauridae	-	*Hygropoda sp. 2D*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
73	Pisauridae	-	*Polybetes vulpina*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	TM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
74	Psechridae	-	*Fecenia protensa*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
75	Psechridae	-	*Psechrus singaporensis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
76	Salticidae	-	*Cosmophasis thalassina*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + Indonesia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
77	Salticidae	-	*Epeus sumatranus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Indonesia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
78	Salticidae	-	*Epeus tener*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
79	Salticidae	-	*Euryattus sp. MM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
80	Salticidae	-	*Euryattus sp. SR*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
81	Salticidae	-	*Myrmarachne cornuta*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + Myanmar	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
82	Salticidae	-	*Myrmarachne maxillosa*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM + EA	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road/ South of Mandai Lake Road	-	-
83	Salticidae	-	*Myrmarachne melanocephala*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
84	Salticidae	-	*Myrmarachne wanlessi*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
85	Salticidae	-	*Myrmarachne sp. LL*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
86	Salticidae	-	*Nannenus syrphus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
87	Salticidae	-	*Pancorius denticheles*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
88	Salticidae	-	*Phaeacius malayensis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
89	Salticidae	-	*Phintella bifurcilinea*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM + EA	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
90	Salticidae	-	*Phintella debilis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
91	Salticidae	-	*Phintella vittata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
92	Salticidae	-	*Portia labiata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
93	Salticidae	-	*Pseudamycus sp. CP*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
94	Salticidae	-	*Ptocasius weyersi*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Mandai	-	-

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence[a]	Current endemicity listing[a]	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
95	Salticidae	-	*Siler semiglaucus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
96	Salticidae	-	*Telamonia dimidiata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + Indonesia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
97	Salticidae	-	*Telamonia festiva*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + Myanmar	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
98	Salticidae	-	*Thiania bhamoensis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + Myanmar	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
99	Salticidae	-	*Thorelliola ensifera*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Indonesia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
100	Salticidae	-	*Viciria praemandibularis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
101	Salticidae	-	*Unidentified sp. BB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
102	Salticidae	-	*Unidentified sp. BF*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
103	Salticidae	-	*Unidentified sp. RS*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
104	Salticidae	-	*Unidentified sp. TC*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
105	Salticidae	-	*Unidentified sp. LP*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
106	Salticidae	-	*Unidentified sp. TB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
107	Scytodidae	-	*Unidentified sp. LL*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
108	Sparassidae	-	*Heteropoda tetrica*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
109	Sparassidae	-	*Heteropoda venatoria*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	South America	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road/ South of Mandai Lake Road	-	-
110	Sparassidae	-	*Pandercetes sp. CM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
111	Sparassidae	-	*Pandercetes cf. macilentis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
112	Sparassidae	-	*Thelcticopis sp. FM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
113	Sparassidae	-	*Unidentified sp. PLI*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
114	Telemidae	-	*Telema fabata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Singapore	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
115	Tetrablemmide	-	*Brignoliella michaeli*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Myanmar	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
116	Tetragnathidae	-	*Leucauge argentina*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	SD + TM + PH	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road/ South of Mandai Lake Road	-	-
117	Tetragnathidae	-	*Leucauge decorata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	IC + BO	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
118	Tetragnathidae	-	*Mesida sp. JB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road/ South of Mandai Lake Road	-	-
119	Tetragnathidae	-	*Opadometa fastigata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	PH	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
120	Tetragnathidae	-	*Tetragnatha chauliodus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
121	Tetragnathidae	-	*Tetragnatha hasselti*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + Mynamar	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
122	Tetragnathidae	-	*Tetragnatha mandibulata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
123	Tetragnathidae	-	*Tetragnatha sp. CM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
124	Tetragnathidae	-	*Tetragnatha sp. AM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
125	Tetragnathidae	-	*Tetragnatha sp. AZ*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
126	Tetragnathidae	-	*Tetragnatha sp. SJ*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
127	Tetragnathidae	-	*Tylorida striata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	BO + IC	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
128	Tetragnathidae	-	*Tylorida ventralis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	IM + Oceania	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road/ South of Mandai Lake Road	-	-
129	Theridiidae	-	*Argyrodes fissifrons*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
130	Theridiidae	-	*Argyrodes flavescens*	-	*Joseph K H Koh et.al (2014) Mandai Spiders* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Mandai	-	-
131	Theridiidae	-	*Argyrodes sp. ST*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere	-
132	Theridiidae	-	*Ariamnes flagellum*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Indonesia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
133	Theridiidae	-	*Chrysso sp. TT*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
134	Theridiidae	-	*Coleosoma blandum*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
135	Theridiidae	-	*Episinus sp. JB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
136	Theridiidae	-	*Janula triangularis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
137	Theridiidae	-	*Janula sp. CP*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
138	Theridiidae	-	*Janula sp. MS*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
139	Theridiidae	-	*Janula sp. YF*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
140	Theridiidae	-	*Parasteatoda mundula*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM + EA + Oceania	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
141	Theridiidae	-	*Parasteatoda sp. 4S*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence[#]	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
142	Theridiidae	-	*Parastaotoda sp. BU*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
143	Theridiidae	-	*Rhomphaea labiata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	EA	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
144	Theridiidae	-	*Rhomphaea tanikawai*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	EA	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
145	Theridiidae	-	*Theridion t-notatum*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Myanmar	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
146	Theridiidae	-	*Theridion sp. AZ*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
147	Theridiidae	-	*Theridula gonygaster*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	Europe + SEA	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
148	Theridiidae	-	*Thwaitesia sp. MA*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
149	Theridiidae	-	*Unidentified sp. SS*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
150	Theridiidae	-	*Unidentified sp. B2*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
151	Theridiidae	-	*Unidentified sp. BK*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
152	Theridiidae	-	*Unidentified sp. GP*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
153	Theridiidae	-	*Unidentified sp. PR*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
154	Theridiidae	-	*Unidentified sp. T8*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
155	Theridiidae	-	*Unidentified sp. VP*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere in Singapore	-
156	Theridiosomatidae	-	*Theridiosoma fasciatum*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	SD	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
157	Thomisidae	-	*Angaeus rhombifer*	-	*Joseph K H Koh et.al (2014) Mandai Spiders* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
158	Thomisidae	-	*Camaricus maugei*	-	*Joseph K H Koh et.al (2014) Mandai Spiders* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	IM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
159	Thomisidae	-	*Monaeses aciculatus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	PH + EA	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
160	Thomisidae	-	*Pharta bimaculata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	TM + BO	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
161	Thomisidae	-	*Runcinia affinis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	IM + EA	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
162	Thomisidae	-	*Thomisus guangxicus*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	BO + China	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
163	Thomisidae	-	*Tmarus sp. SC*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
164	Thomisidae	-	*Unidentified sp. SB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
165	Uloboridae	-	*Miagrammopes sp. SB*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	Found only in Mandai, previously not collected elsewhere	-
166	Zodariidae	-	*Asceua sp. CG*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
167	Zodariidae	-	*Asceua sp. AM*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road/ South of Mandai Lake Road	-	-
168	Zodariidae	-	*Asceua sp. CE*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road/ South of Mandai Lake Road	-	-
169	Zodariidae	-	*Mallinella annulipes*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	SD + Myanmar	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road	-	-
170	Corinnidae	-	*Corinnomma serverum*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
171	Tetragnathidae	-	*Tylorida ventralis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North and South of Mandai Lake Road	-	-
172	Nephilidae	-	*Herennia multipunctata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
173	Salticidae	-	*Thiania bhamoensis*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road, previously not recorded elsewhere in Singapore	-	-
174	Thomisidae	-	*Pharta bimaculata*	-	*Joseph K H Koh et.al (2014) Mandai Spiders*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road, previously not recorded elsewhere in Singapore	-	-
Butterflies																
1	Hesperiidae	Coeliadinae	*Burara harisa consobrina*	Orange Awlet	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
2	Hesperiidae	Coeliadinae	*Hasora badra badra*	Common Awl	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone E	-	-
3	Hesperiidae	Coeliadinae	*Hasora vitta vitta*	Plain Banded Awl	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone E	-	-
4	Hesperiidae	Coeliadinae	*Badamia exclamationis*	Brown Awl	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
5	Hesperiidae	Pyrginae	*Odina hieroglyphica ortina*	Hieroglyphic Flat	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
6	Hesperiidae	Pyrginae	*Tagiades japetus atticus*	Common Snow Flat	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
7	Hesperiidae	Pyrginae	*Tagiades gana gana*	Large Snow Flat	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F	-	-
8	Hesperiidae	Pyrginae	*Tagiades ultra*	Ultra Snow Flat	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
9	Hesperiidae	Pyrginae	*Tagiades calligana*	Malayan Snow Flat	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
10	Hesperiidae	Pyrginae	*Odontoptilum angulatum angulatum*	Chestnut Angle	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
11	Hesperiidae	Hesperiinae	*Ampittia dioscorides camertes*	Bush Hopper	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
12	Hesperiidae	Hesperiinae	*Halpe ormenes vilasina*	Dark Banded Ace	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
13	Hesperiidae	Hesperiinae	*Iambrix salsala salsala*	Chestnut Bob	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, D, E and F	-	-

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence[a]	Current endemicity listing[a]	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
14	Hesperiidae	Hesperiinae	*Ancistroides nigrita maura*	Chocolate Demon	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D, E and F	-	-
15	Hesperiidae	Hesperiinae	*Udaspes folus*	Grass Demon	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D and F	-	-
16	Hesperiidae	Hesperiinae	*Plastingia naga*	Chequered Lancer	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
17	Hesperiidae	Hesperiinae	*Plastingia pellonia*	Yellow Chequered Lancer	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone A	-	-
18	Hesperiidae	Hesperiinae	*Pemara pugnans*	Pugnacious Lancer	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone E	-	-
19	Hesperiidae	Hesperiinae	*Pyroneura latoia latoia*	Yellow Vein Lancer	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
20	Hesperiidae	Hesperiinae	*Gangara lebadea lebadea*	Banded Redeye	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	NE	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
21	Hesperiidae	Hesperiinae	*Matapa aria*	Common Redeye	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
22	Hesperiidae	Hesperiinae	*Erionota torus*	-	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
23	Hesperiidae	Hesperiinae	*Erionota thrax thrax*	Banana Skipper	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone E	-	-
24	Hesperiidae	Hesperiinae	*Hidari irava*	Coconut Skipper	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *WRS Data*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F	-	-
25	Hesperiidae	Hesperiinae	*Eetion elia*	White Spotted Palmer	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone B	-	-
26	Hesperiidae	Hesperiinae	*Taractrocera archias quinta*	Yellow Grass Dart	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
27	Hesperiidae	Hesperiinae	*Oriens gola pseudolus*	Common Dartlet	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
28	Hesperiidae	Hesperiinae	*Potanthus omaha omaha*	Lesser Dart	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, D, E and F	-	-
29	Hesperiidae	Hesperiinae	*Telicota besta bina*	Besta Palm Dart	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
30	Hesperiidae	Hesperiinae	*Telicota augias augias*	Palm Dart	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
31	Hesperiidae	Hesperiinae	*Pelopidas mathias mathias*	Small Branded Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone D	-	-
32	Hesperiidae	Hesperiinae	*Borbo cinnara*	Formosan Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D and E	-	-
33	Hesperiidae	Hesperiinae	*Pelopidas assamensis*	Great Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
34	Hesperiidae	Hesperiinae	*Pelopidas conjunctus conjunctus*	Conjoined Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
35	Hesperiidae	Hesperiinae	*Polytremis lubricans lubricans*	Contiguous Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone B	-	-
36	Hesperiidae	Hesperiinae	*Baoris oceia*	Paintbrush Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
37	Hesperiidae	Hesperiinae	*Caltoris cormasa*	Full Stop Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone B	-	-
38	Hesperiidae	Hesperiinae	*Caltoris philippina philippina*	Philippine Swift	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
39	Lycaenidae	Poritiinae	*Poritia sumatrae sumatrae*	Sumatran Gem	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
40	Lycaenidae	Miletinae	*Miletus biggsii biggsii*	Bigg's Brownwing	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone B	-	-
41	Lycaenidae	Miletinae	*Miletus symethus petronius*	Blue Brownwing	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
42	Lycaenidae	Miletinae	*Allotinus unicolor unicolor*	Lesser Darkwing	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
43	Lycaenidae	Miletinae	*Logania marmorata damis*	Pale Mottle	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone D	-	-
44	Lycaenidae	Curetinae	*Curetis santana malayica*	Malayan Sunbeam	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone E	-	-
45	Lycaenidae	Lycaeninae	*Caleta elna elvira*	Elbowed Pierrot	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
46	Lycaenidae	Lycaeninae	*Zizina otis lampa*	Lesser Grass Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D, E and F	-	-
47	Lycaenidae	Lycaeninae	*Zizula hylax pygmaea*	Pygmy Grass Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone D	-	-
48	Lycaenidae	Lycaeninae	*Chilades pandava pandava*	Cycad Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *NParks (2009) Rapid Biodiversity Assessment of Lorong Asrama* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama; Zone E	-	-
49	Lycaenidae	Lycaeninae	*Euchrysops cnejus cnejus*	Gram Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D and F	-	-
50	Lycaenidae	Lycaeninae	*Catochrysops panormus exiguus*	Silver Forget-Me-Not	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence[#]	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
51	Lycaenidae	Lycaeninae	*Lampides boeticus*	Pea Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *NParks (2009) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama	-	-
52	Lycaenidae	Lycaeninae	*Jamides alecto ageladas*	Metallic Caerulean	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	NE	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
53	Lycaenidae	Lycaeninae	*Jamides celeno aelianus*	Common Caerulean	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D, E and F	-	-
54	Lycaenidae	Lycaeninae	*Nacaduba berenice icena*	Rounded 6-Line Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
55	Lycaenidae	Lycaeninae	*Nacaduba calauria malayica*	Dark Malayan Sixline Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
56	Lycaenidae	Lycaeninae	*Ionolyce helicon merguiana*	Pointed Line Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
57	Lycaenidae	Lycaeninae	*Prosotas nora superdates*	Common Line Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
58	Lycaenidae	Lycaeninae	*Prosotas dubiosa lumpura*	Tailless Line Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F	-	-
59	Lycaenidae	Lycaeninae	*Anthene emolus goberus*	Ciliate Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
60	Lycaenidae	Lycaeninae	*Anthene lycaenina miya*	Pointed Ciliate Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
61	Lycaenidae	Lycaeninae	*Arhopala amphimuta amphimuta*		*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
62	Lycaenidae	Lycaeninae	*Arhopala major major*		*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
63	Lycaenidae	Lycaeninae	*Arhopala athada athada*	Vinous Oakblue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
64	Lycaenidae	Lycaeninae	*Arhopala abseus abseus*	Aberrant Oakblue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
65	Lycaenidae	Lycaeninae	*Flos diardi capeta*	Bifid Plushblue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
66	Lycaenidae	Lycaeninae	*Flos fulgida singhapura*	Shining Plushblue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
67	Lycaenidae	Lycaeninae	*Flos anniella anniella*	Darky Plushblue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
68	Lycaenidae	Lycaeninae	*Flos apidanus saturatus*	Plain PlushBlue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone B	-	-
69	Lycaenidae	Lycaeninae	*Semanga superba deliciosa*		*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
70	Lycaenidae	Lycaeninae	*Surendra vivarna amisena*	Acacia Blue	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
71	Lycaenidae	Lycaeninae	*Iraota rochana bosvelliana*	Scarce Silverstreak	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F	-	-
72	Lycaenidae	Lycaeninae	*Eooxylides tharis distanti*	Branded Imperial	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A, E, F and H	-	-
73	Lycaenidae	Lycaeninae	*Jacoona anasuja anasuja*	Great Imperial	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone E	-	-
74	Lycaenidae	Lycaeninae	*Deudorix epijarbas cinnabarus*	Cornelian	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
75	Lycaenidae	Lycaeninae	*Rapala domitia domitia*	Yellow Flash	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
76	Lycaenidae	Lycaeninae	*Rapala suffusa barthema*	Suffused Flash	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
77	Lycaenidae	Lycaeninae	*Rapala varuna orseis*	Indigo Flash	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
78	Nymphalidae	Danainae	*Parantica agleoides agleoides*	Dark Glassy Tiger	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F	-	-
79	Nymphalidae	Danainae	*Ideopsis vulgaris macrina*	Blue Glassy Tiger	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *NParks (2009) Rapid Biodiversity Assessment of Lorong Asrama* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area* *WRS Data*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama; Zones D, E and F	-	-
80	Nymphalidae	Danainae	*Euploea mulciber mulciber*	Striped Blue Crow	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
81	Nymphalidae	Danainae	*Euploea radamanthus radamanthus*	Magpie Crow	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
82	Nymphalidae	Satyrinae	*Melanitis leda leda*	Common Evening Brown	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, D, E and F	-	-
83	Nymphalidae	Satyrinae	*Elymnias panthera panthera*	Tawny Palmfly	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B and F	-	-
84	Nymphalidae	Satyrinae	*Elymnias hypermnestra agina*	Common Palmfly	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *WRS Data*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F	-	-
85	Nymphalidae	Satyrinae	*Mycalesis fusca fusca*	Malayan Bush Brown	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
86	Nymphalidae	Satyrinae	*Mycalesis mineus macromalayana*	Dark Brand Bush Brown	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B and E	-	-
87	Nymphalidae	Satyrinae	*Mycalesis visala phamis*	Long Brand Bush Brown	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *NParks (2009) Rapid Biodiversity Assessment of Lorong Asrama* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama; Zone B	-	-
88	Nymphalidae	Satyrinae	*Orsotriaena medus cinerea*	Dark Grass Brown	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, D and E	-	-

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89	Nymphalidae	Satyrinae	*Ypthima fasciata torone*	Malayan Six Ring	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CR	-	-	-	SEA *Davidson et.al (2008) The Singapore Red Data Book*	-
90	Nymphalidae	Satyrinae	*Ypthima baldus newboldi*	Common Five Ring	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
91	Nymphalidae	Satyrinae	*Ypthima horsfieldii humei*	Malayan Five Ring	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
92	Nymphalidae	Morphinae	*Faunis canens arcesilas*	Common Faun	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, E, and F	-	-
93	Nymphalidae	Morphinae	*Amathusia phidippus phidippus*	Palm King	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D and F	-	-
94	Nymphalidae	Nymphalinae	*Ariadne ariadne ariadne*	Angled Castor	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	NE	-	-	-	-	-
95	Nymphalidae	Nymphalinae	*Hypolimnas anomala anomala*	Malayan Eggfly	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, D, F and H	-	-
96	Nymphalidae	Nymphalinae	*Hypolimnas bolina bolina*	Great Eggfly	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F	-	-
97	Nymphalidae	Nymphalinae	*Hypolimnas bolina jacintha*	Jacintha Eggfly	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F	-	-
98	Nymphalidae	Nymphalinae	*Doleschallia bisaltide bisaltide*	Autumn Leaf	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F	-	-
99	Nymphalidae	Nymphalinae	*Doleschallia bisaltide pratipa*	Autumn Leaf	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
100	Nymphalidae	Nymphalinae	*Junonia hedonia ida*	Chocolate Pansy	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, D, E and F	-	-
101	Nymphalidae	Nymphalinae	*Junonia atlites atlites*	Grey Pansy	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D and E	-	-
102	Nymphalidae	Nymphalinae	*Junonia almana javana*	Peacock Pansy	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D, E and F	-	-
103	Nymphalidae	Nymphalinae	*Junonia orithya wallacei*	Blue Pansy	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones E and F	-	-
104	Nymphalidae	Heliconiinae	*Cethosia hypsea hypsina*	Malay Lacewing	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
105	Nymphalidae	Heliconiinae	*Phalanta phalantha phalantha*	Leopard	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, D, E and F	-	-
106	Nymphalidae	Heliconiinae	*Cupha erymanthis lotis*	Rustic	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones E and F	-	-
107	Nymphalidae	Heliconiinae	*Vindula dejone erotella*	Cruiser	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones E and F	-	-
108	Nymphalidae	Limenitidinae	*Moduza procris milonia*	Commander	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F	-	-
109	Nymphalidae	Limenitidinae	*Lebadea martha parkeri*	Knight	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A, E and G	-	-
110	Nymphalidae	Limenitidinae	*Athyma pravara helma*	Lance Sergeant	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
111	Nymphalidae	Limenitidinae	*Athyma kanwa kanwa*	Dot-Dash Sergeant	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A and B	-	-
112	Nymphalidae	Limenitidinae	*Athyma nefte subrata*	Colour Sergeant	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *WRS Data*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F	-	-
113	Nymphalidae	Limenitidinae	*Pandita sinope sinope*	Colonel	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
114	Nymphalidae	Limenitidinae	*Neptis hylas papaja*	Common Sailor	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *NParks (2009) Rapid Biodiversity Assessment of Lorong Asrama* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama; Zones E and F	-	-
115	Nymphalidae	Limenitidinae	*Neptis leucoporos cresina*	Grey Sailor	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone E	-	-
116	Nymphalidae	Limenitidinae	*Neptis harita harita*	Chocolate Sailor	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	VU	-	-	-	SEA *Davidson et.al (2008) The Singapore Red Data Book*	-
117	Nymphalidae	Limenitidinae	*Phaedyma columella singa*	Short Banded Sailor	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
118	Nymphalidae	Limenitidinae	*Lasippa heliodore dorelia*	Burmese Lascar	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	-	-	-	-	-	-
119	Nymphalidae	Limenitidinae	*Lasippa tiga siaka*	Malayan Lascar	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
120	Nymphalidae	Limenitidinae	*Pantoporia hordonia hordonia*	Common Lascar	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones E and F	-	-
121	Nymphalidae	Limenitidinae	*Pantoporia paraka paraka*	Perak Lascar	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
122	Nymphalidae	Limenitidinae	*Tanaecia pelea pelea*	Malay Viscount	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A, B, E and F	-	-
123	Nymphalidae	Limenitidinae	*Tanaecia iapis puseda*	Horsfield's Baron	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, D, E and F	-	-

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence[a]	Current endemicity listing[a]	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
124	Nymphalidae	Limenitidinae	*Euthalia monina monina*	Malay Baron	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
125	Nymphalidae	Limenitidinae	*Lexias pardalis dirteana*	Archduke	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A, B, E and F	-	-
126	Nymphalidae	Apaturinae	*Eulaceura osteria kumana*	Purple Duke	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A, B, E and F	-	-
127	Nymphalidae	Apaturinae	*Euripus nyctelius euploeoides*	Courtesan	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CR	-	-	-	Northern India through SEA to the Phillipines *Davidson et.al (2008) The Singapore Red Data Book*	-
128	Nymphalidae	Charaxinae	*Polyura hebe plautus*	Plain Nawab	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
129	Papilionidae	Papilionidae	*Troides helena cerberus*	Common Birdwing	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Endangered Species (Import and Export) Act, 2008 Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	VU	Appendix II	-	North and South of Mandai Lake Road; Zone F	Northern India, Hong Kong, Thailand, Malaysia, Singapore, Indonesian islands *Davidson et.al (2008) The Singapore Red Data Book*	-
130	Papilionidae	Papilionidae	*Pachliopta aristolochiae asteris*	Common Rose	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	VU	-	-	-	Sri Lanka, India, Central China, Indo-China, Malaysia, Singapore, Phillipines *Davidson et.al (2008) The Singapore Red Data Book*	-
131	Papilionidae	Papilionidae	*Chilasa clytia clytia*	Common Mime	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B and E	-	-
132	Papilionidae	Papilionidae	*Papilio demoleus malayanus*	Lime Butterfly	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A, E and F	-	-
133	Papilionidae	Papilionidae	*Papilio demolion demolion*	Banded Swallowtail	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
134	Papilionidae	Papilionidae	*Papilio polytes romulus*	Common Mormon	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *NParks (2009) Rapid Biodiversity Assessment of Lorong Asrama* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama; North and South of Mandai Lake Road; Zones A, B, D, E, F, and H	-	-
135	Papilionidae	Papilionidae	*Papilio memnon agenor*	Great Mormon	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone B	-	-
136	Papilionidae	Papilionidae	*Graphium sarpedon luctatius*	Common Bluebottle	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *NParks (2009) Rapid Biodiversity Assessment of Lorong Asrama* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama; Zones B, E and G	-	-
137	Papilionidae	Papilionidae	*Graphium evemon eventus*	Blue Jay	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F	-	-
138	Papilionidae	Papilionidae	*Graphium agamemnon agamemnon*	Tailed Jay	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A and E	-	-
139	Papilionidae	Papilionidae	*Graphium antiphates itamputi*	Five Bar Swordtail	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
140	Pieridae	Pieridae	*Delias hyparete metarete*	Painted Jezebel	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *NParks (2009) Rapid Biodiversity Assessment of Lorong Asrama* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area* *WRS Data*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama; Zones A, B, D, E, F	-	-
141	Pieridae	Pieridae	*Leptosia nina malayana*	Psyche	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *NParks (2009) Rapid Biodiversity Assessment of Lorong Asrama* *Mandai Conceptual Masterplan Study Appendix C (2014)* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area* *WRS Data*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road; Lorong Asrama; Zones D, E and F	-	-
142	Pieridae	Pieridae	*Appias libythea olferna*	Striped Albatross	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D, E and F	-	-
143	Pieridae	Coliadinae	*Catopsilia pyranthe pyranthe*	Mottled Emigrant	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F	-	-
144	Pieridae	Coliadinae	*Catopsilia pomona pomona*	Lemon Emigrant	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *NParks (2009) Rapid Biodiversity Assessment of Lorong Asrama* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area* *WRS Data*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama; Zones A, B, D, E and F	-	-
145	Pieridae	Coliadinae	*Catopsilia scylla cornelia*	Orange Emigrant	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones E and F	-	-
146	Pieridae	Coliadinae	*Eurema hecabe contubernalis*	Common Grass Yellow	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *NParks (2009) Rapid Biodiversity Assessment of Lorong Asrama* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama; Zones E and G	-	-
147	Pieridae	Coliadinae	*Eurema simulatrix tecmessa*	Forest Grass Yellow	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-		-	-
148	Pieridae	Coliadinae	*Eurema blanda snelleni*	Three Spot Grass Yellow	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-		-	-
149	Pieridae	Coliadinae	*Eurema andersonii andersonii*	Anderson's Grass Yellow	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone B	-	-
150	Pieridae	Coliadinae	*Eurema sari sodalis*	Chocolate Grass Yellow	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, E, G, H	-	-

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151	Pieridae	Coliadinae	*Gandaca harina distanti*	Tree Yellow	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone E	-	-
152	Riodinidae	-	*Abisara savitri savitri*	Malay Tailed Judy	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F	-	-
153	Riodinidae	-	*Abisara saturata kausambicides*	Malayan Plum Judy	*Khew Sin Khoon (2014) Mandai Butterfly Diversity*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-		-	-
154	Riodinidae	-	*Laxita thuisto thuisto*	Lesser Harlequin	*Khew Sin Khoon (2014) Mandai Butterfly Diversity* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone E	-	-
155	Papilionidae	-	*Pachliopta aristolochiae*	Common Rose	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road; Zones E and F	-	-
156	Papilionidae	-	*Papilio demolion*	Banded Swallowtail	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
157	Papilionidae	-	*Troides helena*	Common Birdwing	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
158	Pieridae	-	*Catopsilia pomona*	Lemon Emigrant	*Mandai Conceptual Masterplan Study Appendix C (2014)* *NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North and South of Mandai Lake Road; Lorong Asrama	-	-
159	Nymphalidae	Danainae	*Euploea crameri*	Spotted Black Crow	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area* *WRS Data*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North of Mandai Lake Road; Zone F	-	-
160	-	-	*Euploea mulciber*	Striped Blue Crow	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
161	Nymphalidae	Satyrinae	*Elymnias hypermnestra*	Common Palmfly	*Mandai Conceptual Masterplan Study Appendix C (2014)* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North and South of Mandai Lake Road; Zones B, D, E and F	-	-
162	Nymphalidae	Satyrinae	*Elymnias panthera*	Tawny Palmfly	*NSS Report on STB* *Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Forest dependent species	North and South of Mandai Lake Road	-	-
163	Nymphalidae	-	*Melanitis leda*	Common Evening Brown	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
164	Nymphalidae	-	*Orsotriaena medus*	Nigger	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Grassland dependent species	North and South of Mandai Lake Road	-	-
165	Nymphalidae	Satyrinae	*Ypthima pandocus*	Common Three Ring	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
166	Nymphalidae	-	*Faunis canens*	Common Faun	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Forest dependent species	North and South of Mandai Lake Road	-	-
167	Nymphalidae	-	*Cupha erymanthis*	Rustic	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Forest dependent species	North of Mandai Lake Road	-	-
168	Nymphalidae	-	*Junonia almana*	Peacock Pansy	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	This species inhabits a wide variety of habitats including secondary rainforest, monsoon forest, plantations, rural areas and gardens	North and South of Mandai Lake Road	-	This is a common species
169	Nymphalidae	-	*Junonia hedonia*	Chocolate Pansy	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	North and South of Mandai Lake Road	-	-
170	-	-	*Lascar* sp.	-	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
171	-	-	*Sailor* sp.	-	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
172	Nymphalidae	-	*Pandita sinope*	-	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
173	-	-	*Phalantha phalantha*	Leopard	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
174	-	-	*Euchrysops cnejus*	Gram Blue	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	South of Mandai Lake Road	-	-
175	Hesperiidae	-	*Udaspes folus*	Grass Demon	*Mandai Conceptual Masterplan Study Appendix C (2014)*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Grassland dependent species	South of Mandai Lake Road	-	-
176	-	-	*Zeuxida amethystus amethystus*	Saturn	*NSS Report on STB* *Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone B	-	-
177	-	-	-	Common Posy	*NSS Report on STB*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-		-	-
178	Papilionidae	Papilioninae	*Papilio iswara*	Great Helen	*NParks (2015) Rapid Biodiversity of Mandai East Camp*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Caterpillar host plant: *Maclurodendron porteri*; occurs in forested areas where host plant is abundant	Mandai East camp	Locally, occurrence of species is restricted to the CCNR where its host plant is common along MacRitchie Nature Trail and Nee Soon Pipeline.	-
179	Nymphalidae	Satyrinae	*Lethe europa*	Bamboo Tree Brown	*NParks (2015) Rapid Biodiversity of Mandai East Camp*	O	Thailand, India, Singapore (Known)	Not yet assessed	Not Assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Lowland forests where preferred host plant, bamboo, is cultivated. Likely that its caterpillars may also feed on several species of *Bambusa* and other related monocotyledons in SEA.	Mandai East camp	Locally, sightings have been recorded in very localised areas, at Khatib Bongsu, Sime Forest, Pulau Ubin and at the Singapore Botanic Gardens, always not far from where its host plant grows.	-
180	Nymphalidae	Danainae	*Idea stolli logani*	Common Tree Nymph	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not Assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Frequents treetops and flowering trees.	Zone F	-	-
181	Nymphalidae	Satyrinae	*Mycalese perseoides perseoides*	Perseoides Bush Brown	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	DD	-	Adult typically sighted flying low among vegetation in and around grassy patches. Two locally common grass species, *Ottochloa nodosa* and *Ischaemum ciliare* have been recorded as larval hosts.	Zones A and B	Found at multiple locations across Singapore.	-
182	Nymphalidae	Satyrinae	*Mycalesis perseus cepheus*	Dingy Bush Brown	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Caterpillars feed mainly on monocotyledons (eg grasses, padi and bamboos). Adults remain low in the undergrowth and several individuals can often be seen, fluttering in low shrubbery and feeding on organic material on the forest floor.	Zones B and D	Found at multiple locations across Singapore.	-
183	Nymphalidae	Heliconiinae	*Acraea violae*	Tawny Coster	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Migrant species that has established a firm foothold in Singapore. Found in wastelands and park lands where host plant *Passiflora foetida* grows in relative abundance. Other host plants include *Passiflora suberosa*, *Passiflora edulis* and *Tunera umlifolia*.	Zones D and F	In suitable wasteland and park habitats. Relatively common species in Singapore.	-
184	Nymphalidae	Heliconiinae	*Cethosia cyane*	Leopard Lacewing	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	From India, throughout SEA and south to PNG	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Host plants include *Passiflora foetida* and *Adenia macrophylla*. Migrant species recently discovered in Singapore in 2005. Can be found in many wastelands where host plant *Passiflora foetida* grows in relative abundance.	Zone F	Relatively common species in Singapore	-
185	Nymphalidae	Limenitidinae	*Euthalia aconthea garda*	Baron	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	TM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Host plant *Mangifera indica*. Feeds on ripened inflorescence (fermenting nectar source) of *Melastoma malabathricum*. Mainly found in urban areas, wastelands or abandoned farmlands.	Zone B	Relatively common urban butterfly	-
186	Riodinidae	Riodininae	*Abisara geza niya*	Spotted Judy	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	TM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Woodland and secondary vegetation; shaded forest fringes. Known host plant: *Embelia canescens*	Zone A	Relatively rare butterfly	-
187	Lycaenidae	Lycaeninae	*Acytolepis puspa lambi*	Common Hedge Blue	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Usually found flying along brightly lit sunlit footpahts along forest tracks; males are usually observed feeding on damp patches on the forest floor. Also found in forested areas of the nature reserves but occasional sightings made in urban parks and gardens. Known host plant: *Combretum sundaicum, Ventilago maingayi, Prunus polystachya, Rosa* hybrids.	Zone F	Nature reserves, urban parks and gardens	-
188	Lycaenidae	Lycaeninae	*Jamides caeruleus caeruleus*	Sky Blue	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	DD	-	Known host plants: *Saraca cauliflora*. Forests, urban gardens, and in theory urban parks, and roadsides where its host plant is planted. Eggs are laid on the Saraca flowers.	Zone A	Rarely encountered in Singapore, sightings made previously of lone specimens in the nature reserves, until the discovery of a small colony in an urban garden.	-
189	Lycaenidae	Lycaeninae	*Arhopala atosia malayana*	Tailed Disc Oakblue	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	TM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone A	Nature reserves	-

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence[#]	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
190	Lycaenidae	Lycaeninae	*Loxura atymnus fuconius*	Yamfly	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Host plant: young shoots of*Smilax bracteata* . Forests, abandoned farmland.	Zone F	Locally uncommon, but wide distribution and recorded from CCNR, BTNR, Southern ridges and abandoned farmland in the western part of Singapore.	-
191	Hesperiidae	Hesperiinae	*Notocrypta paralysos*	Banded Demon	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	Singapore, India	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, D and F	-	-
192	-	-	*Neopithercops zalmora zalmora*	Quaker	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone A	-	-
193	Hesperiidae	Hesperiinae	*Zographetus doxus*	Spotted Flitter	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	TM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone A	-	-
194	Lycaenidae	Lycaeninae	*Drupadia rufotaenia rufotaenia*	Pygmy Posy	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	CR	-	-	Zone A	-	-
195	Hesperiidae	Hesperiinae	*Suastus gremius*	Palm Bob	*Yeo SH (2015) Report on Butterflies Survey at Mandai Area*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Host plant: Cocos nucifera, Rhapis excelsa. Typically palm species.	Zone B	Potentially where its host plant can be found; both palm species are commonly cultivated in parks and gardens across Singapore	-
Orthoptera																
1	Acrididae	Acrididae	*Acrida willemsei*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
2	Acrididae	Acrididae	*Phlaeoba antennata*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones D and E	-	-
3	Acrididae	Acrididae	*Phlaeoba infumata*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
4	Acrididae	Catantopinae	*Acrida willemsei*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
5	Acrididae	Catantopinae	*Phlaeoba antennata*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
6	Acrididae	Catantopinae	*Phlaeoba infumata*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zone D	-	-
7	Acrididae	Catantopinae	*Acrida willemsei*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
8	Acrididae	Catantopinae	*Phlaeoba antennata*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
9	Acrididae	Cyrtacanthacridinae	*Valanga nigricornis*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones B and D	-	-
10	Acrididae	Oedipodinae	*Trilophidia annulata*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones B and D	-	-
11	Acrididae	Oxyinae	*Oxya japonica japonica*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones B, D, E and F	-	-
12	Acrididae	Oxyinae	*Pseudoxya diminuta*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A, D, E and F	-	-
13	Acrididae	Spathosterninae	*Spathosternum prasiniferum*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
14	Chorotypidae	Erianthinae	*Erianthus sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
15	Chorotypidae	Mnesicleinae	*Mnesicles sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
16	Pyrgomorphidae	Pyrgomorphinae	*Atractomorpha psittacina psittacina*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
17	Pyrgomorphidae	Pyrgomorphinae	*Tagasta marginella*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
18	Tetrigidae	Scelimeninae	*Criotettix cf. robustus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zone E	-	-
19	Tetrigidae	Tetriginae	*Coptotettix spp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
20	Tetrigidae	Tetriginae	*Euparatettix variabilis*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
21	Tetrigidae	Tetriginae	*Euparatettix sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
22	Tetrigidae	Tetriginae	*Phaesticus insularis*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zone A	-	-
23	Gryllidae	Eneopterinae	*Cardiodactylus singapura*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A, B and E	-	-
24	Gryllidae	Eneopterinae	*Nisitrus vittatus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A, D, E and F	-	-
25	Gryllidae	Euscyrtinae	*Beybienkoana trapeza*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
26	Gryllidae	Euscyrtinae	*Euscyrtus concinnus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A, B, D, E and F	-	-
27	Gryllidae	Euscyrtinae	*Euscyrtus cf. hemelytrus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
28	Gryllidae	Euscyrtinae	*Patiscus malayanus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones B and D	-	-

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence[#]	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
29	Gryllidae	Gryllinae	*Gymnogryllus sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
30	Gryllidae	Gryllinae	*Teleogryllus sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
31	Gryllidae	Gryllinae	*Velarifictorus aspersus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
32	Gryllidae	Landrevinae	*Duolandrevus (Eulandrevus) sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
33	Gryllidae	Landrevinae	*Duolandrevus (Surdolandrevus) sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A and B	-	-
34	Gryllidae	Landrevinae	*Landrevinae nymph*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
35	Gryllidae	Nemobiinae	*Pteronemobius sp. 1*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones B and E	-	-
36	Gryllidae	Nemobiinae	*Pteronemobius sp. 2*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
37	Gryllidae	Oecanthinae	*Oecanthus sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
38	Gryllidae	Podoscirtinae	*Aphonoides sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
39	Gryllidae	Podoscirtinae	*Sonotrella (Megatrella) typica*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
40	Gryllidae	Sclerogryllinae	*Sclerogryllus sp. 1*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zone D	-	-
41	Gryllidae	Sclerogryllinae	*Sclerogryllus sp. 2*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
42	Gryllidae	Trigonidiinae	*Amusurgus sp. 1*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A, D, E and F	-	-
43	Gryllidae	Trigonidiinae	*Amusurgus sp. 2*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
44	Gryllidae	Trigonidiinae	*Amusurgus sp. 3*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
45	Gryllidae	Trigonidiinae	*Amusurgus sp. 4*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
46	Gryllidae	Trigonidiinae	*Amusurgus sp. 5*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
47	Gryllidae	Trigonidiinae	*Anaxipha sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
48	Gryllidae	Trigonidiinae	*Homoeoxipha lycoides*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones B, D and E	-	-
49	Gryllidae	Trigonidiinae	*Metioche pallipes*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
50	Gryllidae	Trigonidiinae	*Natula longipennis*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones B and E	-	-
51	Gryllidae	Trigonidiinae	*Sesistella sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
52	Gryllidae	Trigonidiinae	*Trigonidiinae sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
53	Gryllotalpidae	Gryllotalpinae	*Gryllotalpa nymphicus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zone B	-	-
54	Mogoplistidae	Mogoplistinae	*Apternemobius sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
55	Mogoplistidae	Mogoplistinae	*Cycloptiloides cf. timah*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A and B	-	-
56	Mogoplistidae	Mogoplistinae	*Ectatoderus angusticollis*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A, B and E	-	-
57	Mogoplistidae	Mogoplistinae	*Micronebius sp. 1*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
58	Mogoplistidae	Mogoplistinae	*Micronebius sp. 2*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
59	Mogoplistidae	Mogoplistinae	*Ornebius albipalpus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zone A	-	-
60	Mogoplistidae	Mogoplistinae	*Ornebius cf. pallus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A, E and F	-	-
61	Mogoplistidae	Mogoplistinae	*Ornebius sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
62	Rhaphidophoridae	Rhaphidophorinae	*Rhaphidophora sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A, B and D	-	-
63	Gryllacrididae	Gryllacridinae	*Gryllacris sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence[#]	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
64	Tettigonidae	Conocephalinae	*Conocephalus longipennis*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones B, D and F	-	-
65	Tettigonidae	Conocephalinae	*Conocephalus maculatus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	Africa + Asia	LC	Least Concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones B, D, E, and F	-	-
66	Tettigonidae	Conocephalinae	*Conocephalus melaenus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	This species is ubiquitous and probably found in all habitats which possess lowland grass, including roadside verges and pastures.	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A, D, E and F	-	No information on population sizes or trends is available.
67	Tettigonidae	Conocephalinae	*Conocephalus sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
68	Tettigonidae	Conocephalinae	*Euconocephalus mucro*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
69	Tettigonidae	Conocephalinae	*Euconocephalus nasutus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zone B	-	-
70	Tettigonidae	Conocephalinae	*Euconocephalus pallidus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zone B	-	-
71	Tettigonidae	Conocephalinae	*Peracca macritchiensis*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zone A	-	-
72	Tettigonidae	Conocephalinae	*Xestophrys horvathi*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
73	Tettigonidae	Conocephalinae	*Nahlaksia bidadari*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
74	Tettigonidae	Conocephalinae	*Oxylakis sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
75	Tettigonidae	Hexacentrinae	*Hexacentrus unicolor*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones D and E	-	-
76	Tettigonidae	Lipotactinae	*Lipotactes maculatus*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A, B and E	-	-
77	Tettigonidae	Listroscelidinae	*Carliphisis sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
78	Tettigonidae	Meconematinae	*Alloteratura sp.*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A, B, D and E	-	-
79	Tettigonidae	Mecopodinae	*Mecopoda elongata*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A, D, E and F	-	-
80	Tettigonidae	Phaneropterinae	*Ducetia japonica*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zone D	-	-
81	Tettigonidae	Phaneropterinae	*Elimaea*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
82	Tettigonidae	Phaneropterinae	*Phaneroptera brevis*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones B and D	-	-
83	Tettigonidae	Pseudophyllinae	*Chondroderella borneensis*	-	*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones B, D and E	-	-
83	-	-	*Agraccini* sp 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F	-	-
83	Grylloidea	Baissogryllidae	*Aiolopus thalassinus tamulus* (Fabricius, 1798)		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone D	-	-
83	Tettigonioidea	Phaneropteridae	*Arnobia pilipes tropica* Gorochov, 1998		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, E and F	-	-
83	-	-	*Apalarcris varicornis* Walker 1870		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, D and E	-	-
83	Hagloidea	-	*Apterornebius* sp.1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A, B and E	-	-
83	Tettigonioidea	Haglotettigoniidae	*Aphonoides* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A, B, D, and E	-	-
83	Tettigonioidea	Haglotettigoniidae	*Aphonoides* sp. 2		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A, B, D, and E	-	-
83	Tettigonioidea	Tettigoniidae	*Asiophlugis temasek temasek* Gorochov & Tan, 2011		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A, B and E	Bukit Timah Nature Reserve, along Hindhede Drive, secondary forest	-
83	Tettigonioidea	Tettigoniidae	*Asiophlugis thaumasia* (Hebard, 1922)		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone E	-	-
83	Pyrgomorphoidea	Pyrgomorphidae	*Atractomorpha* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone E	-	-
83	Tettigonioidea	Tettigoniidae	*Conocephalus* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B and D	-	-
83	Tetrigoidea	Tetrigidae	*Coptotettix* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A, B, D and F	-	-
83	Gryllidae	Landrevinae	*Duolandrevus* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A and F	-	-

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence[a]	Current endemicity listing[a]	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
83	Tettigonioidea	Tettigoniidae	*Euconocephalus* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, D and F	-	-
83	Tettigonioidea	Tettigoniidae	*Euconocephalus picteti*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D and E	-	-
83	Tettigonioidea	Tettigoniidae	*Euconocephalus varius*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B and D	-	-
83	Tettigonioidea	Phaneropteridae	*Elimaea chloris*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, D and E	-	-
83	Tetrigoidea	Tetrigidae	*Euparatettix* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A, B and D	-	-
83	-	-	*Eurianthus* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D, E and F	-	-
83	Gryllacrididae	Gryllacridinae	*Gryllacris* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A and D	-	-
83	Gryllacrididae	Gryllacridinae	*Gryllacris (signifera group)* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A and D	-	-
83	Tettigonioidea	Haglotettigoniidae	*Gymnogryllus cf. angustus*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone A	-	-
83	Tettigonioidea	Haglotettigoniidae	*Gymnogryllus malayanus*			O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone A	-	-
83	Grylloidea	Baissogryllidae	*Gesomula mundata mundata*	Common Gesonula	*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B and D	-	-
83	Tettigonioidea	Tettigoniidae	*Holochlora* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone B	-	-
83	Tetrigoidea	Tetrigidae	*Hedotettix gracilis*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone D	-	-
83	Tettigonioidea	Tettigoniidae	*Jambiliara selita*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone A	-	-
83	Grylloidea	Baissogryllidae	*Lucretilis* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone A	-	-
83	Tettigonioidea	Haglotettigoniidae	*Loxoblemmus parabolicus*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone B	-	-
83	Tettigoniidae	Meconematinae	*Meconematini* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A and B	-	-
83	Tettigonioidea	Phaneropteridae	*Macedna martini*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone A	-	-
83	Grylloidea	Baissogryllidae	*Meltripata picta*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	A forest associated species; not found in grassy habitats	Zones B and D	-	-
83	Tettigoniidae	Phisidini:	*Oceaniphisis* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone A	-	-
83	Grylloidea	Baissogryllidae	*Oxya hyla intricata*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B and D	-	-
83	Grylloidea	Baissogryllidae	*Pareuthymia* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone A	-	-
83	Tettigonioidea	Haglotettigoniidae	*Sonotrella bipunctata*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D and E	-	-
83	Tettigonioidea	Haglotettigoniidae	*Sonotrella typica*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone E	-	-
83	Tettigonioidea	Haglotettigoniidae	*Singapuriola separata*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B and D	-	-
83	-	-	*Suvistella* sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A, B, D, E and F	-	-
83	-	-	*Suvistella* sp. 2		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone D	-	-
83	-	-	*Suvistella* sp. 3		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone A	-	-
83	Grylloidea	Gryllidae	*Teleogryllus* sp.1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone D	-	-
83	Tettigonioidea	Haglotettigoniidae	*Tremellia timah timah*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B, D and E	-	-
83	Grylloidea	Baissogryllidae	*Traulia azureipennis*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D and E	-	-
83	Tettigonioidea	Haglotettigoniidae	*Velarifictorus aspersus aspersus*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D and F	-	-
83	Tettigonioidea	Haglotettigoniidae	*Varitrella orion*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones B and D	-	-
83	Grylloidea	Baissogryllidae	*Xenocatantops humilis*		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones D, E and F	-	-
83	Tettigoniidae	Meconematinae	*Xiphidiopsis* (Xiphidiopsis) sp. 1		*MK Tan (2015) Orthoptera (grasshoppers, crickets and katydids) of Mandai forest*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A, D and E	-	-
Reduviidae																
1	Reduviidae	Emesinae	*Emesopsis gauis*		*Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone D	-	-
2	Reduviidae	Emesinae	*Gardena muscicapa*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A, B and D	-	-
3	Reduviidae	Emesinae	*Gardena melinarthrum*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zone A	-	-
4	Reduviidae	Emesinae	*Emesopsis sp.*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
5	Reduviidae	Emesinae	*Empicoris sp.*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
6	Reduviidae	Emesinae	*Tridemula cf. mixta*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
7	Reduviidae	Emesinae	*Tridemula plurima*		*Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone A		
8	Reduviidae	Harpactorinae	*Biasticus* sp.		*Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone F		
9	Reduviidae	Harpactorinae	*Agyrius cf. podagricus*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
10	Reduviidae	Harpactorinae	*Cosmolestes picticeps*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zone B	-	-

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence[#]	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
11	Reduviidae	Harpactorinae	*Euagoras plagiatus*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones B, D and F	-	-
12	Reduviidae	Harpactorinae	*Sycanus sp. 1*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A, B and D	-	-
13	Reduviidae	Harpactorinae	*Sycanus sp. 2*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
14	Reduviidae	Harpactorinae	*Red and black Harpactorine*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
15	Reduviidae	Harpactorinae	*Rhynocoris* sp.		*Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed			Zone B		
16	Reduviidae	Peiratinae	*Ectomocoris atrox*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones B and D	-	-
17	Reduviidae	Reduviinae	*Acanthaspis inermis*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zone B	-	-
18	Reduviidae	Reduviinae	*Acanthaspis cf. quadriannulata*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
19	Reduviidae	Reduviinae	*Acanthaspis signifera*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
20	Reduviidae	Reduviinae	*Inara flavopicta*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones B and D	-	-
21	Reduviidae	Reduviinae	Debris piling nymph		*Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O		Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed			Zones B and D		
22	Reduviidae	Saicinae	*Sp. 1*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
23	Reduviidae	Salyavatinae	*Lisarda annularis*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A and E	-	-
24	Reduviidae	Salyavatinae	*Lisarda inornata*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zones A, D, and E	-	-
25	Reduviidae	Stenopodainae	*Aulacogenia patalungae*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR	-	-
26	Reduviidae	Salyavatinae	*Lisarda pallidispina*		*Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A and E		
27	Reduviidae	Salyavatinae	*Lisarda rhypara*		*Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zones A, D and E		
28	Reduviidae	Stenopodainae	*Sastrapada sp.*		*Ming Kai Tan, Huiqing Yeo (2014) Diversity of entomofauna in Mandai Lake Road Vegetation, Sinagpore* *Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Vegetation along Mandai Lake Road located on the northern margin of CCNR; Zone B	-	-
29	Reduviidae	Stenopodainae	*Pygolampis ridelyi*		*Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O	-	Not yet assessed	Not Assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone D		
30	Reduviidae	Tribelocephalinae	*Tribelocephala cf. indica*		*Yeo HQ (2015) Report on the Assasin Bugs (Hemiptera: Reduviidae) of Mandai*	O		Believed to be the first record of this genus in Singapore		Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Zone D		
Freshwater Invertebrates																
1	Hydroptilidae	-	*Hellyethira* sp.	Caddisfly	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama streams	-	-
2	Belostomatidae	-	*Sphaerodema* sp.	Giant Water Bug	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama streams	-	-
3	Culicidae	-	*Culicidae* sp.	Mosquito	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama streams	-	-
4	Gerridae	Eotrechinae	*Amemboa nodosa*	Water Skater	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	Singapore and Peninsular Malaysia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Fast-flowing and slow-flowing forest streams; lakes, reservoirs or ponds	Lorong Asrama streams	Suitable habitats in Singapore and Peninsular Malaysia.	-
5	Gerridae	Gerrinae	*Limnogonus fossarum*	Water Strider	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	Singapore and Peninsular Malaysia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Lakes, reservoirs or ponds; temporary pools	Lorong Asrama streams	Suitable habitats in Singapore and Peninsular Malaysia.	-
6	Gerridae	Gerrinae	*Limnogonus nitidus*	Water Strider	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	Singapore and Peninsular Malaysia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	peaty streams (blackwater, acidic), lowland streams (non-acidic, swampy)	Lorong Asrama streams	Suitable habitats in Singapore and Peninsular Malaysia.	-
7	Gerridae	Ptilomerinae	*Ptilomera tigrina*	Water Strider	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	Singapore and Peninsular Malaysia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Fast-flowing and slow-flowing forest streams; peaty streams (blackwater, acidic), lowland streams (non-acidic, swampy)	Lorong Asrama streams	Suitable habitats in Singapore and Peninsular Malaysia.	-
8	Gerridae	Halobatinae	*Ventidius malayensis*	Oriental Water Strider	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	Singapore and Peninsular Malaysia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Fast-flowing and slow-flowing forest streams; lowland streams (non-acidic, swampy); river banks or margins	Lorong Asrama streams	Suitable habitats in Singapore and Peninsular Malaysia.	-
9	Nepidae	-	*Ranatra* sp.	Water Stick Insect	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama streams	-	-
10	Gyrinidae	-	*Orectochilus* sp.	Whirligig Beetle	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama streams	-	-
Crustaceans																
1	-	-	Crustacean sp. 1	-	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama streams.	-	-
2	-	-	Crustacean sp. 2	-	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama streams.	-	-
3	-	-	Crustcacean sp. 3	-	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama streams.	-	-
4	-	-	Crustacean sp. 4	-	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama streams.	-	-
5	Atyidae	-	*Caridina* sp.	-	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	Lorong Asrama streams.	-	-
6	Palaemonidae	-	*Macrobrachium lanchesteri*	-	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama* *Tan HH, Lim LKP (2015) Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area*	O	TM + SD	LC	Least concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Non-native		Almost all types of freshwater bodies, rice fields, ponds, reservoirs, streams and rivers. Still or slow moving waters in open country. Wide temperature tolerance and can occur in habitats with very low oxygen content. Not normally found in forested areas, but from typical slow-flowing, lowland streams flowing through disturbed woodland. Water is normally stained due to high tannin content and other dissolved organic material. Dissolved oxygen and pH are generally low.	Lorong Asrama streams; Zone H (More than 11 individuals)	Potentially present in woodland streams throughout Singapore.	Widely distributed in Asia.
7	Atyidae		*Caridina johnsoni*		*Tan HH, Lim LKP (2015) Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area*		TM	LC	Least Concern v 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Native; understood to be widespread and common		Reservoirs, lakes, rivers and streams	Zone A	-	No information available on population trend but species is widely distributed and lack any maior threats.

Item	Family	Sub-Family	Genus species	Common Name	Source	Presence#	Current endemicity listing*	IUCN Category	IUCN Status	Protected by Law	Local Status (SRDB)	CITES (I, II, III)	Habitat Requirements	Expected range within Project Area	Predicted range outside Project Area	Estimated global population size/status
8	Palaemonidae		*Macrobrachium nipponense*	Oriental river prawn	*Tan HH, Lim LKP (2015) Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area* *WRS Data*		IC	LC	Least Concern v 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Non-native		Wide range of freshwater ecosystems, from rivers through to seasonal pools	Zones A and F	-	No information available on population trends but species is considered to be abundant where it is found.
9	Parastacidae		*Cherax quadricarinatus*	Tropical blue crayfish	*Tan HH, Lim LKP (2015) Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area* *WRS Data*		EA	LC	Least Concern v 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Non-native		Non-burrowing species that is tolerant of a wide variety of habitats, including coastal streams and freshwater environments, with a preference for the slower moving upper reaches of rivers as well as lakes and lagoons.	Zones A and F	-	Insufficient population data available.
10	Gercarcinucidae		*Irmengardia johnsoni*	Johnson's freshwater crab	*Tan HH, Lim LKP (2015) Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area* *WRS Data*		Singapore	VU	Vulnerable D2 ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Native; EN (endemic)		Prefers slower parts of shaded streams, sometimes found under rocks but usually amongst leaf litter with muddy substrates. Not an obligate highland crab and can commonly be found in lowland secondary forest streams. Predominantly feeds on dead leaves and freshwater oligochaete worms.	Zone F	BTNR, various parts of the CCNR, especially in the Nee Soon Swamp Forest	No information on population size, abundance or trends.
11	Sesarmidae		*Geosesarma perracae*	Peracca's Land Crab	*Tan HH, Lim LKP (2015) Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area* *WRS Data*		Singapore and Peninsular Malaysia	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Native; understood to be restricted but common		Swampy lowland habitats, usually near a streamline or water seepage. Mainly scavanger cum herbivore and burrows into wet ground. Twice recorded in pitcher plants, thus believed to be nepenthiphilous.	Zones A and F	BTNR, Nee Soon Swamp Forest (CCNR), MacRitchie Forest (CCNR), periphery of Greenbank Park. Elsewhere, lowland habitats in southern part of Peninsular Malaysia.	-
Gastropods																
1	Planorbidae	-	*Gyraulus convexiusculus*	-	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	Distributed globally, including middle east, TM + SD+ IC + IM	LC	Least concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Various types of running and stagnant natural and artificial water bodies such as lakes, ponds, ditches and rice fields.	Suitable stream habitats within project Area	Potentially widespread throughout Singapore.	There is no information on its population status and trends, however it is one of the most common snail species throughout its distribution range.
2	Planorbidae	-	*Indoplanorbix exustus*	-	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	Middle East, TM + SD + IC + IM	LC	Least concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Various types of stagnant waters with dense vegetation. It remains attached to floating plants and it also occurs in very polluted waters.	Suitable stream habitats within project Area	Potentially widespread throughout Singapore.	Very common species
3	Thiaridae	-	*Melanoides tuberculata*	-	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	Middle East, TM + SD + IC + IM + Africa	LC	Least concern ver 3.1	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Found in all types of permanent waters, from small springs to vast lakes. Browser of microalgae and a detritivore; able to survive in relatively alkaline and saline waters.	Suitable habitats within project Area	Potentially widespread throughout Singapore.	The species' populations may reach extremely high densities of 200-300 ind./m² (Lévêque 1967) up to 10.000 ind/ m² (Pererea et al. 1996) in sandy or gravelly sediments where the snails do not only live upon the surface but also in the top-layer (endobenthic). The global population is believed to be increasing.
4	Thiaridae	-	*Sermyla riquetii*	-	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	TM	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-
5	Lymnaeidae	Amphipepleinae	*Lymnaea rubiginosa* (currently known as *Radix rubiginosa*)	-	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	Freshwater streams	-	-	-
6	-	-	Snail sp.	-	*NParks (2008) Rapid Biodiversity Assessment of Lorong Asrama*	O	-	Not yet assessed	Not yet assessed	Wild Animals and Birds Act, 2000 Parks and Trees Act, 2006	Not listed	-	-	-	-	-

* Endemicity definitions:
PH = Philippines only
BO = Borneo Island, which includes only Brunei, Sabah, Sarawak and Kalimantan
TM = Thai-Malay Peninsula, which includes only Myanmar, Thailand, Singapore and Peninsular Malaysia
IC = Indochinese Region, which includes only Cambodia, Laos, Vietnam, Myanmar, Thailand and Southern China
SD = Sundaland, which includes only Borneo, Peninsular Malaysia, Singapore and Indonesia
IM = Indomalaya Ecozone, which includes South Asian countries, Southeast Asian countries, Southern China and parts of East Asia
EA = East Asia region, which includes from Sakhalin to the north, Japan, Korean Peninsula, mainland China, and Taiwan

# Presence definitions:
O = Reportedly observed
O/A = Observed always
O/S = Observed sometimes
O/R = Rarely observed
O/N = Never observed
PP = Potentially present

Annex 11.0

Priority Species Profiles

S/N	Species	Common Name	Conservation Status		Listing Rationale	Population		Habitat Requirements	Migration	Endemicity	Congregation	Threats		Stakeholder/Expert Comments
			IUCN	SRDB		Global Population and Range	Local Population and Range					Global Threats	Local Threats	
Mammals														
1	*Manis javanica*	Sunda Pangolin	CR	CR	High levels of hunting and poaching for meat and scales. Species suspected to have declined by more than 80% over the last 21 years, and a continuing decline of more than 80% is projected for the next 21 years. In Singapore, the species is threatened by habitat loss, poaching and often falls victim to road kill.	The species is widely distributed geographically, occurring across mainland and island Southeast East Asia, from southern China and Myanmar through lowland Lao PDR, much of Thailand, central and southern Viet Nam, Cambodia, to Peninsular Malaysia, to Sumatra, Java and adjacent islands (Indonesia) and to Borneo (Malaysia, Indonesia, Brunei) though the northern and western limits of its range are poorly known (Schlitter 2005, Wu et al. 2005). It has been recorded from sea level up to 1,700 m asl. *M. javanica* is now extremely rare in the northern part of its range where there have been massive declines.	The species can be found on mainland Singapore and adjacent islands, including Pulau Tekong and potentially Pulau Ubin (IUCN). To be exact, it is mainly found in the CCNR with some recorded from the BTNR, as well as in the rural and scrub areas especially north of the Pan-Island Expressway, in Bukit Batok, Western Catchment Area and on islands of Ubin and Tekong (Davison *et al*., 2008). There have also been records of the *M. javanica* in the Western Catchment area and Mandai forest (Lim, 2007). While there have been massive declines in the species in the northern part of its range, populations appear stable in Singapore.	*Manis javanica* is a nocturnal, solitary animal specialised in feeding on ants and termites. It is fairly arboreal and can climb trees to access ant nests. They sleep in hollows either in, or at the base of trees, but have also been known to dig burrows in soil. This species is found in primary and secondary forest, including lowland dipterocarp forest, and cultivated areas including gardens and oil palm and rubber plantations, including near human settlements (Azhar et al. 2013, Nowak 1999). They can also be found in scrublands (SRDB). Anecdotal evidence states that primary forests are likely to support more pangolins due to the presence of large trees with hollows used as dens and support lower levels of human activity. However, the population in Singapore is in very low quality forest in which they have been able to survive for decades without an obvious decline (J.W. Duckworth pers. comm. 2006). Based on studies by Challender et al 2011, witnessed behaviour in captivity, all natal dens associated with hollows in large trees (>50 cm DBH), and home range size estimated at 6.97 ha. Peak activity was between 0300 hrs and 0600hrs. Based on studies by Lim & Ng (2007), it is highly probable that pangolins will take refuge in a safe location (e.g. tree hollow) as opposed to a clump of tall grasses when giving birth and providing maternal care for their young, demonstrating a high level of den fidelity for extended periods during its reproductive stages. The strict use of hollows of big trees (>50 cm DBH) as natal dens by the female *M. javanica* in the study suggests that it might require reasonably mature forest to locate and utilise den sites during reproductive stages. Woodland Specialist (Mandai Terrestrial Fauna Interim Report)	It is presently unclear as to whether there is migration of individuals amongst the different patches *M. javanica* are found in Singapore. That said, it is relatively slow-moving and travels a limited distance when foraging during the night (Lim, 2007). The mean daily active duration of the pangolins is very short, approx. 2.5h.			The primary threat to *M. javanica* is hunting and poaching for international trade, both targeted and untargeted, and which is largely driven by export trade to China, involving live animals, their meat and scales. Local use also comprises a threat although this may be largely forgone in favour of international trade.	In Singapore, roadkill is probably the biggest threat to the species and though poaching does occur, it is not thought to be a significant problem. The Singapore Red Data Book (2008) adds that habitat loss is another threat.	
2	*Tragulus kanchil*	Lesser Mouse Deer	LC	CR	Listed as LC because historically proven to be widespread and common, and chevrotains remain in large numbers in its specimen-validated range and at least in non-Sundaic areas persist in environments of very heavy forest degradation and fragmentation and hunting. Presumed short generation length of the species, considered to be likely under five years, also influences assessment, in that, for decline criteria to be invoked in Red Listing one would have to assume relatively high rates of decline over a large part of the species range in a relatively short window of time (10-15 years). Thus although there may be/have been drastic (local) reductions, these have probably not been synchronous over a large enough area. Several major uncertainties, although these are not adjudged sufficient for listing as Data Deficient: (1) a rather low proportion of modern records of Tragulus from Sundaic and non-Sundaic portions of the range have been identified conclusively to species; (2) conflicting nature of the information available concerning the effects of hunting (harvest levels are locally very high) and habitat destruction; (3) strong indications that in its non-Sundaic range it is localized in occurrence which has been proposed to result from hunting; (4) the apparent restriction to the extreme level lowlands in at least Borneo, placing it within the altitudinal zone of rapid forest loss. Listed as CR in the SG RDB due : Habitat loss, illegal trapping and possible predation by feral dogs. Restricted to the CCNR and BTNR.	T. kanchil as defined here occurs in Borneo, Sumatra, the Thai–Malay Peninsula, many islands within the Greater Sunda region, and continental Southeast Asia north to at least 18°10′N, as established through Lao PDR specimens from Thangon (Osgood 1932, Chasen 1940, Meijaard 2003, Meijaard and Groves 2004, E. Meijaard pers. comm. 2004). This includes the countries of Indonesia, Malaysia, Brunei, Singapore, Myanmar, Thailand, Cambodia, Lao PDR, and Viet Nam. Grubb (2005) also included China, but the occurrence there of T. kanchil is not confirmed, reflecting the difficulty of separation from T. williamsoni.	It is restricted to the CCNR and BTNR (SRDB, 2008).	This species is found in lowland/foothill primary and secondary forests as well as cultivated areas up to 600 m in elevation (Semiadi and Boeadi pers. comm.). The habitat of this species is a mosaic of riverine, seasonal swamp and dry undulating country, vegetated predominantly by legumes and dipterocarps. In Sabah, it also inhabits mangrove forest. In Peninsular Malaysia, it feeds on shoots, young leaves and fallen fruits in the tall forest of the lowlands. During the day it may prefer crown-gap areas with dense undergrowth of creeping bamboo, and move to higher and drier ridge areas at night. All Tragulus species are associated with forests, but there is strong evidence that T. kanchil does not require old-growth forest or even particularly mature secondary forest. It has been found to utilise disturbed habitats, feeding primarily in crown-gap areas dominated by bamboo stands (possibly due to preference of fruit and soft leaves of pioneer plants with lower concentrations of secondary metabolites) (Matsubayashi et al., 2003), immature forests and logged forests. In areas where hunting is negligible, Tragulus spp. densities were positively correlated with fruit abundance and negatively correlated with pioneer trees and grass and herbs. Other studies produced findings suggesting that Tragulus sp. distribution is tied to specific microhabitats, perhaps related to water requirements as there is a regularity with which authors note commonness in riverine areas. Forest Dependent (Mandai Terrestrial Fauna Interim Report)	T. kanchil is often stated to be nocturnal but in fact most activity is diurnal in the first and last few hours of daylight, with animals spending more of the night resting. It is highly solitary and apparent territorial behaviour has been observed. Males are highly philopatric but females establish new home ranges when giving birth. The estimated home-range size for females is 4.3 ha and males 5.9 ha. The mean daily distance travelled for males was 519 ± 89 m and females 574 ± 220 m. T. kanchil is partly frugivorous but feeds also on shoots and young leaves, mostly of fast growing gap species rather than closed forest understorey species. Gestation period is 140-177 days with 2-3 young per year, the fawns kept hidden.			Hunting and habitat loss occur at high levels almost throughout its range. While the genus remains widespread and sommon in its Sundaic range in the face of these threats, few data is available to support assessment speeifically of T. kanchil's current status. Studies show that despite heavy hunting, major habitat degradation and isolation from forest areas, T. kanchil appears to persist in several areas although decreasing population densities, at least in parts of southern Vietnam were observed. Logging may drive substantial reductions in density, although other studies have found that it allows an increase in numbers. It is concluded that inferring proportionately large population losses in Lesser Chevrotain populations is not possible: depending on how serious hunting is and what exactly is being done to the habitat post-logging (forest regeneration, tree plantation or non-woody habitat) in any given area, chevrotain numbers might remain broadly unaffected, decrease or increase in logged-over areas.	T. kanchil is now rather rare on Singapore (K. Lim pers. comm. 2008), presumably nowadays constrained by habitat quality rather than by ongoing hunting, although the role of free-ranging dogs, if any, in restraining population numbers is unclear. However, the 'island within an island' situation of remaining forest on Singapore and the extreme habitat loss over the last 150 years prevent useful extrapolation of this species' situation there to other Sundaic areas. In the Red Data Book, main threats in Singapore are habitat loss, illegal trapping and possibly predation by feral dogs.	
3	*Hystrix brachyura*	Malayan Porcupine	LC	CR	The species is listed as Least Concern (IUCN, 2008) in view of its wide distribution, its occurrence in a number of protected areas, tolerance of a degree of habitat modification, and because it is presently unlikely to be declining fast enough to qualify for listing in a more threatened category. However in Singapore, while there have been recorded sightings of the species in Singapore (one on Pulau Ubin, one on Pulau Tekong, one in Bukit Timah Nature Reserve), these are limited, therefore classifying the species as 'critically endangered' by the SRDB.	This species ranges from Nepal, through northeastern India, to central and southern China, throughout Myanmar, Thailand, Lao PDR, Cambodia and Viet Nam, through Peninsular Malaysia, to Singapore, Sumatra (Indonesia) and throughout Borneo (Indonesia, Malaysia and Brunei). It is also present on the island of Penang, Malaysia. It can be found from sea level to at least 1,300 m asl.	Pulau Ubin, Pulau Tekong, Bukit Timah Nature Reserve	It can be found in various forest habitats, and in scrubby, open areas close to forest. It can be found in agricultural areas, but needs to have rocky outcrops or other areas in which it can create a den or dig burrows. Burrows are generally occupied by family groups.				In Southeast Asia, it is hunted for food but this not thought to impact populations. In South Asia, it is threatened by habitat loss due to construction of dams, human settlements and other infrastructure development. It is harvested for subsistence food and medicinal purposes.	The species is threatened by habitat loss and hunting for 'wild meats' (SRDB, 2008).	
4	*Nycticebus coucang*	Sunda Slow Loris	VU	CR	The species has been listed as Vulnerable (IUCN, 2008) as there has probably been a more than 30% reduction in population over three generations (approximately 21-24 years) based on harvesting for the pet trade and extensive habitat loss. In Singapore, the distribution and presence of the species is unclear due to scant sightings. Given that home ranges of the species average nearly 20 ha, but Bukit Timah and the Central Catchment Nature Reserves total only about 3000 ha, of which about half are reservoirs and the remainder highly fragmented, the population of the species has been estimated to be very small (Fam *et al* ., 2014). Therefore, the SRDB has listed it as 'critically endangered'.	This species occurs in Indonesia, Malaysia, southern peninsular Thailand, and Singapore. Surveys in Sumatra have found this species to occur at very low densities. Its presence is patchy through Peninsular Malaysia. Several short-term studies indicated that it usually occurs at low densities: Pasoh Forestry Research Centre, Peninsular Malaysia (0.01-0.02 animals/km); Petalang Jaya, Malaysia (0.40 animals/km); Genting Sempah, Malaysia (3 captures after 30,000 trap nights).	Central Catchment Nature Reserve and Pulau Tekong.	The species occurs in primary and secondary lowland forest, gardens, and plantations. It is seen more often in edge habitat of forest, possibly because the edge has more supports that may increase foraging efficiency, but this also may be due to sampling bias, as they are more easily seen on forest edges. It is frugivorous, but will also eat insects, leaves, and bird eggs. One long-term study has shown that they consume mainly nectar gum and sap, with fruit and arthropods forming small proportion of diet. Nectar from the flowers of the burttram palm (*Eugeissona tristus*) seems to be a key resource.				Habitat loss and illegal poaching are major threats to the Sunda Slow Loris. The species is collected for use as pets, and the animals are sold throughout Southeast Asia. It is relatively adaptable to anthropogenic habitats, and so it might less affected by forest loss than some other primate species. Nevertheless, forest loss has been so severe in the region that it is likely to have had some negative impacts. Animals are also shot as crop pests and for other reasons.	Habitat loss and poaching (SRDB, 2008).	
5	*Presbytis femoralis femoralis*	Banded Leaf Monkey	NT	CR	Considering the extensive habitat loss that has taken place within the range of the species, there is reason to believe that this species is in decline, probably at a rate of less than 30% over three generations (approximately 30 years), thus qualifying it for listing as Near Threatened by the IUCN (2008). In Singapore, less than 20 individuals have been known to survive as of 2006, although a few of these were juveniles (IUCN, 2008).	The species as a whole is found in Indonesia (east-central Sumatra), Singapore and the Malay Peninsula. t's overall abundance is poorly known.	Less than 20 individuals of P. f. femoralis were known to survive on Singapore as of 2006, although a few of these were juveniles. SRDB estimates local population to be no more than 30 individuals (SRDB, 2008).	Based on what is known of closely-related species, such as *P. siamensis* and *P. melalophos* , this species is found in mixed mangrove, primary freshwater, riverbank, primary lowland logged, scrub-grassland riverbank, and secondary riverbank habitats. It is primarily frugivorous, but also consumes immature leaves. It is found in taller trees of swampy peat forest in Malay Peninsula, while in Singapore it is found in primary, secondary, swamp, and dryland rainforests.				Deforestation and conversion of habitat would appear to be the major threats to this species. It is particularly affected by oil palm plantations, which are expanding very rapidly within its range.	Habitat loss in the form of deforestation and conversion of habitat threaten the species. This is coupled with a seriously low population that may not be self-sustaining in the long term (SRDB, 2008).	
6	*Tylonycteris pachypus*	Lesser Bamboo Bat	LC	CR	Listed as Least Concern in view of its wide distribution, presumed large population, it occurs in a number of protected areas, has a tolerance of a degree of habitat modification, and because it is unlikely to be declining fast enough to qualify for listing in a more threatened category.	According to IUCN, there are no major threats to this species as a whole. In South Asia, this species is threatened by deforestation, generally resulting from commercial logging operations and the conversion of land to agricultural and other uses. It is also threatened due to disturbance to roosting sites by humans (A. Madhavan pers. comm. January 2002, Molur et al. 2002).	In Singapore, loss of forest habitat and bamboo groves (SRDB, 2008).	This species is found in prime tropical deciduous forests with extensive bamboo growth, and has been recorded from lowland agricultural areas and disturbed habitats. It prefers to roost in internodal spaces of hollow bamboo and narrow crevices in other trees. The roosting site is located 0.25 to 10 m from the ground. It is a gregarious species and roosts in groups of up to 40 individuals. It feeds on termites.				There are no major threats to this species as a whole. In South Asia, this species is threatened by deforestation, generally resulting from commercial logging operations and the conversion of land to agricultural and other uses. It is also threatened due to disturbance to roosting sites by humans.	Loss of forest habitats and bamboo groves (SRDB, 2008).	
7	*Iomys horsfieldi*	Horsfield's Flying Squirrel	LC	EN	Listed as Least Concern as it is widespread, common, and highly adaptable. This species is widespread and common in Malaysia. In Singapore, these animals are listed as rare.	This species ranges from Peninsular Malaysia to Sumatra, Java, and Borneo. It has also been recorded from Singapore, Tioman, and Penang. This species is widespread and common in Malaysia.	In Singapore, these animals are listed as rare.	These squirrels occur up to 1,000 m in primary forests, secondary, degraded forests and scrub, as well as cultivated areas. They can be a pest in plantations. It is nocturnal, and uses tree hollows. It is considered to be an adaptable species which may consume a range of seasonal food items, but predominantly fruits.				In general, there appears to be no major threats to this species.	In Singapore, main threat is habitat loss (SRDB, 2008).	
8	*Rusa unicolor*	Sambar Deer	VU	Not Listed	Sambar is listed as Vulnerable through sustained declines across its range. These vary in severity between regions, and in some areas considerably exceed the threshold for Vulnerable. The global population trend is still considered to be a decline somewhere between 30 and 50 % over three generations, for the past, present and future. Almost everywhere outside Taiwan and well-managed protected areas in India, the Sambar is in rapid decline, which has lead to very low numbers and many local-level extinctions over a wide area. The Sambar Deer was a deer native to Singapore. It was last sighted in the Bukit Timah area in the 1920s. In the 2000s, they were reintroduced into the Central Catchement area. According to a local fauna specalist, fewer than 20 Sambar deer are estimated to be in the wild locally.	The Sambar extends from India and Sri Lanka east along the southern Himalayas through much of south China to Taiwan. Further south it occurs in Bangladesh, throughout mainland Southeast Asia and many of the main islands of the Greater Sundas The current distribution is now highly fragmented in much of this range. Almost everywhere outside Taiwan and well-managed protected areas in India, the Sambar is in rapid decline, which has lead to very low numbers and many local-level extinctions over a wide area.	CCNR	No large Indian ungulate has adapted itself to a wider variety of forest types and environmental conditions than has Sambar. Within India, Sambar occurs in the thorn and arid forests of Gujarat and Rajasthan, in the moist and dry deciduous forests throughout peninsular India, in the pine and oak forests at the Himalayan foothills, and in the evergreen and semi-evergreen forests of northeastern India and the Western Ghats. Outside India it extends into temperate-latitude and alpine-zone woodlands of Taiwan. This habitat flexibility is permitted by its broad diet: Sambar has been documented to eat 130–180 species of plants in India alone, with food requirements less specialised than those of other deer.				Habitat encroachment and hunting (IUCN, 2015).		Ng commented that the Sambar Deer may be VU on IUCN but is not native to Singapore and its presence complicates the ecosystem due to the lack of a top predator. Unrestrained population growth of these large herbivores may pose serious management and ecosystem problems for the future (Ng, 2014)
9	*Prionailurus bengalensis*	Leopard Cat	LC CITES Appendix II	CR	The Leopard Cat is a widespread and relatively common species (Nowell and Jackson 1996, Sunquist and Sunquist 2002), although some island subspecies are included in the Red List. Although there is a declining population trend in parts of its range due to habitat loss and hunting, the species is stable in many areas, even thriving in some altered habitats including oil palm and sugar cane plantations (IUCN Cats Red List Workshop 2007).	The leopard cat is a widespread species in Asia. It is native to Afghanistan; Bangladesh; Bhutan; Brunei Darussalam; Cambodia; China; Hong Kong; India; Indonesia (Jawa, Kalimantan, Sumatera); Japan (Nansei-shoto); Korea, Democratic People's Republic of; Korea, Republic of; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Pakistan; Philippines; Russian Federation; Singapore; Taiwan, Province of China; Thailand; Viet Nam The leopard cat is the most frequently recorded small cat across most of its wide range, in comparison with sympatric species (Nowell and Jackson 1996, Duckworth et al. 1999, Holden 2001, Duckworth et al. 2005, Lynam et al. 2006, Yasuda et al. 2007), and with its broad distribution has an abundant population The population is believed to be declining due to habitat loss and hunting. Island populations are most at risk of extinction.	Pulau Ubin, Pulau Tekong, Jalan Bahar and the Mandai Road area. (Known from Jalan Bahar and the Mandai Road area from roadkill collection.)	The species can range up to 3,000 m in parts of its range, which extends into the Himalayas along river valleys. It occurs in a broad spectrum of habitats, from tropical rainforest to temperate broadleaf and, marginally, coniferous forest, as well as shrub forest and successional grasslands. The northern boundaries of its range are limited by snow cover; the leopard cat avoids areas where snow is more than 10 cm deep. It is not found in the cold steppe grasslands, and generally does not occur in arid zones, although there are a few records from relatively dry and treeless areas in Pakistan. Leopard cats occur commonly in dense secondary growth, including logged areas, and have been found in agricultural and forest (rubber tree, oil palm, sugarcane) plantations. The species can live close to rural settlements. Leopard cats are excellent swimmers, and have successfully colonized offshore islands throughout their range (Nowell and Jackson 1996; Sunquist and Sunquist 2002). In the most comprehensive study, based on a large sample size of 20 radio-collared cats in Thailand's Phu Khieu Wildlife Sanctuary, mean home range size (95% MCP) was 12.7 km², larger than in other areas of Thailand (4.5 km²) (Grassman et al. 2005), on Borneo (3.5 km²: Rajaratnam 2000), or on Japan's Iriomote island (Schmidt et al. 2003). There was no significant difference between male and female home range size. Open and closed forest habitats were used in proportion to their occurrence, and activity patterns showed crepuscular and nocturnal peaks. On Borneo, Rajaratnam et al. (2007) found that leopard cats hunted rodents in oil palm plantations, and used forest fragments for resting and breeding. Specifically, Murids dominate the diet (85-90%: Grassman et al. 2005b; Rajaratnam et al. 2007). Other small mamals, eels and fish have also been reported, as well as occasional scavenging of carrion (Nowell and Jackson 1996). In the oil palm plantations of Sabah, they have been observed up to 4 m (13 ft) above ground hunting rodents and beetles. In this habitat, males had larger home ranges than females, averaging 3.5 km2 (1.4 sq mi) and 2.1 km2 (0.81 sq mi) respectively. Higher survival rates (92%) were recorded in a protected area with little human influence, compared with lower rates in areas with greater human activity (53-82%) (Haines et al. 2004). While the leopard cat is more tolerant of disturbed areas than other small Asian felids, it likely undergoes higher mortality in such areas. In Singapore, forest, scrubland and plantations. Tends to be solitary but sometimes occurs in pairs or small family groups. Nocturnal animal that is largely terrestrial but can climb trees with ease. Diet consists mainly of small vertebrates such as frogs, lizards, birds and rats. Cubs are raised in a hollow tree, rock crevice or burrow until they are ready to leave.	In a study conducted by Austin *et al*. (2007), leopard cats were found to use larger areas during the wet season than dry season. Most used vegetation types in proportion to their presence. They exhibited arrhythmic activity with increased activity during nocturnal and crepuscular periods. Some are active during the day, but most hunt at night, preferring to stalk murids, tree shrews and hares. They are agile climbers and quite arboreal in their habits.			Commercial exploitation for the fur trade Hunting for food Pet trade They are also widely viewed as poultry pests and killed in retribution Hybridization in the wild has been reported, but is not considered a significant threat. Although the species is less dependent on forest cover than others, habitat loss and fragmentation is still a major threat across most of its Asian range (Nowell and Jackson 1996).	In Singapore, habitat loss and possible illegal poaching. In addition, two roadkills were collected from Mandai Road and Jalan Bahar in 2001 and 2007 respectively (Baker and Lim, 2012).	
10	*Tylonycteris robustula*	Greater Bamboo Bat	LC	Not listed.	Listed as Least Concern in view of its wide distribution, presumed large population, it occurs in a number of protected areas, has a tolerance of a degree of habitat modification, and because it is unlikely to be declining fast enough to qualify for listing in a more threatened category.	This species ranges from northeastern India, through parts of southern China, to much of mainland and insular Southeast Asia. This is a fairly common species of much of its range.		This species is associated with bamboo vegetation in both intact and disturbed habitats. Small colonies, of up to 32 animals, can be encountered roosting in both bamboo and rock crevices. It is known to feed on termites.				There are no major threats to the species as a whole. In South Asia the threats to this species remain unknown, however, it is presumed that this species may be threatened by deforestation.		
Birds														
11	*Copsychus malabaricus*	White-rumped Shama	LC	CR	This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence <20,000 km2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation). Despite the fact that the population trend appears to be decreasing, the decline is not believed to be sufficiently rapid to approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations). The population size has not been quantified, but it is not believed to approach the thresholds for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure). For these reasons the species is evaluated as Least Concern.	This species has a large range extending from northern India, Nepal and southern China south to Sri Lanka and Indonesia. The global population size has not been quantified, but it is believed to be large as the species is described as common in at least parts of its range (Robson 2000). The population is suspected to be in decline.	According to the Lee Kong Chian Natural History Museum, the white rumped shama can be found locally at Bukit Batok Nature Park, CCNR, Pulau Ubin, Pulau Tekong, Sentosa and Singapore Botanic Gardens. The bird is almost extinct on mainland Singapore where its population has been greatly reduced by the bird trade; it is more numerous at offshore islands. In addition, Lamont A (1998) reported that the bird can also be found at Kent Ridge Park. It is uncertain if the birds spotted in the field are wild birds, released speciments or escaped caged birds (NLB, 2009)	This species inhabits lowland tropical moist forest, swamp forest, overgrown tree plantations, secondary jungle, mangroves and forest clearings, from sea-level to 1500 m in Thailand, but more usually to 500-600 m. It tends to prefer dense undergrowth and shady ravines, where it forages on the ground and in the lower strata for arthropods, also taking worms and berries (Collar 2005). Primary and secondary forests, forest edge, scrub and old plantations. Shy, skulking in the understorey where it can be difficult to see (Yong et al 2013). As a forest bird, it takes its bath in pools and streams in the forests as a mode of feather maintenance. Its diet largely comprises invertebrates such as cockroaches, grasshoppers, caterpillars, centipedes and earthworms. It picks its prey up on the ground or among bushes (NLB, 2009). Builds a shallow cup-shaped nest on low branches or in tree cavities (Yong et al 2013) which are formed from rootlets, fibers, grass and bamboo leaves, and usually placed 2-5 m up in a natural hollow in a tree trunk, stump top or at the base of a bamboo clump and padded with rootlets and leaves (Fan *et al* ., 2009). Man-made cavities can also be used (NatureServe, 2015). A successful nesting was observed in 2006 with the nest inside the cavity of a rotting palm stem. There were 4 chicks in the nest, fledgling 12 days after encounter. According to Wells (2007), a brood left the nest 27 days from the laying of the final egg. The feeding, nesting, and care of young occur almost entirely within the territory. Forest Dependent (Mandai Terrestrial Fauna Interim Report)	The *C. malabaricus* is a generally sedentary bird (Fan *et al* ., 2009)			This species is exploited for the cage-bird trade and has declined to near-extinction in some countries within its range (Collar 2005). Habitat destruction also contributes to the decreasing population trend.	According to the LKCNHM, it is a popular cage-bird and constantly trapped by poachers.	

S/N	Species	Common Name	Conservation Status		Listing Rationale	Population		Habitat Requirements	Migration	Endemicity	Congregation	Threats		Stakeholder/Expert Comments
			IUCN	SRDB		Global Population and Range	Local Population and Range					Global Threats	Local Threats	
12	*Surniculus lugubris*	Drongo Cuckoo	LC	CR	This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence <20,000 km2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation). Despite the fact that the population trend appears to be decreasing, the decline is not believed to be sufficiently rapid to approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations). The population size has not been quantified, but it is not believed to approach the thresholds for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure). For these reasons the species is evaluated as Least Concern.	The population is suspected to be in decline owing to ongoing habitat destruction. NE India, parts of mainland SEA, Thai-Malay Peninsula, Greater Sundas, Palawan. (Yong et al. 2013)	According to the SG RDB, in Singapore it is found in the central forests. Presumed non-breeding birds (possible migrants) have been found on Sentosa, Pulau Ubin, Marina South and St. John's Island. Yong *et al* . (2013) further add that it may be found in the CCNR and Bidadari Cemetery. The species has also been recorded at Bukit Batok Nature Park, BTNR, CCNR, Changi, Mount Faber, Poyan and Sungei Buloh Wetland Reserve (LKCNHM). Residents are estimated to number between 20-50 birds.	The Drongo Cuckoo frequents forests, secondary woodland and forest edges. Specifically, its habitat type includes broadleaved evergreen deciduous forest, tall secondary growth; up to at least 1l 1120 m. In Singapore, residents occur mostly in primary and secondary forests, while migrants may show up in forests, old plantations, scrub and even parkland. Known hosts in Singapore include the Pin-striped tit babbler and Chestnut winged babbler. It feeds mainly on caterpillars, insects, spiders and sometimes figs. Forest Dependent (Mandai Terrestrial Fauna Interim Report)	Some northern populations are migratory, wintering in Thai-Malay Peninsula and Greater Sundas, as well as Singapore.			Habitat destruction.	In Singapore, unviable population levels	
13	*Nycticorax nycticorax*	Black crowned Night Heron	LC	CR	This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence <20,000 km2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation). Despite the fact that the population trend appears to be decreasing, the decline is not believed to be sufficiently rapid to approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations). The population size is very large, and hence does not approach the thresholds for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure). For these reasons the species is evaluated as Least Concern. This species has triggered the IBA criteria in several IBAs around the world.	Species is circumtropical in distribution. The global population is estimated to number c.510,000-3,600,000 individuals (Wetlands International 2006), while national population estimates include: c.100,000-1 million breeding pairs, >c.10,000 individuals on migration and >c.10,000 wintering individuals in China; c.100,000-1 million breeding pairs in Taiwan; c.10,000-100,000 breeding pairs and c.50-1,000 wintering individuals in Korea and c.10,000-100,000 breeding pairs and c.1,000-10,000 individuals on migration in Japan (Brazil 2009). Widespread across much of Americas, Eurasia and Aprica. Many northern populations migrate to winter in the tropics. This species has undergone a large and statistically significant increase over the last 40 years in North America (294% increase over 40 years, equating to a 40.8% increase per decade.	Occurs throughout Singapore coastline but concentrated mostly in the less developed north and west, and the islands of Pulau Ubin and Pulau Tekong. Other areas include the Lorong Halus Wetlands, Jurong Birdpark and Sungei Buloh Wetland Reserve. Most Black Crowned Night Heron populations in the SEA region are resident. A few populations that breed in the north may migrate, doing so at night and resting during the day. Only one definitely known wild colony survives (circa 20-50 nesting birds) in the Jurong Lake area. Colonies in Khatib Bongsu, Pasir Ris and Sungei Buloh have all been abandoned in the last 20 years (SRDB, 2008).	The species is largely crepuscular and nocturnal, but may feed diurnally especially during the breeding season (del Hoyo et al. 1992). The species inhabits fresh, brackish or saline waters with aquatic vegetation and bamboo or trees (e.g. pine, oak or mangroves) for roosting and nesting in (del Hoyo et al. 1992), showing a preference for islands or predator-free areas for nesting sites (Kushlan and Hancock 2005). It occupies the forested margins of shallow rivers, streams, lagoons, pools, ponds, lakes, marshes and mangroves and may feed on pastures, reservoirs, canals, aquaculture ponds (del Hoyo et al. 1992) and rice-fields (up to 96 % of a colony's food resources may be taken from nearby rice-fields) (Kushlan and Hancock 2005). On migration the species may also frequent dry grasslands or marine coasts (del Hoyo et al. 1992), kelp beds (Kushlan and Hancock 2005) and estuaries (Hockey et al. 2005). It breeds up to 4,800 m (Chile) (Kushlan and Hancock 2005) but is more common at elevations of up to c.2,000 m (Snow and Perrins 1998). It is an opportunistic feeder taking fish, frogs, tadpoles, turtles, snakes, lizards, adult and larval insects (del Hoyo et al. 1992) (e.g. beetles, bugs, grasshoppers, crickets, flies and dragonflies) (Kushlan and Hancock 2005), spiders, crustaceans, molluscs, leeches, small rodents, bats and the eggs and chicks of other bird species (del Hoyo et al. 1992). The nest is a platform constructed of sticks and vegetation (del Hoyo et al. 1992, Kushlan and Hancock 2005) placed 2-50 m above water or on dry ground near water (Snow and Perrins 1998) in trees, bushes, reedbeds, on cliff ledges (del Hoyo et al. 1992) (overhanging rivers) (Hockey et al. 2005) and on the ground (del Hoyo et al. 1992) in protected sites (Kushlan and Hancock 2005). The first nest built by young birds are fragile, but become a bulky platforms as it is reused over the years. The species nests close together in single- and mixed-species colonies (del Hoyo et al. 1992) with as many as 20-30 pairs in the same tree (Kushlan and Hancock 2005). Colony sites may be reused in consecutive years or flocks may move to new sites (usually such movements are a result of nesting trees being destroyed due to the colony's nesting activities) (Kushlan and Hancock 2005). Colony sites are dispersed throughout the landscape in relation to distance from feeding areas (Kushlan and Hancock 2005). In Singapore, found in mangroves, ponds, mudflats, canals and well-vegetated reservoir fringes. Often seen dispersing from roost sites to forage in evening. Regularly seen feeding in urban canals at night. Roosts in dense clumps of mangroves and waterside vegetation during the day. Gregarious and nests colonially (Yong et al 2013). Although they may fly around during the day, Night Herons hunt throughout the night and early morning when the other herons are sleeping. But when food is scarce or in high demand (e.g., during the breeding season), they may also hunt during the day. Juveniles and adults out of breeding season may also hunt during the day. The young fledge in about 2-3 weeks but do not leave their parents until about 6-7 weeks.	Northern populations of this species are migratory, with those breeding in the western Palearctic travelling on a broad front across the Sahara (del Hoyo et al. 1992) and those breeding in North American travelling on a narrow front along the Atlantic and Pacific coasts (Kushlan and Hancock 2005). Post-breeding southward movements occur from September to October and return northward movements occur from March to May (Kushlan and Hancock 2005). Tropical populations are not migratory but may undergo seasonal post-breeding dispersive movements (del Hoyo et al. 1992).			The species is threatened by wetland drainage and destruction (del Hoyo et al. 1992, Kushlan and Hancock 2005) and by drought in wintering areas (Hafner and Kushlan 2002). It is highly susceptible to pesticides (del Hoyo et al. 1992, Kwon et al. 2004, Kushlan and Hancock 2005) such as organophosphates, carbamates (Kwon et al. 2004) and DDE (a breakdown product of DDT) which negatively affect hatching success (Kushlan and Hancock 2005). There are also cases of genetic damage to chicks as a result of petroleum contamination (Custer 2000). The species is susceptible to avian influenza (Melville and Shortridge 2006) and Newcastle disease so may be threatened by future outbreaks (Kuiken et al. 2006). It is also persecuted (anti-predation killing) at aquaculture facilities due to its depredation on fish stocks (Kushlan and Hancock 2005), and has suffered declines due to the exploitation of chicks from nesting colonies in the past (del Hoyo et al. 1992). Utilisation Chicks of the species are still taken for food in some areas (e.g. Madagascar) (Kushlan and Hancock 2005, Hafner 200) and adults are hunted and traded at traditional medicine markets in Nigeria (Nikolaus 2001).	In Singapore, destruction or disturbance of feeding and nesting sites is a potentially fatal threat as it requires large, often separate areas to feed, roost and nest. A traditional breeding site in Singapore where up to 1,200 birds nested was destroyed apparently by fogging which poisoned the birds; this is because their preferred habitats like mangroves are considered mosquito breeding sites (Naturia, 2001).	2013 study by Lim and Yong found that the black-crowned night heron count is decreasing over a sixteen year period from 1996 to 2011.
14	*Halcyon coromanda*	Ruddy Kingfisher	LC	CR	This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence <20,000 km2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation). Despite the fact that the population trend appears to be decreasing, the decline is not believed to be sufficiently rapid to approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations). The population size has not been quantified, but it is not believed to approach the thresholds for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure). For these reasons the species is evaluated as Least Concern.	The global population size has not been quantified, but the species is reported to be widespread but generally rare and uncommon (del Hoyo et al. 2001), while national population estimates include: c.100-10,000 breeding pairs and c.50-1,000 individuals on migration in China; < c.1,000 individuals on migration in Taiwan; c.100-10,000 breeding pairs and c.50-1,000 individuals on migration in Korea and c.100-10,000 breeding pairs, c.50-1,000 individuals on migration and c.10,000-100,000 breeding pairs in Japan (Brazil 2009). Possibly extinct in Bangladesh. Distribution size (breeding/resident) is estimated at 3,630,000 km2. However, population is suspected to be in decline.	In Singapore, an uncommon migrant and very rare resident. CCNR, Bidadari Cemetery, Pulau Tekong, BTNR, Chinese Garden, Fort Canning Park, Loyang, Malcolm Park, Pasir Ris, Sungei Buloh Wetland Reserve, Tuas, Tyersall Road area.	Plantations, rural gardens, urban areas, subtropical/tropical dry forests, subtropical/tropical mangrove vegetation above high tide level, temperate forests, permanent rivers/streams/creeks including waterfalls. In Singapore, wintering and passage birds occur in secondary forests, scrub, old plantations and occasionally parkland. Residents are only known from mangroves on Pulau Tekong, but there are no recent records. Diet depends on the habitat. In terrestrial habitats it feeds in insect like grasshoppers, bugs, cicadas, butterflies, bees, earthworms, snails and lizards. In aquatic habitats it takes crabs, frogs and their tadpoles and fish. Woodland specialist (Mandai Terrestrial Fauna Interim Report)	Northern populations are migratory, wintering mostly in SEA.			Loss of coastal mangroves as well as occasional collisions with lighthouses and collection for taxidermy.	In Singapore, extensive loss of mangroves has reduced much of the suitable habitat for this species. The resident population is either extirpated or on the verge of extinction.	
15	*Arachnothera chrysogenys*	Yellow-eared Spiderhunter	LC	CR	This species has a very large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence <20,000 km2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation). Despite the fact that the population trend appears to be decreasing, the decline is not believed to be sufficiently rapid to approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations). The population size has not been quantified, but it is not believed to approach the thresholds for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure). For these reasons the species is evaluated as Least Concern.	Brunei Darussalam; Indonesia; Malaysia; Myanmar; Singapore; Thailand; Viet Nam The global population size has not been quantified, but the species is described as local and uncommon on Sumatra, rare in west Java and very scarce on Borneo (Cheke et al. 2001). Distribution size (breeding/resident) is estimated at 1,240,000 km2. The global population trend is assessed to be decreasing.	According to Yong et al, this species is rare and unlikely to occur even in preferred habitat, with fewer than 5 records annually. Now it is confined to the CCNR, although there was a record of 1 bird at Pulau Ubin in 1998 possibly disperse from Malaysia.	Globally it can be found in a variety of habitats including plantations, subtropical/tropical moist lowlands and subtropical/tropical mangrove vegetation above high tide level. Altitudes of 0 to 1,400 m. In Singapore it is confined to primary and seconday forests in the CCNR, usually foraging in the forest canopy but descending regularly to feed on nectar at ginger flowers. It is also known to take insects. Territorial and defends regular foraging areas (eg flower clumps) from conspecifics aggressively. Nest is a basket-like structure of plant matter built beneath a large palm frond with a clutch of 2. (Yong et al. 2013) Forest dependent (Mandai Terrestrial Fauna Interim Report)				Ongoing habitat destruction.		Specialist believes that every record of this species is a youngling, perhaps a visitor from Malaysia, with no record of breeding logged till date.
16	*Ichthyophaga ichthyaetus*	Grey-headed fish eagle	NT	CR	Although widespread, this species is now only locally common and may have a moderately small population, which is thought to be undergoing a moderately rapid population reduction owing to habitat degradation, pollution and over-fishing. It is therefore classified as Near Threatened.	India, Nepal, Sri Lanka, Bangladesh, Myanmar, Philippines, Thailand, Laos, Vietnam, Cambodia, Peninsular Malaysia, east Malaysia, Singapore, Brunei, Greater Sundas and Sulawesi, Indonesia. Apart from India and Bangladesh, the species is rare and declining in its range. This species's global population is preliminarily estimated at 10,000-100,000 mature individuals on the basis that it may not exceed a five-figure total. This estimate equates to 15,000-150,000 individuals in total. A moderately rapid and on-going population decline is suspected on the basis of rates of habitat degradation and levels of pollution and over-fishing.	In Singapore, present in the CCNR, Little Guilin and Kranji marshes. BTNR, Sungei Buloh Wetland Reserve, Bukit Batok Nature Park, Singapore Botanic Gardens. The population in Singapore has steadily grown in recent years, apparently exploiting stocks of fish in the reservoirs. (Yong et al 2013)	It is found near slow-moving rivers and streams, lakes, reservoirs and tidal lagoons in wooded country, usually in lowlands but ascending locally to 1,525 m. In Singapore, it inhabits primary and secondary forests, old plantations and scrub adjacent to inland water bodies, less frequently in coastal areas. Feeds mostly on fish but also takes large lizards and terrapins. It has been recorded to prey on water snakes such as the Tonle Sap water snake (Tingay *et al* ., 2006). It does not tend to re-use nests, which are large bulky structures of sticks, usually built on tall trees near water (eg Albizia *Falcataria moluccana*). Mostly breeds December to March. Clutch size 2. (Yong et al, 2013) Breeding was first recorded on 12 January 1950, in the Central Catchment Nature Reserve, where nest building was observed. Breeding also recorded from October to December 1996 (OBC Bulletin 25). Nest building was recorded in October. Brooding was observed in January, February, October through December. Chicks seen in January and March. Fledgling seen in October. (LKCNHM) It has been to noted to have the ability to forage in waterbodies near urban areas, tolerate heavily degraded habitats such as young secondary scrub dominated by non-native trees and feed on possibly abundant alien prey species in Singapore. Forest dependent (Mandai Terrestrial Fauna Interim Report)				The most pertinent threats are the loss of undisturbed wetlands, over-fishing, siltation, pollution and persecution. The construction of dams on the Mekong River has potential negative implications for the flood regime of Lake Tonle Sap and the Fish-eagle population there.	Understand from specialist consultation that this species was not a resident in Singapore previously but has now colonised Singapore reservoirs in Peirce, and Western Catchment from Malaysia in the 1980s. As the reservoirs are well-stocked with fish, the population has been increasing and now has adapted to Quarry pools. However, still a species that depends on forested areas and need large trees for nesting/roosting. Nest site was observed at the quarantine station at the zoo few years ago, now the suspected nest site is at Nature Reserve area.	
17	*Heliopais personatus*	Masked Finfoot	EN	Not listed	This elusive species has a very small, and very rapidly declining population as a result of the ongoing loss and degradation of wetlands and especially riverine lowland forest in Asia; it therefore qualifies as Endangered.	Heliopais personatus is patchily distributed from north-east India and Bangladesh, through Myanmar, Thailand, Cambodia, Laos and Vietnam to Peninsular Malaysia, Sumatra and Java (one record), Indonesia (BirdLife International 2001). Breeds in East India and parts of mainland Southeast Asia. Apparently winters in Thai-Malay Peninsula and Sumatra (Yong et al 2013). The species appears to have declined dramatically and is now known from comparatively few sites, occurring at low densities everywhere. The population may now number as low as 1,000 individuals (J. C. Eames in litt. 2007), and so is placed in the band 1,000-2,499 individuals. This equates to 667-1,666 mature individuals, rounded here to 600-1,700 mature individuals.	Upper Seletar Reservoir, Sungei Buloh Wetland Reserve At Sungei Buloh, a juvenile male was recorded on 28 Apr 1998 and a female was recorded on 7 Jul 1998, and 12-13 Jan 1999, a male was recorded. Found in reservoirs, streams and coastal areas.	A rare migrant, secretive and usually seen alone. Mangroves and secluded well-forested inlets of reservoirs. Feeds on aquatic invertebrates and small animals such as frogs. Most of world's population breeds in mangrove swamps in the Sunderbans and lowland riverine forests in Kachin, N Myanmar where habitat loss poses a major threat (Yong et al 2013). It occurs principally in rivers in lowland riverine forest including mangroves, but has been recorded in coastal and inland wetlands, such as tidal creeks, flooded forest, swamps and lakes (rarely reservoirs or industrial pools on passage). In the Sundarbans of Bangladesh all records originate from the fresh and brackish waters with no records from the saltwater zone (Gani 2005). Most breeding appears to occur inland while most records are from lowlands, although it has occurred up to 1,220 m on migration. There is an emerging pattern of non-breeding season records in peninsular Thailand, Malaysia and Indonesia and breeding season records in continental South-East Asia, with passage migrants observed between these ranges. It has been observed catching freshwater shrimp, large beetles and small fish (Shepherd 2006), but feeds mainly by gleaning insects from overhanging vegetation (J. C. Eames in litt. 2007). The species is generally very shy and retiring but can appear extremely tame and confiding while incubating, rendering it susceptible to human predation (Neumann-Denzau 2008). The diet of the species is varied, consisting of insects, small fish, amphibians, crustaceans, molluscs, small reptiles, aquatic invertebrates and vegetable matter (Birdbase). All confirmed reports of breeding have occurred in the monsoon, or wet season. Nests have been observed to be built on a fork, naturally formed by branches or the branching trunk. All nest trees observed by Neumann-Denzau *et al* . (2008) in the Sundarbans in Bangladesh were leaning over water at all tide levels and positioned in the first row of vegetation along a creek or in an isolated group of dead trees in the water near the bank. Chicks take about 2-3 days to hatch and leave the nest within a day of hatching (Neumann-Denzau *et al* ., 2008).	The Masked Finfoot's movements remain poorly understood. Baker (1922-1930) suggested that there is local movement after the breeding season, when birds follow streams out of their usual swampy habitat, although this is evidently based on very few sightings and specimen records. There is a highly seasonal pattern of occurrence in the Thai-Malay peninsula, suggesting that the species is probably a non-breeding visitor.			The main threat is the destruction and increased levels of disturbance to rivers in lowland riverine forest, driven by agricultural clearance and logging operations and increased traffic on waterways. Habitats have been further degraded by the removal of bankside vegetation and changes in hydrology resulting from dam construction, and siltation. Hunting and collection of eggs and chicks have been recorded and although their contribution to population declines is probably minimal this requires clarification (Neumann-Denzau 2008); indeed the species is easily caught at the nest making it prey to opportunistic human hunters.	In the Red Data Book, main threats in Singapore are habitat loss, illegal trapping and possibly predation by feral dogs (SRDB, 2008).	Specialist believes that this is a visitor to Singapore with the nearest nesting area being Thailand mangroves. There have been more than 4 records, with 2 records from Mandai area (Upper seletar and mangroves at Sungei Buloh) where there is food availability. A migrant bird is considered one with more regular occurrence; a visitor has a more sporadic occurrence.
18	*Pycnonotus zeylanicus*	Straw-headed Bulbul	VU CITES Appendix II	CR	This species is declining rapidly across its range as a result of high levels of trapping for the cage-bird trade, compounded by habitat loss within its rather specific habitat type. It therefore qualifies as Vulnerable.	Brunei Darussalam; Indonesia; Malaysia; Myanmar; Singapore. *Pycnonotus zeylanicus* is known from Tenasserim, Myanmar (status unknown), south through Peninsular Thailand and Malaysia and Singapore to Sumatra, Java and Kalimantan, Indonesia, Brunei and Sabah and Sarawak (Malaysia) (BirdLife International 2001). Widespread and locally abundant across its range until as recently as two decades ago. Thought to be extinct in Thailand and Java, virtually extinct on Sumatra. May only remain in moderately healthy numbers in peninsular Malaysia, Singapore, and remote Kalimantan. The population size is preliminarily estimated to fall into the band 10,000-19,999 mature individuals. This equates to 15,000-29,999 individuals in total, rounded here to 15,000-30,000 individuals.	Bukit Batok Nature Park, CCNR, Pulau Ubin, Dairy Farm Nature Park Population 100-200 birds. Two or three populations are known to exist. Pulau Ubin has the largest population, Followed by the scattered sites within the main island centred in the centre, north and western parts (SRDB). Pulau Ubin and Bukit Batok, the two most critical sites for this species, and Bukit Timah Nature Reserve are listed as protected areas in the Singapore Green Plan 2012 (NParks Flora and Fauna Web, 2013).	It occupies successional habitats bordering rivers, streams, marshes and other wet areas, where seasonal flooding prevents the establishment of climax communities. These include secondary and disturbed primary evergreen forest, plantations, gardens and cultivation fringe, scrub and, locally, reedbeds and mangroves. It is most frequent in lowlands, but has been recorded (historically) up to 1,100 m and, locally (on Borneo and Sumatra), up to 1,600 m. It is sedentary, generally occurring in pairs or family parties of up to five. In Singapore, secondary forests, forest edge, scrub and plantations along water bodies including rivers, lakes, reservoirs and abandoned quarries. Seldom recorded in tall primary forest. Nest is a cup of sticks, usually high up in a tree from March to May. Pairs or small groups are frequently seen at fruiting trees by the forest edge (Yong et al 2013). Plant diet includes of fruits of Kenidai (Bridelia tomentosa), Red Tree-vine (Loea indica), various figs (Ficus spp.), Indian Cherry (Muntingia calabura) and Macarthur Palm (Ptychosperma macarthurii). It has also been reported to eat the petals of Hongkong Orchid Tree (Bauhinia x blakeana. Animal diet includes arthropods - grasshoppers, spiders, caterpillars and stick insects. There is an observation that it eats the petals of the Hongkong Orchid Tree (Bauhinia x blakeana) (LKCNHM) Woodland Specialist (Mandai Terrestrial Fauna Interim Report)				The quality of its songs makes it a very popular cage-bird, which has resulted in extensive trapping for both domestic and international trade. Its lack of shyness and habit of roosting and nesting in easily accessible locations has compounded its vulnerability to trapping. A single bird cost over US$20 in 1987, after which prices have increased exponentially, and individuals have recently been seen on sale in Medan (Sumatra) for US$1,300. Despite its tolerance of secondary habitats, clearance of lowland forest along rivers has probably contributed to its decline.	Poaching and habitat loss are the greatest threats to this species in Singapore (SRDB, 2008).	Specialist is of the view that Singapore seems to be a stronghold for the straw headed bulbul due to low hunting pressure.
19	*Psittinus cyanurus*	Blue-Rumped Parrot	NT	CR	This newly split and forest-associated species is listed as Near Threatened (IUCN, 2008) because it is assumed to be undergoing a moderately rapid population decline owing to the extensive loss of lowland forests from large areas of the Sundaic lowlands, and it may be impacted by trade. It is not considered more threatened because it can use secondary and modified habitats and also occurs in (less threatened) lower montane forest. In Singapore, it has become more frequently recorded as observers gain better access to the canopy.	*Psittinus cyanurus* is confined to the Sundaic lowlands, where it is known from southern Tenasserim, Myanmar, peninsular Thailand, Sabah, Sarawak and Peninsular Malaysia, Singapore, Kalimantan, Sumatra, Indonesia and Brunei. t is only locally common and generally rarer than sympatric Psittacula species. The global population size has not been formally quantified, but it is thought to number more than 100,000 individuals, and the species is described as common in primary habitat and uncommon in secondary habitats and plantations.	It was once thought to be very rare in Singapore's remnant forest areas; however, it has become more frequently recorded as observers gain better access to the canopy.	It inhabits primary, dry-land evergreen and semi-evergreen lowland forest, both mature and selectively logged, and also visits edge vegetation, cultivated areas and gap-phase growth of forest clearings and occasionally mangroves, up to 1,300 m, although generally below 700 m (Juniper and Parr 1998). It appears to be more readily observed in areas with some logging activity, possibly preferring secondary and logged forest, and has been noted to feed on the fruits of ornamental plants				Regional threats include extensive forest destruction in the Sundaic lowlands of Indonesia and Malaysia. Population decline has also been compounded by trapping for the cage-bird industry. That said, the species' use of logged and fragmented forest, secondary growth, other modified areas and habitats at higher elevations implies that it has not suffered rapid declines.		

S/N	Species	Common Name	Conservation Status		Listing Rationale	Population		Habitat Requirements	Migration	Endemicity	Congregation	Threats		Stakeholder/Expert Comments
			IUCN	SRDB		Global Population and Range	Local Population and Range					Global Threats	Local Threats	
20	*Psilopogon rafflesii*	Red-crowned Barbet	NT	Not assessed	In Singapore, the red-crowned barbet is an uncommon resident and is only observed in the Bukit Timah Nature Reserve and the Central Catchment Nature Reserve in mature secondary and primary forest. Due to its restricted range in Singapore, it was listed as nationally rare in the 1st edition of the Singapore Red Data Book andnationally-near threatened (Wang & Hails, 2007). In the latest (2nd) edition of the Singapore Red Data Book, this species has not been of conservation concern, so unlisted. However, there have been opinions that given scant sightings of the species, the species should be at least conferred the status of nationally vulnerable (Lok *et al*., 2009).	Rates of forest loss in the Sundaic lowlands have been extremely rapid, owing partly to the escalation of illegal logging and land conversion, with deliberate targeting of all remaining stands of valuable timber including those inside protected areas. Forest fires have also had a damaging effect (particularly in 1997-1998). The magnitude of these threats may be allayed by this species's tolerance of secondary and slope forest, although further studies are required to determine whether this species can genuinely persist in these habitats in the absence of adjacent primary habitat (BirdLife International, 2015).	Regular bird in central nature reserves but confined to forest. Specialist opinion is that the local population appears to be in decline.	This species occurs in primary lowland evergreen forest up to 800 m asl. It is also found in tall secondary forest, poor-quality Dipterocarp slope forest and occasionally in rubber plantations.				Rates of forest loss in the Sundaic lowlands have been extremely rapid, owing partly to the escalation of illegal logging and land conversion, with deliberate targeting of all remaining stands of valuable timber including those inside protected areas. Forest fires have also had a damaging effect (particularly in 1997-1998). The magnitude of these threats may be allayed by this species's tolerance of secondary and slope forest, although further studies are required to determine whether this species can genuinely persist in these habitats in the absence of adjacent primary habitat.		Specialist opinion is that this is a regular bird in central nature reserves but confined to forest.
21	*Pitta megarhyncha*	Mangrove Pitta	NT	CR	Although the species is tolerant of disturbance, the near-total removal of the mangrove habitat has caused its extinction on the main island of Singapore and Pulau Ayer Merbau. It is now only known from the mangrove of Pulau Tekong and Pulau Ubin (SRDB, 2008).	Pitta megarhyncha occurs in Bangladesh, India, Myanmar, Thailand, Singapore, Malaysia, and Indonesia. The population size of this species has not been quantified, but it is described as generally scarce to locally common.	At present, the species is found locally on Pulau Tekong Besar and Pulau Ubin.It is no longer found on the main island. Population of the species is estimated at 10-20 birds.	This species occurs in coastal mangroves, as well as in mangrove and Nipa palm stands along tidal rivers, and freshwater swamp forest. It feeds on crustaceans, molluscs and terrestrial insects in drier mud at the bases of mangroves.				Habitat loss: Coastal mangrove forests are suffering severe pressure through clearance for fuelwood, charcoal production and construction materials, as well as for the development of fish and shrimp ponds.	Habitat loss (SRDB, 2008)	The mangrove pitta found in Mandai is a unique record because forest is not its habitat. Attempts to find nesting site in northern mangroves in Singapore but not successful, only found regularly on P. Tekong and P. Ubin. Specialist suspects that the sighting is that of a stray bird/displaced from Johor due to destruction of several coastal mangroves.
22	*Ardea purpurea*	Purple Heron	LC	EN	According to BirdLife International, this species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence <20,000 km2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation. Despite the fact that the population trend appears to be decreasing, the decline is not believed to be sufficiently rapid to approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations). The population size is very large, and hence does not approach the thresholds for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure). In Singapore, they are not considered as threatened as some other herons because they are widespread and able to adapt to a wide range of breeding conditions. However, also affected by habitat destruction and water pollution. Populations in the Malay peninsula are hunted and have their nests raided for eggs (Naturia, 2001).	This species has an estremely large range (hence its IUCN Least Concern status due to range size criterion). The global population is estimated to number c.270,000-570,000 individuals. The overall population trend is decreasing, although some populations may be stable and others have unknown trends.	Widespread and can adapt to a wide range of breeding conditions.	The species inhabits wetlands from sea level to 1,800 m (Madagascar), showing a preference for dense, flooded, freshwater reedbeds (Phragmites spp.) in temperate areas (occupying Typha, Scirpus and Papyrus swamps elsewhere). It also utilises lake shores, river margins, ditches, canals, brackish water lagoons, rice-fields, mangroves and coastal mudflats.				Habitat destruction, water pollution. In Malay peninsula, hunted and eggs are taken. Less tolerant of disturbed and artificial habitats (Naturia, 2001). The main threat to this species in Europe is the loss of reedbeds.		
23	*Spilornis cheela*	Crested Serpent Eagle	LC	CR	According to BirdLife International, this species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence <20,000 km2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation). The population trend appears to be stable, and hence the species does not approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations). The population size has not been quantified, but it is not believed to approach the thresholds for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure). For these reasons the species is evaluated as Least Concern. In Singapore, considered an extremely rare resident where one to two pairs were believed to still survive in 2007.	This species has an estremely large range (hence its IUCN Least Concern status due to range size criterion). The global population size has not been quantified, but the species is described as widespread and common, although locally uncommon .	Currently, birds sighted in Singapore are believed to be visitors and can be found in parts of the CCNR, Bukit Timah, Sungei Buloh, Pulau Tekong and Pulau Ubin (Bird Ecology Group, 2007).	The species appears to inhabit a wide range of subtropical/tropical environments, including Moist Lowland forests, Moist Montane forests, Estuaries, Mangrove Vegetation Above High Tide Level, and Heavily Degraded Former Forests and Plantations.				According to research conducted in 2004, scientists had recommended that remaining forest patches in Kenting National Park (Taiwan) be protected, citing that crested serpent eagles require relatively large patches so they can place their nests away from edges. The protection of forests supporting taller trees in stream valleys (or near to sources of water) were also recommended and further fragmented cautioned against (Chou et al. 2004). Threats to this species can be considered to be habitat degradation and fragmentation.		.
24	*Nisaetus cirrhatus*	Changeable Hawk Eagle	LC	EN	Large range, does not approach thresholds for Vulnerable under range size criterion. Despite the fact that population trend appears to be decreasing, decline not believed to be sufficiently rapid to approach thresholds for VU under population trend criterion. Population size also not believed to approach thresholds for VU in next ten years or three generations.	This species has an estremely large range (hence its IUCN Least Concern status due to range size criterion). The global population size has not been quantified, but the species is described as common to uncommon.		The species appears to inhabit a wide range of environments, including Subtropical/Tropical Moist Lowland forests, Permanent Rivers/Streams/Creeks, Savannah, and plantations and rural gardens. They live in deciduous, semi-evergreen, and logged forest, along with savannah woodland, tea plantations, cultivated regions, and even along the edges of suburban areas. They usually live from 0-1,500 meters above sea level, but are known to occupy habitat as high as 2,200 m.				According to IUCN & BirdLife International, the population is suspected to be declining locally due to ongoing habitat destruction and increased human disturbance (Ferguson-Lees & Christie, 2001).		In Singapore, a 2011 study showed that majority of Changeable Hawk-eagle nests in Singapore were found on Albizia trees within secondary woodland. The study had recommended the conservation of this forest type in Singapore for the continued survival of this species (Tan KH, 2011). Position paper by Nature Society Singapore had cited utilisation of Bukit Brown woodland by the Changeable Hawk-Eagle as part of its justification of the importance of the area for conservation (NSS, nd).
25	*Treron curvirostra*	Thick-billed Green Pigeon	LC	EN	Large range, does not approach thresholds for Vulnerable under range size criterion. Despite the fact that population trend appears to be decreasing, decline not believed to be sufficiently rapid to approach thresholds for VU under population trend criterion. Population size also not believed to approach thresholds for VU in next ten years or three generations. In Singapore, although found in three protected areas, its population levels at the other sites are small and/or are in unprotected areas that may be subject to development. RDB has noted that it is an indicator species for the quality of remaining forest in Singapore and a seed disperser that helps to maintain tree populations. At the time of publication of the RDB, population estimated at 100-200 birds.	The global population size has not been quantified, but the species is described as generally common to abundant.	Species is present in Bukit Timah and Central Catchment Nature Reserves. Vagrants have also been recorded in forests outside of the nature reserves, in e.g. Bukit Brown, Sembawang, Sungei Buloh and Kranji. There is an estimated population of 100 to 200 individuals in Singapore (SRDB, 2008).	The species inhabits Subtropical/Tropical Moist Lowland forests, Mangrove Vegetation Above High Tide Level, and Heavily Degraded Former Forests and plantations. Found in forests, heavily-wooded areas, scrub, orchards, and gardens. It is never found far from old forests but it frequently wanders away from forests to feed on fruiting tree.				There is no record of any substabtial threat to species populations.	In Singapore, habitat destruction. Nomadic and able to move around	
26	*Loriculus galgulus*	Blue-crowned Hanging Parrot	LC	EN	Large range, does not approach thresholds for Vulnerable under range size criterion. Despite the fact that population trend appears to be decreasing, decline not believed to be sufficiently rapid to approach thresholds for VU under population trend criterion. Population size also not believed to approach thresholds for VU in next ten years or three generations. In Singapore, while population seems to have increased since last estimate, still vulnerable and underlying causes are unknown. Remains at unviable levels. True native population believed to be confined to central forests where it is scarce but regular in occurrence.	The global population size has not been quantified, but the species is reported to be common and widespread throughout most of its range.	Species is present throughout the central forests and Botanic Gardens. Vagrants have also been spotted in Sembawang, Sungei Buloh, Yishuin, St John's Island and Pulau Ubin. There is an estimated population of 50 to 100 individuals locally (SRDB, 2008).	The species inhabits Subtropical/Tropical Moist Lowland forests, Mangrove Vegetation Above High Tide Level, and Heavily Degraded Former Forests. In the wild, this parrot eats nectar, flowers, fruits, buds, nuts and seeds.				The species has been heavily traded internationally.	Popular in international bird trade (RDB, 2008). Still valid in Singapore, but currently not posing a serious threat. Status improving. Despite being a woodland bird (wooded habitat), it is starting to adapt away from the woodlands and can be found in suburban areas. Spreading and doing well.	
27	*Chrysococcyx xanthorhynchus*	Violet Cuckoo	LC	EN	Large range, does not approach thresholds for Vulnerable under range size criterion. Despite the fact that population trend appears to be decreasing, decline not believed to be sufficiently rapid to approach thresholds for VU under population trend criterion. Population size also not believed to approach thresholds for VU in next ten years or three generations.	The global population size has not been quantified, but the species is reported to be uncommon in most of its range.		The species inhabits Subtropical/Tropical Moist Lowland forests, Mangrove Vegetation Above High Tide Level, and plantations. Caterpillars are a favourite - in none hairy ones, the bird will swing it vigorously to remove the stomach contents before swallowing. Also takes insects, ants and fruits. Again little is known about its food.				Forest fragmentation (Lambert & Collar, 2002).		
28	*Ketupa ketupu*	Buffy Fish Owl	LC	CR	This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence <20,000 km2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation). The population trend appears to be stable, and hence the species does not approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations). The population size has not been quantified, but it is not believed to approach the thresholds for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure). For these reasons the species is evaluated as Least Concern.	The global population size has not been quantified, but the species is reported to be uncommon to common.		The species inhabits Permanent and seasonal wetland environments such as Rivers/Streams/Creeks/Freshwater lakes, as well as artificial terrestrial environments such as pastureland and urban areas. The Buffy Fish Owl can be found in secondary forests, forest edges, mangrove forests, and rubber plantations. During the day, it usually roosts in a tall tree and emerges at about dusk to hunt. It regularly bathe to keep its feathers in optimum conditions. This owl eats large insects, crabs, fish, frogs, small birds, and mammals like rats. After eating it will cast a pellet consisting of the undigestable parts like feathers, bones, etc.				There is no record of any substabtial threat to species populations.	In Singapore, carelessly discarded fishing lines can pose an entanglement hazard (LCKNHM, 2015) . Habitat loss and disturbance (Lim & Yong, 2011).	
29	*Strix seloputo*	Spotted Wood Owl	LC	CR	Large range, does not approach thresholds for Vulnerable under range size criterion. Despite the fact that population trend appears to be decreasing, decline not believed to be sufficiently rapid to approach thresholds for VU under population trend criterion. Population size also not believed to approach thresholds for VU in next ten years or three generations. In Singapore, largest and most spectacular owl to be found in several parks. Population may number at around 22 or more individuals.	This species has an estremely large range (hence its IUCN Least Concern status due to range size criterion). The global population size has not been quantified, but the species's status is reported to vary from uncommon to common.	Species is found throughout Singapore in e.g. the Central Catchment Nature Reserve, Labrador Nature Reserve, Singapore Botanic Gardens, Jurong Lake and Pulau Ubin. Population may b around 22 or more (SRDB, 2008).	The species inhabits Subtropical/Tropical Moist Lowland forests, Mangrove Vegetation Above High Tide Level, Heavily Degraded Former Forest, plantations and urban areas.				There is no record of any substabtial threat to species populations.	In Singapore, habitat loss and disturbance.	Largest owl in Singapore, most spectacular owl to be found in several parks
30	*Alcedo meninting*	Blue-eared Kingfisher	LC	CR	This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence <20,000 km2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation). Despite the fact that the population trend appears to be decreasing, the decline is not believed to be sufficiently rapid to approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations). The population size has not been quantified, but it is not believed to approach the thresholds for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure). For these reasons the species is evaluated as Least Concern.	This species has an estremely large range (hence its IUCN Least Concern status due to range size criterion). The global population size has not been quantified, but the species is reported to be widespread but seldom common.		The species inhabits Subtropical/Tropical Moist Lowland forests, wetlands, estuaries and plantations.				On an international level, the species is suspected to be in decline owing to clearance of streamside habitat (del Hoyo et al. 2001).		

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			IUCN	SRDB		Global Population and Range	Local Population and Range					Global Threats	Local Threats	
31	*Pycnonotus brunneus*	Red-eyed Bulbul	LC	CR	This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence <20,000 km2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation). Despite the fact that the population trend appears to be decreasing, the decline is not believed to be sufficiently rapid to approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations). The population size has not been quantified, but it is not believed to approach the thresholds for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure). For these reasons the species is evaluated as Least Concern.	This species has an estremely large range (hence its IUCN Least Concern status due to range size criterion). The global population size has not been quantified, but the species is described as generally fairly common throughout its range.		The species inhabits Subtropical/Tropical Moist Lowland forests, swamps, shrubland, Heavily Degraded Former Forest and plantations.				On an international level, global population suspected to be in decline owing to ongoing and rapid deforestation (del Hoyo et al 2005).	In Singapore, a study conducted by Lim and Yong in 2011 found that there is an increasing trend in the number of red-eyed bulbuls counted over a 16 year period, from 1996 to 2011 (Lim & Yong, 2011).	
32	*Copsychus saularis*	Oriental Magpie Robin	LC	EN	This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence <20,000 km2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation). The population trend appears to be stable, and hence the species does not approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations). The population size has not been quantified, but it is not believed to approach the thresholds for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure). For these reasons the species is evaluated as Least Concern. Listed on SRDB due to huge decline in population in 1970s caused by a combination of poaching, habitat destruction and competition from more aggressive Javan and Common Mynas. At time of publication of SRDB, population estimated between 50-150 birds, with less than 50 birds surviving on mainland Singapore in protected areas.	This species has an estremely large range (hence its IUCN Least Concern status due to range size criterion). The global population size has not been quantified, but the species is described as common to abundant, although generally uncommon in the Philippines, while national population sizes have been estimated at c.10,000-1 million breeding pairs in China and < c.10,000 introduced breeding pairs in Taiwan.	In Singapore, the species was formaly very widespread, but it is now reduced to the following sites: Bukit Batok, Serangoon, Punggol, Sembawang, Loyang, Poyan, Khatib Bongsu, Botanic Gardens, Sime Road, Changi, Sungei Buloh, Prince Albert Park and Fort Canning Park. Population is estimated between 50 - 150 birds; less than 50 birds now survive on the main island.	The species inhabits Subtropical/Tropical Dry forests, moist lowland forests, moist montane forests, Mangrove Vegetation Above High Tide Level, shrubland, wetlands, plantations and urban areas. Feeds on insects like alate termites, lizard, and ... Also fruits of the Oil Palm (Elaeis guineensis) that it forages from the ground and Madras Thorn (Pithecellobium dulce).			Poaching, habitat destruction and competition from more aggressive species.	In Singapore, a study conducted by Lim and Yong in 2011 found that there is an increasing trend in the number of oriental magpie robins counted over a 16 year period, from 1996 to 2011 (Lim & Yong, 2011).	
33	*Anthracoceros albirostris*	Oriental Pied Hornbill	LC	CR	This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence <20,000 km2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation). The population trend appears to be stable, and hence the species does not approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations). The population size has not been quantified, but it is not believed to approach the thresholds for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure). For these reasons the species is evaluated as Least Concern. Should the species be found to be declining, it may warrant uplisting to a higher threat category	*Anthracoceros albirostris* is a widespread resident in northern South Asia, southern China, Indochina and western Indonesia. The global population size has not been quantified, but the species is reported to be the commonest Asian hornbill.		The species inhabits Subtropical/Tropical Dry and Moist forests, as well as plantations. Most Asian hornbills are omnivorous, taking both plant and animal foods, although there is a preference for fruits and small animals like Changeable Lizard (Calotes versicola). Mating begins with courtship feeding, as the male offers the female a fruit or a an animal prey. Courtship may also include interlocking of bills. The male then will entice the female to enter an appropriate cavity in an old tree with food. If successful, they will proceed to seal off the entrance leaving a small slit when he can pass on food to her and her chicks. The male even pass on snail shells to the female, possibly as a calcium source.				It was recently noted that this species has been almost completely extirpated from southern China. In the Thai-Malay Peninsula, the species may be threatened by oil-take for the trade in fledglings and outright forest clearance. The casques of Oriental Pied Hornbills are common souvenirs in the markets of Thailand, Laos and Vietnam; however, the extent of this trade has not been measured. However, this species is considered the most adaptable of the hornbills to landscape modification and thus the least threatened owing to its very wide range, small size and broad habitat preferences.		
34	*Stachyris erythroptera*	Chestnut-winged Babbler	LC	EN	This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence <20,000 km2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation). Despite the fact that the population trend appears to be decreasing, the decline is not believed to be sufficiently rapid to approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations). The population size has not been quantified, but it is not believed to approach the thresholds for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure). For these reasons the species is evaluated as Least Concern.	The global population size has not been quantified, but the species is described as generally common.		The species inhabits Subtropical/Tropical Moist Lowland forests, shrublands, Mangrove Vegetation Above High Tide Level, as well as plantations.				Ongoing habitat destruction and fragmentation is suspected to contribute to declining populations.		
35	*Gallus gallus*	Red Junglefowl	LC	EN	This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence <20,000 km2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation). Despite the fact that the population trend appears to be decreasing, the decline is not believed to be sufficiently rapid to approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations). The population size has not been quantified, but it is not believed to approach the thresholds for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure). For these reasons the species is evaluated as Least Concern.	The global population size has not been quantified, but the species is reported to be widespread and common to locally common.	True wild birds are only found on Pulau Ubin and in the Western Catchment. Population is estimated between 50 - 100 birds.	The species inhabits Subtropical/Tropical Moist Lowland forests, Montane forests, Mangrove Vegetation Above High Tide Level, as well as pastureland. Forage on the ground for seeds, fruits and insects			Habitat loss and degradation and over-hunting for food is believed to contribute to declining populations.	Habitat loss and disturbance. Other threats are poacing, and interbreeding with doemsti fowls, which has been reduced with the recent culling of domestic fowls on Pulau Ubin in 2005 (SRDB, 2005).	
36	*Rhinomyias brunneata*	Brown-chested Jungle Flycatcher	VU	Not listed.	This species qualifies as Vulnerable because it has a small, declining population as a result of destruction of lowland forest in its breeding and wintering grounds, primarily through logging for timber and conversion to agricultural production.	The population is estimated to number 2,500-9,999 mature individuals based on an assessment of known records, descriptions of abundance and range size.	In Singapore, it is a rare passage migrant and winter visitor.	It breeds in dense bamboo undergrowth or low bushes in subtropical broadleaved evergreen forests between 600-1,600 m and does not utilise logged forest or artificial plantations. In peninsular Malaysia, it winters almost exclusively in mature primary forest on flat lowland plains (D. Wells in litt. 2004).	In Thailand, passage migrants have been recorded in lowland semi-evergreen rainforest, mixed deciduous forest, and Avicennia mangrove/beach scrub.			It is threatened by the continued loss and fragmentation of habitat in both its breeding and non-breeding ranges. Its requirement for mature primary lowland forest during the non-breeding season makes it particularly susceptible to habitat loss, as very little of such forest now remains. Habitat degradation along the migration route may also be an issue.		
37	*Pycnonotus atriceps*	Black-headed Bulbul	LC	CR	This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence <20,000 km2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation). The population trend appears to be stable, and hence the species does not approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations).	The global population size has not been quantified, but the species is described as locally common throughout much of its range, although very rare in southern China and rare in India. Species occurs from east Pakistan to Indochina and Greater Sunda Islands.	Local population is estimated at 10-15 birds. Restricted to CCNR. Birds believed to have been escapees have recently been found on Pulau Ubin. There has also been one recent record from BTNR.	Broadleaf evergreen forest, mixed deciduous forest and peatswamp-forest, often where fairly open. Feeds in the canopy and forest edge in small local flocks, usually with other species.				The population is suspected to be stable in the absence of evidence for any declines or substantial threats. A true forest species of which little is known.	Local population level is believed to be unviable in the long run. A detailed survey of the catchment area is needed to assess its actual numbers and territory in order to facilitate its conservation.	
Reptiles														
38	*Boiga dendrophila*	Yellow-ringed Cat Snake	Listed in IUCN as a synonym for *Boiga wallichi* but seems to be erroneous	VU	On Ecology Asia, described as mainly occurring in mangrove or riverine habitats.			It occurs mainly in mangrove or riverine habitats. By day it lies motionless on overhanging branches, but at night becomes active coming to the ground and feeding on other vertebrates including rodents, small birds and their eggs, frogs, bats and sometimes other snakes. It is also an adept swimmer. This is a venomous, rear-fanged species. Though it may appear quite docile by day it should not be approached too closely as some specimens may be unpredictable in temperament.					In Singapore, general threats to reptiles are habitat degradation and destruction; human persecution due to venomous nature; and illegal collection (SRDB, 2008).	Doing well elsewhere in region and also occurs in Mangroves (eg Batam or Bintan). In Singapore, confined to forests and mangroves, of which the latter habitat is declining. Still fairly common in nature reserves, but the specialist's overall assessment is VU. This species is nocturnal and hunts along riparian areas for frogs, birds. May be quite faithful to certain streams; venomous, specially attuned to birds.
39	*Chrysopelea pelias*	Twin-barred Tree Snake	Not yet assessed	VU		This species is found from the Malay peninsula to the Greater Sundas	Central Catchment Nature Reserve and Pulau Ubin	This species inhabits lowland moist forests and plantations (David and Vogel 1996), and was recorded recently in the outskirts of Kuala Lumpar (Ismail et al. 2010). This snake is diurnal and predominantly arboreal, however, it can also be found active among bushes, and on the ground in thick vegetation. As with the Paradise Tree Snake, this species is able to glide considerable distances by inverting its ventral surface and launching itself from the tree tops.					In Singapore, general threats to reptiles are habitat degradation and destruction; human persecution due to venomous nature; and illegal collection (SRDB, 2008). Specialist has advised that another threat is roadkill as this species appears to adapt to baordwalks very well. It is a forest species and cannot occur outside the nature reserves, therefore its population is restricted.	Considered a common snake throughout its range. This species is arboreal and possesses an ability to glide; it feeds on geckos lizards to birds and bats (based on its cousin species). Distributed generally through the forest and not restricted to riparian areas.
40	*Coelognathus flavolineatus*	Common Malayan Racer	LC	VU	Common species that faces no major threats, occurs in a variety of human-modified habitats (IUCN, 2012). No apparent threats are recorded and no species-specific conservation measures have been recommended. On Ecology Asia, described as a widespread species of lowland forests that has also adapted well to disturbed habitats (parklands, open , agricultural areas).	This species occurs in the Andaman Islands across southern Myanmar to central Viet Nam, southward through Sundaland. This species is common and abundant in Sumatra. It is rare in the northeastern part of its range.		This species is found in a variety of habitats, primarily in pristine forests, but it can also be found in degraded forest, mangrove swamps and even agricultural areas with remnants of woodland. It has also been found swimming in rivers in non-forested land and probably occurs in palm oil plantations, however it is not yet clear whether oil palm plantations can support viable populations of this species.				This species is threatened by destruction of habitat due to logging and agricultural expansion, as Southeast Asia is experiencing one of the highest rates of deforestation in the tropics (Sodhi et al. 2009) and this species appears to be most abundant in forested habitats. Snakes can however survive in a range of degraded habitats and so this is unlikely to be the primary threat to this species globally. The extent to which degraded areas can maintain viable populations of this snake is unknown. Deforestation is however likely to exert strong pressure at local scales, particularly where snakes are also hunted, and is likely to lead to declines in many of the snakes on which this species feeds (R.P.H. Lilley pers. comm. 2011). The snake is also at risk from harvesting of individuals for skin, food, pets and traditional Chinese medicine. It also faces high levels of persecution by humans throughout its range as the world's largest venomous snake. The possibility of this snake actually representing a complex of species makes all of these threats even more acute, as individual species within the complex will occur over a smaller area and as smaller populations than the currently recognized *Ophiophagus hannah* .	In Singapore, general threats to reptiles are habitat degradation and destruction; human persecution due to venomous nature; and illegal collection (SRDB, 2008).	More widespread than believed because it is a woodland species. However in Singapore several rural areas are being cleared and rural species becoming more restricted. Found in nature reserves and military areas in Singapore where it is able to survive. Also dwells in grassland and suburban estates. Widespread but uncommon.
41	*Dendrelaphis kopsteini*	Red-necked Bronzeback	LC	VU	This species covers a wide geographic range and faces no major threats and is therefore listed as Least Concern.	This species is represented by specimens from southern Thailand, Peninsular Malaysia, Singapore and Sumatra. It has also been recorded from Borneo. The species appears to be common.		In common with some other species in the genus, this snake is commonly found in primary and secondary lowland forest but can also be encountered in gardens in villages. The elevational range is from sea level to about 620 m asl. It mainly feeds on lizards but also on frogs.				It is unknown whether there are any threats to this widespread and at least somewhat adaptable species. Any threats that exist are likely to be localized (IUCN, 2013).	In Singapore, general threats to reptiles are habitat degradation and destruction; human persecution due to venomous nature; and illegal collection (SRDB, 2008).	Woodland species but more restricted to fringes of reserve, not found widespread throughout singapore. Can be found in the nature reserves and similar habitats around nature reserve. This species forages across the landscape and is a ground dweller. Eats mainly lizards.
42	*Gonyosoma oxycephalum*	Red-tailed Racer	LC	EN	Listed a Least Concern on the IUCN Red List on the basis that, while this snake is generally not common, no major threats have been identified and there does not appear to be any impact on the overall population from current levels of exploitation, it occurs in a number of protected areas, and is tolerant of a degree of habitat modification.	This species ranges from Myanmar eastward to central Viet Nam, southward through the Malay Peninsula and in island Southeast Asia as far east as the Philippines and Lombok, Indonesia. This species is common in Borneo but it is generally hard to find in the Philippines. It is uncommon in Viet Nam. Due to high rates of harvesting in parts of its range, it is likely to be suffering local population declines, but the impact of this activity on the global population is unknown.		This is a diurnal, arboreal snake that occurs in primary forest, but appears to prefer edge habitats, secondary growth, plantations and rural gardens. The species occurs up to 1,100m asl.				High rates of local harvesting for the international pet trade or food nd skin, are likely to have led to local population declines but the impact of this activity on the global population is unknown. The scale of exploitation may not be large enough to threaten the species across its range although the effects of harvesting on local subpopulations are unclear. Recommended conservation actions: Research to determine harvest and trade levels of this species to see if these represent threats to its persistence (IUCN, 2012).	In Singapore, general threats to reptiles are habitat degradation and destruction; human persecution due to venomous nature; and illegal collection (SRDB, 2008).	True forest dweller and constrictor, lying in wait to capture prey eg squirrels. Only records outside the nature reserves are from P. Tekong where there are forest fragments. Arboreal, needs taller forest to move about. Requires fairly continuous canopy - may benefit from vine crossings across road.

S/N	Species	Common Name	Conservation Status		Listing Rationale	Population		Habitat Requirements	Migration	Endemicity	Congregation	Threats		Stakeholder/Expert Comments
			IUCN	SRDB		Global Population and Range	Local Population and Range					Global Threats	Local Threats	
43	*Macropisthodon rhodomelas*	Blue-necked Keelback	LC	EN	Due to its wide distribution range and the absence of any major threats, this species is listed as Least Concern on the IUCN Red List.	The species has been recorded from southern Thailand, Malaysia (Peninsular and East Malaysia), Singapore and the Indonesian territories of Sumatra, Bangka, Kalimantan and Java. The species is uncommon in much of its range.		This species is only known from lowland forest near riparian areas. In Peninsular Malaysia it is found in low-lying wet areas up to 200 m asl. This attractively patterned snake occurs in lowland primary and mature secondary rainforest, with a preference for areas near forest streams and swamps. Reportedly it also inhabits waterlogged, grassy areas. The species is terrestrial and semi-aquatic in habits, though there is a record of a juvenile found coiled on a leaf about a metre from the ground. Their prey comprises mainly frogs.				No threats specific to this species have been described.	In Singapore, general threats to reptiles are habitat degradation and destruction; human persecution due to venomous nature; and illegal collection (SRDB, 2008).	
44	*Calliophis intestinalis*	Blue Malayan Coral Snake	LC	VU	Calliophis intestinalis is listed as Least Concern in view of its wide distribution, tolerance of a variety of habitats, including human-modified environments, and because it faces no major threats.	This species occurs from southern Thailand to the Philippines and Sulawesi, Indonesia.		This species has been recorded from primary and secondary tropical moist forest, as well as from town gardens and agricultural fields. On Palawan and Calauit in the Philippines, it has been found in rural gardens and inside forest often close to watercourses.				This species is not known to be used or traded.	In Singapore, general threats to reptiles are habitat degradation and destruction; human persecution due to venomous nature; and illegal collection (SRDB, 2008).	
45	*Ophiophagus hannah*	King Cobra	VU	EN	Ophiophagus hannah has been assessed as Vulnerable. This species has a wide distribution range, however, it is not common in any area in which it occurs (with the apparent exception of Thailand, and there only in forested areas), is very rare in much of its range, and has experienced local population declines of over 80% over 10 years in parts of its range. Pressure on this species from both habitat loss and exploitation are high throughout this snake's range, and while no quantitative population data is available, it can be conservatively estimated that the population size has declined globally by at least 30% over an estimated three-generation period of 15-18 years. More detailed population monitoring in the more poorly-known parts of this snake's range may reveal that this is a conservative estimate.	The King Cobra is widely distributed in South and Southeast Asia. The snake remains common in good habitat in Thailand, where it is a protected species, with no evidence of declines. However, this species is not frequently encountered anywhere else within its wide range		This species is found in a variety of habitats, primarily in pristine forests, but it can also be found in degraded forest, mangrove swamps and even agricultural areas with remnants of woodland. It has also been found swimming in rivers in non-forested land and probably occurs in palm oil plantations, however it is not yet clear whether oil palm plantations can support viable populations of this species.				This species is threatened by destruction of habitat due to logging and agricultural expansion, as Southeast Asia is experiencing one of the highest rates of deforestation in the tropics (Sodhi et al. 2009) and this species appears to be most abundant in forested habitats. Snakes can however survive in a range of degraded habitats and so this is unlikely to be the primary threat to this species globally. The extent to which degraded areas can maintain viable populations of this snake is unknown. Deforestation is however likely to exert strong pressure at local scales, particularly where snakes are also hunted, and is likely to lead to declines in many of the snakes on which this species feeds (R.P.H. Lilley pers. comm. 2011). The snake is also at risk from harvesting of individuals for skin, food, pets and traditional Chinese medicine. It also faces high levels of persecution by humans throughout its range as the world's largest venomous snake. The possibility of this snake actually representing a complex of species makes all of these threats even more acute, as individual species within the complex will occur over a smaller area and as smaller populations than the currently recognized *Ophiophagus hannah* .	In Singapore, main threat is habitat degradation. Other threats include human persecution and collection (SRDB).	
46	*Tropidolaemus wagleri*	Wagler's Pit Viper	LC	EN	This species is listed as Least Concern because it is widely distributed, is present in many protected areas, and the only current threat (illegal collection for the pet trade) does not seem to be heavily impacting its population.	This species occurs disjunctly in Ca Mau and Binh Duong Provinces of southern Viet Nam, and from southern Thailand to Sumatra, Indonesia.		This arboreal species occurs from sea level to 400 m elevation, usually in wet lowland forests, swamps, marshes, mangroves, and coastal swamps. It is almost always found near water. In Sumatra, juveniles are more terrestrial than adults.				Targeted for international pet trade. (IUCN, 2012)	In Singapore, general threats to reptiles are habitat degradation and destruction; human persecution due to venomous nature; and illegal collection (SRDB, 2008).	
47	*Lipinia vittigera*	Yellow-striped Tree Skink (Striped Tree Skink)	Not yet assessed	EN		The species ranges from Burma, Thailand and Vietnam to Peninsular Malaysia, Singapore and Borneo.	Locally, it is confined to Bukit Timah Nature Reserve and Central Catchment Nature Reserve.	This attractive little skink inhabits tree trunks in lowland primary and secondary forest up to 1600 metres elevation. Its diet probably comprises small insects.					In Singapore, general threats to reptiles are habitat degradation and destruction; human persecution due to venomous nature; and illegal collection (SRDB, 2008).	
48	*Cyrtodactylus majulah*	Singapore Bent-toed Gecko	*Not yet assessed. Cyrtodactylus majulah*	Not listed in SRDB but provided as VU by local fauna specialist	Species recently discovered in 2012 (Grismer et al. 2012).	Cyrtodactylus majulah new species is known from Singapore Island, only from the forested areas of the Central Catchment Nature Reserve, and on Pulau Bintan in the Riau Archipelago of Indonesia. Both islands are located off the southern end of the Malay Peninsula.	Cyrtodactylus majulah new species is known from Singapore Island, only from the forested areas of the Central Catchment Nature Reserve.	The type series was obtained in the Nee Soon Swamp Forest, in the north-eastern part of the Central Catchment Nature Reserve that covers the central area of Singapore Island. All fi ve specimens were found on the trunks of small trees in the vicinity of leafy cover 1.5–2 m above the ground. Four other specimens were seen in the same vicinity under the same conditions. One was seen 0.75 m above the ground on the surface of an exposed leaf. The habitat in which the typ series was collected is a lowland equatorial rainforest criss-crossed by small streams. All specimens were found in dense vegetation in the vicinity of water courses. Cyrtodactylus majulah new species is not restricted to swamp-forest habitat, for it has also been observed (KKPL, pers. obs.) in other parts of the Central Catchment Nature Reserve in drier old secondary lowland forest.					In Singapore, general threats to reptiles are habitat degradation and destruction; human persecution due to venomous nature; and illegal collection (SRDB, 2008).	Recent studies have split bent toed geckos into new species - and now in Singapore taxon still uncertain. True forest animal, quite widespread throughout nature reserves, but needs better forest (does not occur in scrubby forests or secondary forests). Mainly an insectivore. Streams and swamp forests, stays close to water.
49	*Hemiphyllodactylus typus*	Lowland Dwarf Gecko	Not listed on IUCN Red List	VU		The Lowland Dwarf Gecko has a widespread distribution ranging from the Indian Subcontinent (including Sri Lanka), throughout Southeast Asia to New Guinea and many islands in the Pacific Ocean.		This small species of gecko seems to prefer the open margins of forested areas, where it is typically seen clinging to the larger leaves of low secondary growth, including shrubs and small trees. It also occurs in mangrove habitat. It feeds on small insects.					In Singapore, general threats to reptiles are habitat degradation and destruction; human persecution due to venomous nature; and illegal collection (SRDB, 2008).	Not restricted to forest, found in back mangroves, secondary woodland and is quite widespread. Nature reserves are still its primary habitat but also species also exists at western catchment and a record at Kranji mangroves. Species seems quite adaptable and favours Dillenia growths (large leafed plants). Arboreal but stays near lower vegetation layers.
50	*Notochelys platynota*	Malayan Flatshell Terrapin	VU	VU	In Indonesia the population declined from extremely common in the late 1980s to reasonably common at present. In Malaysia, trade volume has increased while habitat has decreased. In Thailand considered at least Vulnerable (OEPP 1997). It was traded in East Asian food markets in 1999 at levels of 2–3 tons per day (B. Chan and R. Kan, pers. comms.), after proportionally very high mortality during transport. Listed on CITES Appendix II.	It is widely distributed in Southeast Asia (SRDB, 2008), and is known to occur in Brunei Darussalam; Indonesia; Malaysia; Thailand; Viet Nam.	In Singapore, the species was recorded once in the Western Catchment Area, and very infrequently from theCentral Catchment Nature Reserve.	The species inhabits forest streams where it seems to be nocturnally active and omnivorous.				The trade volume of this species has increased in Malaysia, whilst habitat has decreased. In East Asian food markets it was traded at levels of 2–3 tons/day in 1999, after proportionally very high mortality during transport.	In Singapore, habitat degradation and illegal collection are the main threats (SRDB, 2008).	
51	*Gecko gekko*	Tokay Gecko	Not listed on IUCN Red List	CR		Mostly from northeast India to the Indo-Australian Archipelago		Tropical rainforests, on cliffs and trees. At night it emerges to feed on insects and small vertebrates.				Illegal and legal trading of this species for chinese medicine.		
52	*Draco melanopogon*	Black Bearded Flying Dragon	Not listed on IUCN Red List	VU		Is range encompasses Southern Thailand, Peninsular Malaysia, and Sumatra, Borneo and other Indonesian Islands.	In Singapore it is restricted to the primary forests of Bukit Timah and the mainly secondary forests of the Central Catchment Area.	They inhabit lowland forests. They are often seen on the tree trunk at eye level but will also inhabit the canopy. Its diet comprises mainly ants, termites and other small invertebrates.					Habitat destruction.	
53	*Eutropis rugifersus*	Striped Sun Skink	Not listed on IUCN Red List	EN	Very little is known of the biology of this apparently rare lizard.	Occurs in the Malay Peninsula, Borneo, Sumatra and Java (SRDB, 2008).	In Singapore it is recorded from the Bukit Timah and Central Catchment Nature Reserves (SRDB, 2008).	Generally inhabits Primary lowland dipterocarp forests (LKCNHM). It is also known to inhabit mature forests where it is largely terrestrial and diurnal in habits, amd feeds mainly on small invertebrates (SRDB, 2008).					Habitat degradation.	
54	*Orlitia borneensis*	Bornean Giant River Terrapin	EN	Not listed	Considered Vulnerable in peninsular Malaysia, and Endangered in Indonesia and exported in large quantities despite official protection. Traded in East Asian food markets in huge numbers of animals of all sizes.	This uncommon to rare species occurs in southern Thailand, Peninsular Malaysia, Sumatra and Borneo.	Introduced specimens may occasionally be found in Singapore's reservoirs and feeder streams.	Semi-aquatic; inhabiting large lakes, swamps and slow-flowing river.				Traded in East Asian food markets in huge numbers of animals of all sizes. It is exported in large quantities from Indonesia despite official protection.		
55	*Amyda ornata (listed in IUCN as Amyda cartilaginea)*	Asian Softshell Turtle	VU	EN	The security of a wide distribution and occurrence in protected areas is offset by specific demand for this species in the consumption trade, currently traded at levels of tons per day.	Brunei, Thai-Malaya	CCNR	Lowland forest streams in forested areas.				The security of a wide distribution and occurrence in protected areas is offset by specific demand for this species in the consumption trade, currently traded at levels of tons per day. Listed on CITES Appendix II		
56	*Cnemaspis peninsularis*	Peninsular Rock Gecko	Not yet assessed	VU (as *Cnemaspis kendallii*)	On Singapore, appears to be restricted to the Bukit Timah and CCNR. However more sightings of the species have been made from Thomson Ridge and Venus Drive area.	Peninsular Malaysia and Singapore	Bukit Timah, CCNR, Venus Drive, Thomson Ridge	Primary or secondary forests up to 1500 m, preferring damp cave entrances or rocky outcrops but also tree trunks. Largely nocturnal but can be active on dull afternoons.		Only in Peninsular Malaysia and Singapore				
Amphibians														
57	*Hylarana baramica*	Golden-eared Rough-sided Frog	LC	VU	Listed as Least Concern in view of its wide distribution, presumed large population, and because it is unlikely to be declining fast enough to qualify for listing in a more threatened category.	This species is known from Johor and Selangor States, in Peninsular Malaysia, from the island of Singapore, and from a number of localities on Borneo in Sabah and Sarawak (Malaysia) and Kalimantan (Indonesia). It is also present on Natuna Besar Island, Pini and Tanah Masa islands in the Mentawai Islands, and on the islands of Sumatra, Bangka and Java, all in Indonesia.	It is considered uncommon in Singapore.	It is known from a variety of lowland floodplain situations, including peat swamp forest and swampy flatland primary forest at low elevations, usually in swampy areas. It breeds in water, but its breeding habits are very poorly known.				Based on IUCN Red List, further loss of swampy habitat is the main threat to this species.	In Singapore, general threats to amphibians are habitat degradation, loss and disturbance (RDB, 2008). The current population trend is believed to be decreasing.	
58	*Nyctixalus pictus*	Spotted Tree Frog (Cinnamon Bush Frog)	NT	VU	Listed as Near Threatened since although this species is still relatively widely distributed, it depends on areas of undisturbed forest habitat, and so its Extent of Occurrence is probably not much greater than 20,000 km2, and the extent and quality of its habitat is declining very rapidly due to widespread forest loss within its range, thus making the species close to qualifying for Vulnerable.	This species is found from Yala in extreme southern Thailand through Peninsular Malaysia, Singapore, Sumatra (including Siberut in the Mentawai Islands) in Indonesia, northern parts of Borneo (both Malaysia and Indonesia), and Palawan in the Philippines. It is widespread but nowhere is it common.		Adults live in the shrub and lower tree strata in primary and secondary forests. This species breeds by larval development in arboreal water-filled cavities and in rotting logs.				Major threat is forest clearance due to agriculture and logging.	In Singapore, general threats to amphibians are habitat degradation, loss and disturbance (SRDB, 2008).	
59	*Kalophrynus limboolutti*	Lim's Black-spotted Sticky Frog	Not yet assessed	*Kalophrynus limboolutti* formerly confused with K. *pleurostigma* , the latter which is listed as VU in the Red Data Book. K. *limboolutti* not listed in RDB		Southern part of Peninsular Malaysia	Bukit Timah Nature Reserve	On Gunung Pulai, Gunung Ledang, and Gunung Lambak, males were found calling in widely scattered choruses at dry nights (from 1930 h) in early September in the dense secondary broad-leaf forest. Calling males hid themselves among dead leaves and were very difficult to locate, but responded to playback of recorded calls and/or whistles imitating their calls. There were no large bodies of water at the calling sites. At Sungai Kenaboi, calls were heard in secondary and bamboo forests on dry night.					In Singapore, general threats to amphibians are habitat degradation, loss and disturbance (RDB, 2008).	True forest species confined to nature reserves, fairly common on BTNR, MacRitchie and good forest; in Mandai beginning to get records but very few. Very sensitive to any changes. According to specialist's opinion, this species should be categorised as VU.
	Specialist advice: All three frogs are inclined to inhabit forests. Out of these 3, the Golden-eared Rough Sided Frog is a swamp species and the Spotted Tree Frog is found in proper good forest (but it is able to adapt to secondary forest and dry forest). The latter species is also considered a low-arboreal dweller, nesting in treeholes and logs. The Black Spotted Sticky Frog can be found in forest, breeding pitcher plants (ideally *Nepenthes*													
Invertebrates														
60	*Pseudothemis jorina*	Banded Skimmer	LC	CR	This is a widespread species in southeast Asia, with no known major threats. It is therefore assessed as Least Concern.	This species is known from Thailand, Cambodia, Viet Nam, Lao PDR, Malaysia, Brunei, and Singapore.	Recorded at MacRitchie Reservoir, Kranji, Singapore Botanic Gardens, Kent Ridge Park, Jurong Lake and the forest edges of Bukit Timah Nature Reserve (LKCNHM)	It occurs in lentic bodies and slow flowing rivers; exposed, mostly tree-lined weedy ponds and lakes (uplands and lowlands). In Singapore, preference for large open water bodies such as ponds and lakes (LKCNHM). When active, the male spends most of his time on the wing, perching orly briefly and intermittently on floating twigs or vegetation. The male is sometimes seen hovering over a fixed spot, very close to the vegetation and close to the water surface. This species seems to be most active during the morning. By noon and later, it becomes less active. This species has been observed to swarm in the company of *Rhyothemis phyllis* and *Rhyothemis obsolescens* . Female oviposits on twigs floating on the water surface.				No major threats have been found to affect the species.		
61	*Ypthima fasciata torone*	Malayan Six Ring	Not Assessed	CR	Listed in the SRDB because it is considered part of Singapore's indigenous biological heritage, and of general educational value and interest to the public and enthusiasts.	South east Asia	Observed rarely in the northern part of Singapore mainland, particularly in the forested areas in Mandai.	Grassy areas, usually under shade. Early stages of this species is dependent on various species of grasses.				Possibly loss of habitat, particularly loss of preferred grassy habitat.	Loss of habitat and availability of host plants (SRDB, 2008).	
62	*Agrionoptera sextilineata*	Handsome Grenadier	Not Assessed	CR		Confined to Sundaland	Swamp forests in the CCNR; sometimes seen in the Singapore Botanic Gardens and Swiss Club Road.	In Singapore, this species favours leafy ponds in swampy forests in the Central Catchment Nature Reserve. Males are often seen perching on a twig for long periods. During oviposition, the male guards the female, hovering or perching on a twig near to where the female is laying her eggs, usually above a puddle of stagnant water. Larvae emergence has been observed to be quick and straightforward. Forest dependent (Mandai Terrestrial Fauna Interim Report)						
63	*Euripus nyctelius euploeoides*	Courtesan	Not Assessed	CR	Listed in the SRDB because it is considered part of Singapore's indigenous biological heritage, and of general educational value and interest to the public and enthusiasts.	Distributed within South-east Asia fro mPeninsualr Malaysia to the Philippines	Occasionally seen in the Singapore Botanic Gardens, Southern Ridges, at Upper Peirce Reservoir Park and at various locations in the forest reserves. The species has been recorded before in 1997 at the fringes of Mandai Orchid Gardens (Butterfly Circle, 2008). Most often seen in the Mandai locality in Singapore and around the forested areas in the vicinity.	Known host plant on which the species has been bred in Singapore is *Trema tomentosa* (Butterfly Circle, 2008). Another host plant is *Trema cannabina* . Males are territorial. Typically found in an area where host plants are thriving. Both host plants are native to Singapore. The preservation of its preferred habitats and its host plant (*Trema tomentosa*) would be critical to this species' continued survival in Singapore.					Loss of habitat and availability of host plants (SRDB, 2008).	

S/N	Species	Common Name	Conservation Status		Listing Rationale	Population		Habitat Requirements	Migration	Endemicity	Congregation	Threats		Stakeholder/Expert Comments
			IUCN	SRDB		Global Population and Range	Local Population and Range					Global Threats	Local Threats	
64	*Camacinia gigantea*	Sultan	LC	CR	*Camacinia gigantea* is a widespread species, whose range of habitats includes rather disturbed ones. Although some populations are likely to be threatened but coastal developments, it is not threatened across its entire range and is assessed as Least Concern.	*Camacinia gigantea* is widely distributed from India to Viet Nam and southwards to New Guinea.		This species breeds in shallow stagnant waters. It is mainly found near the coast, at lagoons and shallow ponds, and at the rearward edges of mangrove, although it is also sometimes encountered far inland (e.g. Chiang Mai in Thailand). In Sarawak numbers of this species have been reported on shallow coastal pools that dry up after a few days without rain. It appears to be tolerant of disturbance.				Individual populations are threatened by development in coastal areas and loss of mangrove, but overall this species does not apear to be threatened.		
65	*Irmengardia johnsoni*	Johnson's freshwater crab	VU	Not Assessed	Its extent of occurrence is approximately 30 km² found in one remnant of forest in Singapore city, parts of which are protected areas. However this area is likely to remain well-protected. Therefore although it might qualify as CR if there was a continuing decline in habitat extent or quality, it is classed here as VU under D2 due to the fragility of this forest fragment in the middle of a city.	Endemic to Singapore	BTNR, various parts of the CCNR, especially in the Nee Soon Swamp Forest	Prefers slower parts of shaded streams, sometimes found under rocks but usually amongst leaf litter with muddy substrates. Not an obligate highland crab and can commonly be found in lowland secondary forest streams. Predominantly feeds on dead leaves and freshwater oligochaete worms; Shallow slow flowing waters with dense leaf litter and mud in well shaded swamp and forest streams. Feed on dead leaves and worms.		Singapore			Habitat degradation and water pollution.	
66	*Drupadia rufotaenia rufotaenia*	Pigymy Posy	Not Assessed	CR	The small area of its known occurrence makes it vulnerable to any habitat loss or disturbance, or loss of food plants, and lack of knowledge about it makes management difficult.	-	Forest butterfly, only rarely been observed in the CCNR	Forest				-	Small area of its known occurrence makes it vulnerable to any habitat loss or disturbance, or loss of food plants, and lack of knowledge makes management difficult.	
67	*Cratilla lineata*	Line Forest-skimmer, or Pale-faced Forest-skimmer	LC	CR	Given the very extensive range for this species and its common occurrence in forested areas throughout much of the entire Indo-Malay zoogeographic region it is not considered to be threatened. It is therefore listed as Least Concern.	Cratilla lineata is an abundant and widespread species ranging from the west coast of India through Indo-China, southern China including Taiwan and Hainan to the Philippines and Indonesia.	-	Occurs in forested areas in lowland and montane regions. Prefers shaded muddy forest pools but will occur in a wide range of lentic forest habitat.				Loss of lowland forest habitat throughout much Oriental Region will undoubtedly have reduced the available habitat for this species. It is common in primary forested locations, but it is a highly dispersive species and has able to colonise secondary forested areas in south China.		
Flora														
68	*Adiantum flabellulatum*		Not Yet Assessed	EN		Global distribution includes Thailand, Laos, Cambodia, India, Burma, SW and S China, Vietnam, Taiwan, throughout Malesia, and northwards to southern edge of Japan.		On humus-rich ground in rather open forests at medium altitudes					According to SRDB, the primary threat to plant species in Singapore is habitat degradation and destruction. All plants in Category D are also considered threatened due to absolute population size.	
69	*Artabotrys maingayi*		Not Yet Assessed	CR		Peninsular Malaysia								
70	*Artabotrys suaveolens*		Not Yet Assessed	EN		India and SEA, to the Philippines and Moluccas		Closed, old-growth forests. Fruits apparently eaten by primates (in the region, gibbons and Orang Utans)						
71	*Daoyamaschalon daoyamaschalum*		Not Yet Assessed	CR		TM		Lowland forest.						
72	*Polyalthia rumphii*		Not Yet Assessed	CR		Peninsular Malaysia, Sumatra, Java, Borneo (Sarawak, Brunei, Sabah, West-, Central-, South- and East-Kalimantan), Philippines, Celebes, Moluccas, New Guinea and the Solomon islands.		Sub-canopy tree up to 26 m tall and 45 cm dbh. In undisturbed forests up to 950 m altitude. More or less growing all over the forest, from alluvial sites to hillsides and ridges. Mostly on sandy-clay soils, but also found in limestone areas. Quite often found in disturbed forests, but usually as a pre-disturbance remnant.						
73	*Anodendron candolleanum*		Not Yet Assessed	CR		-	Pulau Semakau	Coastal forest						
74	*Hoya latifolia*		Not Yet Assessed	EN		Peninsular Malaysia		Mangroves, forests						
75	Strophanthus caudatus		Not Yet Assessed	CR		S Guangxi, cultivated in Taiwan; Cambodia, India, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam								
76	*Tabernaemontana corymbosa*		LC	EN		Brunei Darussalam; China; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Singapore; Thailand; Viet Nam								
77	*Epipremnum pinnatum*		Not Yet Assessed	CR		Temperate Asia, SEA, Oceania and Pacific Islands		Forests but can be cultivated as an ornamental plant. Can climb into canopy of mature trees forming dense stands - is considered an invasive in some countries.						
78	*Nenga pumila var. pachystachya*		-	CR		Sumatra (type), Peninsular Malaysia, Borneo, Thailand		Lowland dipterocarp forest; more rarely in peat swamp forest.						
79	*Pinanga malaiana*			EN		Peninsular Malaysia (type) and Sumatra, Thailand.		Lowland rainforest, to 800 m altitude.						
80	*Canarium pilosum*		-	EN		Peninsular Malaysia, Sumatra and Borneo.	Bukit Timah Nature Reserve, in the vicinity of Seletar Track	Tree, 10-28(-37) m by 20-45(-65) cm. In undisturbed mixed dipterocarp forests up to 400(-1500) m altitude. On hillsides and ridges with sandy soils and swamps.						
81	*Dacryodes longifolia*		-	CR		Peninsular Malaysia, Sumatra, Borneo, Philippines.		Mid-canopy tree up to 40 m tall. In undisturbed mixed dipterocarp and sub-montane forests up to 1700 m altitude. Usually on hillsides and ridges with sandy to peaty soils.						
82	*Santiria tomentosa*			EN		Thailand, Peninsular Malaysia, Sumatra, Borneo (Sarawak, Brunei, Sabah, West-, Central-, South- and East-Kalimantan).		Upper canopy tree up to 50 m tall and 86 cm dbh. In undisturbed mixed dipterocarp and keranga forests up to 500 m altitude. Found throughout the forest, from alluvial sites to ridges. Usually on sandy soils, but also on clay and occasionally on limestone. In secondary forests usually present as a pre-disturbance remnant tree.						
83	*Trimma malaccensis*		-	EN		Sundaland		Emergent tree up to 56 m tall and 99 cm DBH. In undisturbed forests up to 300 m altitude, found throughout forest along rivers, hillsides and on ridges. Usually on sandy soils. In secondary forests usually present as a pre-disturbance remnant tree.						
84	*Calophyllum rubiginosum*			EN		Distributed from Southern Malay Peninsula to Sumatra and Borneo	Bukit Timah Nature Reserve, Central Catchment Nature Reserve	C. rubiginosum is found in lowland or hilly forests, from 30 - 500 m elevation. Flowering occurs from January to May, and from July to August. Fruiting also occur twice: April to July and October to December.						
85	*Gironniera subaequalis*		-	EN		From southern China to New Guinea.		Trees, 10-20(-30) m tall, d.h.h. 25-50(-100) cm. In forested valleys, beside streams; 100-1300 m elevation.						
86	*Salacia grandiflora*			CR		East Asia, Southern India, Myanmar, Thailand, Malaysia, Indonesia		Lowland forests, at elevations of up to 750 m. Common plant in woods and open country. Climbing plant.						
87	*Salacia korthalsiana*			CR		SEA		Forests, sometimes on limestone rock. Climbing shrub that can be up to 18 m long; can grow into a tree up to 10 m tall.						
88	*Garcinia forbesii*		-	CR		Malaysia and Indonesia (Sumatra, Kalimantan)	CCNR	Evergreen tree in the understorey of evergreen, tropical rain forests and lower and upper montane forests up to 1,700 m in elevation. Tolerates heavy shade and thrives in well-drained, organic matter rich soils. Small to medium tree reaching 18 m high with trunk diameter 90 cm.						
89	*Garcinia griffithii*	Apple-Kandis	-	EN		Peninsular Thailand and Malaysia; West Malesia		Tree, 12-18 m tall. Common in lowland forests.						
90	*Garcinia nigrolineata*	Beaked Kandis	-	CR		Southeast Asian mainland into Peninsular Malaysia.		Forest understoreys.						
91	*Garcinia scortechinii*		LC	CR		Found throughout Malaya.		Lowland species.						
92	*Agelaea macrophylla*		-	CR		Malaysia, Indonesia, Singapore		Primary and secondary forests, also on marshy soils and on limestone rocks, at elevations up to 750 m. Usually a climbing woody plant and sometimes adopts a more shrub like habit.						
93	*Connarus semidecandrus*		-	CR		Philippines, Malaysia, Singapore	Springfield Road, Mandai	Climber						
94	*Rourea mimosoides*		-	EN		SEA, Andaman and Nicobar Islands		Lowland and hill forests at elevations up to 750m. Occurs in habitats ranging from beach forest, river banks, roadsides, bamboo forest and shrubberies to secondary and primary forests. Vigorous climbing shrub that can be 50 m long.						
95	*Rourea minor*		-	CR		Guangdong, Taiwan, Yunnan; Cambodia, India, Laos, Sri Lanka, Thailand, Vietnam; N Australia.		Dense mixed forests, bamboo woods, thickets, hills; below 800 m.						
96	*Anisoptera megistocarpa*		CR	CR		Indonesia (Sumatera); Malaysia (Peninsular Malaysia); Singapore LKCNHM, Southeastern Thailand, Malay Peninsula, Singapore, northern Sumatra.	Bukit Timah Nature Reserve, CCNR	A large tree scattered throughout mixed dipterocarp forest on well-drained soil. According to LKCNHM, large emergent tree with tall buttresses that can grow up to more than 1 m in diameter. Found scattered on well-drained, undulating lowland hills. Primary forest species.				Habitat has been widely cleared and destroyed. According to LKCNHM, high silica-containing wood is hard to saw and thus not as popular. Used for light construction and interior construction such as flooring and doors.		
97	*Hopea mengarawan*		-	EN		Peninsular Malaysia, Sumatra, Borneo.	Bukit Timah Nature Reserve	Upper canopy tree up to 44 m tall and 103 cm dbh. In undisturbed mixed dipterocarp forests up to 500 m altitude. Usually on ridges and hillsides with poor sandy to clayey soils, also on ultrabasic.						
98	*Shorea ovalis ssp. ovalis*			CR		[*Shorea ovalis*] Peninsular Malaysia, Sumatra, Borneo.		[*Shorea ovalis*] Upper canopy tree up to 49 m tall and 138 cm dbh. In undisturbed mixed dipterocarp forests up to 700 m altitude. Usually on hillsides and ridges, rarely alluvial. Mostly on (coarse) sandy to clayey soils.						
99	*Elaeocarpus obtusus* ssp. *apiculatus*			CR										
100	*Alchornea tiliifolia*		-	CR		E. Himalaya, Assam Burma, S. China, Indo-china. Andamans, Malay Peninsula.		Shrub or small tree 3–12 m high. In shade in evergreen forest, sometimes near stream from altitude 500 m up to 1300 m.						
101	*Antidesma velutinosum*		-	EN; cultivated		West Malesia		This is a shrub that can develop into a small tree of about 7-10 m tall.						
102	*Croton oblongus*		-	EN		Thailand, Peninsular Malaysia, Sumatra, Java, Lesser Sunda Islands, Borneo (Sarawak, Brunei, Sabah, West-, Central- and East-Kalimantan), Philippines, Celebes, Moluccas, New Guinea.		Understorey tree up to 19 m tall and 26 cm dbh. In undisturbed mixed dipterocarp and sometimes swamp forests up to 700 m altitude. Mostly on hillsides and ridges, sometimes alluvial. Usually on sandy soils, but also on clay and limestone. In secondary forests usually present as a pre-disturbance remnant tree.						
103	*Macaranga hullettii*		-	CR		Peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo.		Understorey tree up to 18 m tall and 32 cm dbh. In undisturbed to disturbed mixed dipterocarp, keranga and sub-montane forests up to 1350 m altitude. Usually on alluvial sites and along rivers. Mainly on rocky to sandy soils, but also on clay. This species is not one of the very high-light demanding species of Macaranga; it has medium growth and photosynthetic rates, and is often found in partial shade within primary mixed dipterocarp forests.						
104	*Macaranga trichocarpa*		-	EN		India, Burma, Indo-China, Thailand, Peninsular Malaysia, Sumatra, Borneo.		Shrub up to 7 m tall and 6 cm dbh. Usually gregarious in severely disturbed mixed dipterocarp forests, but sometimes also found in the understorey, up to 600 m altitude. Locally common in scrub, along roadsides and forest edges, mostly on hillsides and ridges.						
105	*Archidendron microcarpum*		-	EN		Peninsular Malaysia, Sumatra, Borneo.		Small, straight-boled tree to 22 m high, bole up to 10.5 m high, 39 cm in diameter. Light primary and secondary rain forest, forest margins, along rivers, common on hillsides and ridge-tops, also in swampy forest; soil: sandy, sandy loam, lateritic, black, or ultrabasic; altitude 0-500(-1200 m).						
106	*Dialium platysepalum*		-	CR		Peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo, Philiepines.		Upper canopy tree up to 45 m tall and 120 cm dbh. In undisturbed mixed dipterocarp and swamp forests up to 500 m altitude. On alluvial sites, but also on hillsides and ridges. On sandy to clay soils.						
107	*Koompassia malaccensis*		-	EN		Peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo.		Emergent tree up to 56 m tall and 149 cm dbh. In undisturbed mixed dipterocarp, (peat)-swamp and sub-montane forests up to 1100 m altitude. Usually on hillsides and ridges on clay to sandy soils.						
108	*Kunstleria ridleyi*		-	EN		Native to Singapore.		Climber. Prefers full sun to semi-shade conditions and moderate water.						
109	Ormosia bancana		-	EN		Native to Singapore.		Tree. Prefers full sun and moderate water conditions.						
110	*Paraderris elliptica*			EN		Native to Cambodia, India, Indonesia, Laos, Malaysia, Philippines, Thailand, and Vietnam.		Lianas.						
111	*Peltophorum pterocarpum*	Yellow Flame, Yellow Flamboyant, Copper Pod	-	CR		From India and Sri Lanka, through Southeast Asia to Australia		Inhabits terrestrial environments (Coastal forests) and shorelines (Mangrove forest, sandy beach). Prefers light to medium well-drained alkaline soils although it can also tolerate clay soils.						
112	*Pongamia pinnata*	Seashore Mempari, Karun Tree, Indian Beech		EN		Indian Ocean Islands, Indian Subcontinent, Sri Lanka, Southern China, Taiwan, Japan, Vietnam, Thailand, Philippines, Malaysia, Singapore, Papua New Guinea, Australia and Pacific Islands.	Pulau Pawai, Pulau Tekong and Pulau Ubin.	Inhabits terrestrial environments (Coastal forests, riverine) and shorelines (Mangrove forest, sandy beach, rocky beach).						
113	*Sindora wallichii*		-	CR		Peninsular Malaysia, Sumatra, Borneo (Sabah, West-, Central- and East-Kalimantan).		Upper canop tree up to 50 m tall and 192 cm dbh. In undisturbed mixed dipterocarp forests up to 200 m altitude. On ridges. In secondary forests usually present as a pre-disturbance remnant tree.						
114	*Spathoda bus ridleyi*			CR		Suspected endemic to Singapore	Endemic	Climber in the nature reserves.						
115	*Castanopsis wallichii*		VU	CR		Kedah, Penang, Perak, Selangor, Malacca and Singapore		Tree. Lowland rainforest.				Much of the remaining habitat is under threat from development, logging and wood harvesting.		
116	*Lithocarpus conocarpus*		Not Assessed	CR		Peninsular Malaysia, Sumatra, Java, Borneo (Sarawak, Brunei, Sabah, Central- and East-Kalimantan), Singapore		Mid-canopy tree up to 38 m tall and 54 cm dbh. Often found near forest margins or in disturbed areas. In undisturbed mixed dipterocarp, keranga and sub-montane forests up to 1700 m altitude. Usually on hillsides and ridges with clay to sandy soils. In secondary forests usually present as a pre-disturbance remnant tree. Pollinators include a diverse assemblage of insects, which feed on pollen, most of which is trapped in the pistillode as the anthers extend at anthesis (Cannon, 2001). Host plant to the *Flos anniella anniella* (Darky Plushblue). Tree occupies all elevational zones and most habitats, except mangrove swamps, and attains highest diversity and density in lower montane forests on relatively poor soils (1000-2000 m). Occasionally forms dense stands along forest margins and roadcuts at elevations above 1500 m.						
117	*Lithocarpus ewyckii*		-	EN		Peninsular Malaysia, Sumatra and Borneo.		Large trees up to ca. 50 m tall and 90 cm diameter. In primary hill mixed dipterocarp forest, including kerangas forest, to montane forest, at 200 C2000 m altitude, on sandy loam and clay soils.						
118	Cratoxylum formosum		LC	EN		Hainan, Indo-China, Andaman Islands, Peninsular Malaysia, Sumatra, Java, Borneo, Philippines, Celebes.		Widespread species found mainly in lowland primary and secondary forest recorded on many soil types. Sub-canopy tree up to 35 m tall and 39 cm dbh. In undisturbed mixed dipterocarp to secondary forest, keranga, (peat)-swamp, mangrove and coastal forests up to 600(-1200) m altitude. Mostly on alluvial sites, but also on hillsides and ridges. On sandy to ultrabasic soils.						

S/N	Species	Common Name	Conservation Status		Listing Rationale	Population		Habitat Requirements	Migration	Endemicity	Congregation	Threats		Stakeholder/Expert Comments
			IUCN	SRDB		Global Population and Range	Local Population and Range					Global Threats	Local Threats	
119	*Cratoxylum maingayi*		LC	CR		Cambodia, Indonesia, Malaysia, Myanmar, Singapore, Thailand, Vietnam		A rare tree found scattered in lowland primary and secondary forests. Mainly deciduous shrub or tree growing up to 20 m tall, occasionally 35 m tall. Lowland forest and on limestone hills, at elevations from 300 - 800 metres, occasionally descending to 60 metres. Grows on lowland limestone substrates. Plant & Rootzone preference/tolerance includes moist soils, well-drained soils and fertile loamy soils. Pollinated by insects (Useful Tropical Plants Database, 2014). Lifespan in Singapore is perennial (NParks Flora & Fauna web)				The trees are cut for derum timber but are not commercially exploited because they are too scarce.		
120	*Alseodaphne hancana*		Not Assessed	CR		Peninsular Malaysia, Sumatra, Borneo (Sarawak, Brunei, Sabah, Central- and East-Kalimantan), Singapore, Bangka Isl., Moluccas	Gardens' Jungle, Bukit Timah, Mandai Road	Mid canopy tree up to 40 m tall and 66 dbh. In undisturbed mixed dipterocarp, swamp, keranga and sub-montane forests up to 1100 m altitude. Usually on hillsides and ridges, but also in or near swamps and along rivers. Usually on rich clay soils, but also on poor sandy soils. In secondary forests usually present as a pre-disturbance remnant tree.				Wood is used for construction purposes and boat making.		
121	*Beilschmiedia kunstleri*			CR		Peninsular Malaysia, Borneo (throughout the island).		Sub-canopy tree up to 30 m tall and 93 cm dbh. In undisturbed mixed dipterocarp, swamp, keranga and sub-montane forests up to 900 m altitude. On alluvial sites as well as hillsides and ridges. On clay to sandy soils. In secondary forests usually present as a pre-disturbance remnant tree.						
122	*Beilschmiedia madang*		-	EN		Peninsular Malaysia, Sumatra, Java.		Tree up to 25 m tall. In forests up to 900 m elevation.						
123	*Cryptocarya griffithiana*			CR		Burma, Thailand, Peninsular Malaysia, Sumatra, Borneo (Sarawak, Brunei, Sabah, Central- and East-Kalimantan), Philippines, Celebes, Moluccas.		Sub-canopy tree up to 27 m tall and 29 cm dbh. In undisturbed mixed dipterocarp, peat-swamp, keranga, coastal and sub-montane forests up to 1700 m altitude. Common on both alluvial as well as dry sites, usually on sandy soils, but also on clay and limestone. In secondary forests usually present as a pre-disturbance remnant tree.						
124	*Litsea accedens*		-	EN		Peninsular Malaysia, Sumatra, Borneo (Sarawak, Sabah, West- and East-Kalimantan), Celebes, Moluccas.		Mid-canopy tree up to 34 m tall and 37 cm dbh. In undisturbed mixed dipterocarp, keranga and sub-montane forests up to 1200 m altitude. Usually on hillsides and ridges with shallow sandy to rocky soils, but also on clay. In secondary forests usually present as a pre-disturbance remnant tree.						
125	*Litsea cuitanea*		-	EN		Peninsular Malaysia, Sumatra, Java, Borneo (Sarawak, Sabah, East-Kalimantan).		Upper canopy tree up to 41 m tall and 87 cm dbh. In undisturbed mixed dipterocarp, keranga and sub-montane forests up to 1900 m altitude. Usually on ridges with sandy soils, but also found on limestone. In secondary forests usually present as a pre-disturbance remnant tree.						
126	*Litsea erectinervia*		Not Assessed	CR		Peninsular Malaysia, Sumatra, Borneo (Sarawak, West- and East-Kalimantan), Singapore	Nee Soon Swamp Forest	Mid canopy tree up to 31 m tall and 60 cm dbh. In undisturbed mixed dipterocarp forests up to 900 m altitude. Found on ridges and clay soils. In secondary forests usually present as a pre-disturbance remnant tree. It grows in lowland forests. It occurs locally in Nee Soon Swamp Forest. A study conducted in the forests of Peninsular Malaysia to examine the association of Litsea complex and soil properities found that *L. erectinervia* is correlated with potassium (Khamis and Nizam, 2013).						
127	*Litsea ferruginea*		Not Assessed	CR		Peninsular Malaysia, Sumatra, Java, Borneo (Sarawak, Sabah, East-Kalimantan), Celebes, Moluccas, Australia, Singapore	Nee Soon Swamp Forest, Bukit Timah Nature Reserve	Understorey tree up to 21 m tall and 59 dbh. Short buttresses up to 1 m high. In undisturbed to slightly disturbed mixed dipterocarp to sub-montane forests up to 1300 m altitude. Usually along rivers, but also on hillsides and ridges. On poor sandy soils, also on ultramafic. In secondary forests usually present as a pre-disturbance remnant tree. It grows in lowland and hill forests. It occurs locally in Nee Soon Swamp Forest.						
128	*Litsea grandis*		-	EN		Indo-China, Burma, Thailand, Peninsular Malaysia, Sumatra, Java, Lesser Sunda Islands, Borneo (throughout the island), Philippines, Celebes, Moluccas, New Guinea.		Mid-canopy tree up to 34 m tall and 71 cm dbh. In undisturbed mixed dipterocarp to sub-montane forests up to 800 m altitude. Usually on hillsides and ridges with sandy to clay soils, but also on limestone. In secondary forests usually present as a pre-disturbance remnant tree.						
129	*Litsea lancifolia*			CR		India, South China, Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo (Sarawak, Sabah, East-Kalimantan), Philippines.		Mid-canopy tree up to 34 m tall and 48 cm dbh. In undisturbed mixed dipterocarp to sub-montane forests up to 1600 m altitude. Common on alluvial sites but also on hillsides and ridges. Usually on sandy soils, but also on limestone. In secondary forests usually present as a pre-disturbance remnant tree.						
130	*Litsea ridleyi*			EN										
131	*Barringtonia racemosa*	Common Putat, Fish Poison Tree		CR		From eastern Africa and Madagascar to Sri Lanka, India, Burma (Myanmar), Indo-China, southern China, Taiwan, the Ryukyu Islands, Thailand, the Andaman and Nicobar Islands, throughout the Malesian region towards Micronesia, Polynesia (east to Fiji and Samoa) and northern Australia.	Western Catchment, in the vicinity of Macritchie reservoir	A shrub or small to medium-sized tree, 2-20(-27) m tall, trunk 10-50 cm in diameter, twigs 3-6 mm in diameter. Is found in primary and secondary forest, mostly restricted to inundated flood plains on tidal river banks, or in swampy localities, also behind the mangrove or in the upper mangrove swamp. It grows well under slightly saline conditions or on beaches near high water level, with a preference for heavy clay, loam or rich volcanic soils, usually a little above sea-level and occasionally up to 500 m altitude.						
132	*Magnolia villosa*			CR		Magnolia villosa is native to Malaysia (Peninsular Malaysia, Sabah), Singapore and Indonesia (Sumatra). This species has been collected from Bukit Mandai in Singapore and Muara enim (Sumatra).	In Singapore, this species was formerly described from Chua Chu Kang, Ang Mo Kio, Kranji but is now limited to the water catchment area.					Mining and agricultural activities are general threats. There are high rates of deforestation in Indonesia and Malaysia for palm oil plantations but it is unknown if this species is affected.		
133	*Aspidopterys concava*			EN				Climber/Liana/Vine. Tropical, terrestrial.						
134	*Byttneria maingayi*		Not Assessed	CR		Singapore, Peninsular Malaysia, Moluccas	Gardens' Jungle, Changi, Bukit Mandai, Bukit Timah Nature Reserve, Windsor Forest	Big woody climber.						
135	*Pentace triptera*		-	EN		Thailand, Peninsular Malaysia, Sumatra, Borneo (Sarawak, Sabah, West- and East-Kalimantan).		Upper canopy tree up to 43 m tall and 87 cm dbh. In undisturbed mixed dipterocarp forests up to 400 m altitude. On alluvial sites and hillsides with sandy to clay soils. In secondary forests usually present as a pre-disturbance remnant.						
136	*Scaphium macropodum*			EN		Sumatra, Borneo, Singapore, Peninsular Malaysia, Thailand, Cambodia.		Upper canopy tree up to 41 m tall and 87 cm dbh. In undisturbed mixed dipterocarp, (peat)-swamp and sub-montane forests up to 1200 m altitude. Usually on hillsides and ridges. In secondary forests usually present as a pre-disturbance remnant. Grows in primary forests.						
137	*Sterculia parviflora*			CR		Northeast India to Peninsular Malaysia and Singapore		Deciduous tree up to 35m tall. Grows in tropical lowland primary and secondary jungles, as well as hill forests. Its flowers are insect-pollinated. Hardy tree tolerant of urban conditions.						
138	*Memecylon c.f. lilacinum*		-	CR		Peninsular Malaysia and Singapore	Nee Soon Swamp Forest, Mandai Forest, Bukit Timah Nature Reserve, Chestnut Avenue and the vicinity of upper pierce reservoir	Shrub up to 2m tall or small tree up to 4m tall. Grows in forests. Its flowers are insect-pollinated and its fruits are eaten by birds.						
139	*Memecylon paniculatum*		Not Assessed	CR		Thailand, Peninsular Malaysia, Sumatra, Java, Borneo (throughout the island), Philippines, Celebes, Moluccas, Singapore	Windsor Forest	Understorey tree up to 14 m tall and 20 cm dbh. In undisturbed mixed dipterocarp and sub-montane forests up to 1700 m altitiude. Often on alluvial sites near rivers and streams, but also common on ridges. On sandy to clay soils, but also on limestone. In secondary forests usually present as a pre-disturbance remnant tree. Fruits and leaves fed on by proboscis monkeys (Matsuda *et al*., 2009)				Wood used locally.		
140	*Aphanamixis polystachya*			EN		Widespread species found in Indo-China and western Malaysia. Tropical Asia and Pacific. Cultivated in the Neotropics and under glass in Europe.		In Viet Nam, this tree occurs in evergreen tropical rainforest or monsoon forest. Lowland and hill rain forest to 1400 m altitude (1800 m in India), including seasonally flooded forest, secondary forest and forest on limestone. In hill forest in New Guinea it may be very common and there and elsewhere is often collected from riverbanks where it is conspicuous. The flowers are visited by sweat bees.						
141	*Sandoricum beccarianum*		Not Assessed	CR		Thailand, Peninsular Malaysia, Sumatra, Borneo (throughout the island), Singapore	Bukit Timah Nature Reserve, Nee Soon Swamp forest	Under-canopy tree up to 42 m tall and 75 dbh. In undisturbed (coastal) peat- and mixed-swamp forests up to 100 m altitude. In secondary forests usually present as a pre-disturbance remnant.						
142	*Sandoricum koetjape*			EN		Pan-tropical, but originally from tropical Asia. In Borneo found in Sarawak, Brunei, Sabah, Central- and East-Kalimantan.		Mid-canopy tree up to 40 m tall and 113 cm dbh. In undisturbed mixed dipterocarp, coastal and keranga forests up to 600 m altitude. Often near or along rivers and streams, but also common on hillsides and ridges. On sandy to clay soils. In secondary forests usually present as a pre-disturbance remnant.						
143	*Coscinium fenestratum*			EN		India and Sri Lanka to Indochina and western Indonesia (Sunda Shelf Islands).		Creeping and climbing vine of 25-30 m length, diameter 6-7 cm. Prefers mixed and dense evergreen forest with fertile soil and high moisture.						
144	*Cyclea laxiflora*		Not Assessed	CR	Local Medicinal Plant	Singapore, Peninsular Malaysia, Thailand	Changi, Bukit Timah, Tanglin	Slender climber up to circa 15 m tall (van Steenis *et al*., 1948). In hedges and forests. Lifespan in Singapore is perennial. Light preference: semi-shade.						
145	*Siphonia capitata*			CR		Native to Thailand, Sumatra, Peninsular Malaysia, Singapore, Bali, Borneo and Java.	Nee Soon Swamp Forest	It grows scattered in plains, mountains and rainforests, from sea level to 2000m altitude.						
146	*Artocarpus lacucha*			EN		From India and Bhutan and southern China to New Guinea and the Solomon Islands.		Deciduous tree up to 37 m tall, 60 cm diameter. In undisturbed to slightly disturbed mixed dipterocarp forests up to 500 m altitude. Mostly on hillsides and ridges, but also common along rivers and streams. On sandy to clay soils.						
147	*Ficus apiocarpa*			EN		Native to Thailand, Sumatra, Peninsular Malaysia, Singapore and Borneo.	Central Catchment, Western Catchment, and along Mandai Lake Road.	It grows in lowland forests, often in swamp forests. Its flowers are pollinated by fig wasps.						
148	*Ficus globosa*		-	EN		Native to Myanmmar, Thailand, Sumatra, Peninsular Malaysia, Singapore, Borneo and Java.	Central Catchment	It grows in lowland and hill forests, including secondary forests, along rivers, in swamps, and mangrove forests, up to 1,200m altitude.						
149	*Ficus microsyce*			CR		Native to Sumatra, Peninsular Malaysia and Singapore.	Western Catchment area and vicinity of Upper Pierce Reservoir	It grows in forests at low altitudes.						
150	*Ficus obscura var. borneensis*			CR		Native to Thailand, Peninsular Malaysia and Singapore.	Nee Soon Swamp Forest	It grows in lowland forests. In open sites in undisturbed mixed dipterocarp to submontane forests up to 1700 m altitude. Usually along rivers and streams on sandy to limestone soils. Ficus obscura var. borneensis is a true myrmecophyte. It spontaneously forms cavities (domatia) in parts of its twigs which open by slits. These occur in the internodes and are usually not swollen. The domatia are inhabited by a variety of non-specific tree-living ants. Additionally the plant provides a sugar-containing secretion from extrafloral nectaries on the lower surfaces of the leaves.						
151	*Ficus sagittata*			CR		From northeastern India, Andaman Islands to southern China, Myanmmar, Indochina, Thailand, throughout Malesia (including Singapore) and Micronesia.	Nee Soon Swamp Forest, MacRitchie Reservoir, Bukit Kallang, alogn Rifle range link, along Napier Road, and Pulau Tekong.	It climbs on trees in lowland and montane forests up to 1500 m in altitude.						
152	*Ficus stricta*			CR		China, India, Indonesia, Malaysia and Vietnam.		Partial shade, likes constant moisture but well-drained soils. Forests up to 1800 m elevation. Oriental pied hornbills were observed to feed on its ripe syconia in Singapore.						
153	*Ficus tinctoria*		-	EN		South Asia, Sumatra, Peninsular Malaysia, Singapore, Borneo and Java.	Bukit Kallang, along Cluny Road, along Napier Road, along Nassim Road, along Hendon Road and Pulau Ubin.	It grows in gardens, hedges and secondary forests up to 1300 m in altitude. In undisturbed mixed dipterocarp, seasonal and sub-montane forests up to 1400 m altitude. On hillsides and ridges with sandy soils.						
154	*Ficus virens*			CR		East Asia, through tropical Asia to New Guinea, Australia, Solomon Islands		Streamsides at elevations from 300 to 2,700 m. Monsoon forests and rainforests. Begins life as an epiphyte, grows to a tree up to 15 m tall.						
155	*Horsfieldia crassifolia*			CR		Native to Brunei Darussalam; Indonesia (Kalimantan, Sumatera); Malaysia (Peninsular Malaysia, Sabah, Sarawak); Singapore.		A lowland tree which is fairly widespread in marshy forest and freshwater peat-swamp forest.						
156	*Horsfieldia punctatifolia*		LC	CR		Native to Brunei Darussalam; Indonesia (Kalimantan, Sumatera); Malaysia (Peninsular Malaysia, Sabah, Sarawak); Singapore.		Fairly widespread species found in many habitat types (IUCN, 1998)						
157	*Horsfieldia sucosa*			EN		Peninsular Malaysia, Sumatra, Borneo.		Mid-canopy tree up to 35 m tall and 47 cm dbh. In undisturbed mixed dipterocarp and coastal forests up to 800 m altitude. Often on alluvial sites near or along rivers and streams, but also on hillsides and ridges. On sand and limestone soils.						
158	*Knema communis*		VU	EN		Apparently endemic to Peninsular Malaysia.		This scattered species grows in lowland and hill rainforest up to 270 m.				Expansion of settlements and forest clearance are the main threats.		
159	*Knema curtisii*		-	EN		Peninsular Malaysia, Sumatra, Borneo		Understorey tree, with or without stilt roots. Primary and degraded forest, hill slopes; on a variety of soil types: clay, loam, sandy clay, sandstone, lime-containing soils, also found in swamps, usually with stilt-roots; 0-1000 m altitude.						
160	*Knema latericia ssp. Ridleyi*			EN		A widely distributed species in west Malaysia. It is rare in Sumatra.		Grows in primary, degraded and dipterocarp forests, as well as kerangans, on hill sides, ridges, up 10 1500m altitude. It prefers full sun to semi-shade conditions with moderate water. Its flowers are insect pollinated,, and its seeds are dispersed by frugivorous birds and mammals.						
161	*Myristica laxiana*			CR		Native to Indonesia (Kalimantan, Sumatera); Malaysia (Peninsular Malaysia, Sabah, Sarawak); Singapore		This tree is mainly found in peat-swamp forest; it is rarely found on dry land.						

S/N	Species	Common Name	Conservation Status		Listing Rationale	Population		Habitat Requirements	Migration	Endemicity	Congregation	Threats		Stakeholder/Expert Comments
			IUCN	SRDB		Global Population and Range	Local Population and Range					Global Threats	Local Threats	
162	*Syzygium acuminatissimum*		-	EN		From India and Southern China to New Guinea		Small canopy tree, 20-34 m tall, 54 cm in diameter. Small buttresses and often stilt roots. In undisturbed to slightly disturbed (open) forests up to 3000 m altitude. On hillsides and ridges usually with poor sandy to ultrabasic soils but also on clay and limestone.						
163	*Syzygium chloranthum*			CR		IC, Thailand, Peninsular Malaysia, Sumatra, Borneo		Subcanopy tree up to 30 m tall and 60 cm diameter. In undisturbed mixed dipterocarp, keranga and sub-montane forests up to 1200 m altitude. Usually along or near rivers and streams on alluvial sites, including peat-swamps. On sandy soils and limestone						
164	*Syzygium claviflorum*		Not Assessed	CR		From northeast India and southern China to New Guinea, Australia, Singapore	Nee Soon Swamp Forest	Emergent tree up to 69 m tall and 91 cm dbh. In undisturbed but sometimes rather open vegetation types including mixed dipterocarp, coastal, keranga and peat-swamp forests up to 1500 m altitude. Often on alluvial sites, but also on hillsides and ridges. On poor sandy to peaty soils and ultramafic. Found in streamside of the rain forests, in open degraded forest on white sand with large rocks up to 1300 m altitude.						
165	*Syzygium filiforme*		-	EN										
166	*Syzygium inophyllum*			CR		East Asia - Bangladesh, Myanmar, Malaysia, Indonesia.		Tree that can grow up to 24 m tall, found in lowland forests.						
167	*Syzygium ridleyi*		-	EN		Singapore, Malaysia, Thailand		Evergreen tree that can grow up to 30 m tall. Moist and non-seasonal, dense, evergreen forests at elevations from 30-200 m.				Primarily used for timber, has minor role in international trade. Pressures are exerted on the species from felling activities.		
168	*Syzygium singaporense* Synonym: *Pseudoeugenia singaporensis* (The Plant List ver 1.1)		LC	CR		Singapore, Malaysia	Nee Soon Swamp Forest	Tree up to 27 m tall; lowland forest (The Gardens' bulletin, Singapore)						
169	*Scorodocarpus borneensis*		-	EN		Thailand, Peninsular Malaysia, Sumatra, Borneo (throughout the island).		Upper canopy tree up to 42 m tall and 82 cm dbh. In undisturbed to slighti disturbed (open) mixed dipterocarp forests up to 700 m altitude. On alluvial sites near rivers and streams and on hillsides. In secondary forests usually present as a pre-disturbance remnant.						
170	*Pandanus atrocarpus*		-	EN		Thailand, Malaysia		Large evergreen tree, lowland swamps.						
171	*Aporosa lucida*		Not Assessed	CR		Peninsular Malaysia, Sumatra, Java, Borneo, Sulawesi, Moluccas, Singapore	Upper Thomson Forest, Windsor Forest, Nee Soon Swamp Forest	Understorey tree up to 18 m tall and up to 25 cm dbh. Primary, secondary, (somewhat) disturbed, and logged over forest, evergreen, mixed dipterocarp, heath or transition between heath and kerangas, submontane forest, fresh water swamp, or periodically inundated; on steep to gentle ridges, hill sides, and hill tops; on flat or (low) undulating land, open, partly shaded, or dry country. Soil: shale, sandy, granitic sand, clayey sand, or clay, yellow or red. Altitude: 0-1200 m. Flowering: March to October; fruiting throughout the year						
172	*Aporosa lunata*		Not Assessed	CR		Peninsular Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, Singapore	Jurong	Sub-canopy tree up to 27 m tall and 35 cm dbh. Primary and secondary lowland evergreen forest; on hillsides, ridges, and along river banks; in flat, hilly, and moist land. Soil: sandstone, sandy and rich clay, granitic rock, or granodiorite derived. Altitude: low to 1300 m. Flowering: February to April, August to November; fruiting: April to December.						
173	*Baccaurea motleyana*	Rambai	Not Assessed	CR		Peninsular Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, Moluccas, Singapore		Tree 8-26 m high, 13-61 cm dbh. In disturbed sites in mixed dipterocarp forest or open scrub-vegetation up to 500 m altitude. Mostly on alluvial sites, but also on hillsides. On sandy to clay soils. Prefers a position in full sun or light shade. Prefers alluvial soils near rivers or other places where water is available. Plants succeed on yellow clay, sand and limestone soils. Prefers a pH in the range 5 - 6, tolerating 4.5 - 6.5.						
174	*Baccaurea polyneura*			EN		Native to Malaysia; Distributed in Peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo.		Tree (5-)11-32 m high, dbh 10-54 cm, buttresses small. In undisturbed to slightly disturbed mixed dipterocarp forests up to 700 m altitude. On hillsides and ridges, but also on alluvial sites. On sandy, clay, granite, loam soils.						
175	*Breynia discigera*			CR		Thailand, Malaysia, Indonesia		Shrub or small tree growing up to 5 m tall. Open thickets, clearings and the margins of secondary forest, rubber plantations, at elevations from 30 - 300 m. Lowland and hill forest.						
176	*Piper flavimarginatum*		Not Assessed	CR		Singapore	Admiralty Forest, Chea Chu Kang, Bukit Timah, MacRitchie Reservoir and Nee Soon Swamp Forest	Large climber. Grows in lowland forests. Flowers are pollinated by insects. Plant & Rootzone Preference/Tolerance : Moist Soils, Well-Drained Soils, Fertile Loamy Soils						
177	*Piper pedicellosum*			CR		India, Myanmar, Peninsular Malaysia.		Woody climber, dioecious, glabrous, node swollen with climbing roots.						
178	*Centotheca lappacea*		Not Assessed	CR		Africa: west tropical, west-central tropical, southern tropical, and western Indian ocean. Asia temperate: China and eastern Asia. Asia-tropical: India, Indo-China, Malesia, and Papuasia. Australasia: Australia. Pacific: southwestern, south-central, and northwestern. Singapore	Bukit Batok, Admiralty Forest, BTNR	Herb (grass). In forest and partly shaded areas. Adhesive burr like fruits are carried externally by animals. Cultivated.						
179	*Xanthophyllum ellipticum*		Not Assessed	CR		Thailand, Peninsular Malaysia, Sumatra, Borneo (throughout the island), Singapore	Windsor Forest, Bukit Batok	Understorey tree up to 14 m tall and 52 cm dbh. Majority of the species grow in lowland rainforest. In undisturbed to slightly disturbed (open) mixed dipterocarp, keranga and (peat)-swamp forests up to 400 m altitude. Usually on alluvial sites on clay to sandy soils, In secondary forests usually present as a pre-disturbance remnant or planted.						
180	*Xanthophyllum flavescens*		-	EN		India to Thailand and Indo-China, Peninsular Malaysia, Sumatra, Borneo (throughout the island), Philippines.		Upper canopy tree up to 42 m tall and 67 cm dbh. In undisturbed mixed dipterocarp, coastal, swamp and sub-montane forests up to 1500 m altitude. Usually on alluvial sites and near or along rivers and streams (also in tidal regions), but also collected on ridges. On sandy soils, but also on limestone. In secondary forests usually present as a pre-disturbance remnant.						
181	*Ardisia elliptica*	Mata Ayam	-	EN		Ardisia elliptica is native to the west coast of India, Sri Lanka, Indochina, Malaysia, Indonesia and New Guinea. It has naturalised in Hawaii, Southern Florida, Okinawa and Jamaica.		Shrub growing into a small tree of up to 10 m tall. Occurs in natural forests, ruderal/, disturbed. Ardisia elliptica readily invades moist disturbed forests, however, it has also been able to invade relatively undisturbed sites. Frugivorous birds are the principal dispersal agents, attracted to the numerous red to blackish fruits. Seeds do not have any long-term dormancy (i.e., greater than 6 months), however, seedlings and juveniles can survive under very shady conditions for many years. Given enough light, juveniles rapidly develop into reproductive adults. Ardisia elliptica readily forms dense monotypic stands that exclude native species. Due to high reproductive output and high shade-tolerance, carpets of seedlings (>400 plants per square metre) can form underneath adult plants under ideal conditions (moist soil and shallow litter). Seedling carpets and increased shade levels inhibit recruitment by native species.						
182	*Ardisia teysmanniana*		-	EN		Peninsular Malaysia, Sumatra, Java, Borneo (Sarawak, Brunei, East-Kalimantan)		Understorey tree up to 18 m tall and 19 cm dbh. In undisturbed mixed dipterocarp and keranga forests up to 900 m altitude. Mostly on ridges with sandy soils, but also on clay. In secondary forests usually present as a pre-disturbance remnant.						
183	*Drypetes pendula*		Not Assessed	CR		Singapore, Malaysia, Thailand, Borneo	Bukit Timah Nature Reserve	Tree 16-30 m tall Lowland forest. Light preference is for full sun.						
184	*Smythea lanceata*		Not Assessed	CR		Singapore	Kranji Nature Trail, Serangoon River, Mandai Mangroves	Liana or sprawling, scandent shrub, found near sea level along beaches Back mangrove In thickets near the sea						
185	*Ventilago malaccensis*		-	EN		Peninsular Malaysia, Singapore (possibly wider distribution)	Widely distributed around Bukit Timah and Central Catchment Nature Reserves							
186	*Pellacalyx axillaris*		-	EN		Sumatra, Peninsular Malaysia, Singapore, Borneo, and the Philippines	It occurs locally in Bukit Timah Nautre Reserve, Chestnut Track, Mandai Forest, Nee Soon Swamp Forest, Old Upper Thompson Road, and Upper Peirce Reservoir	It grows in lowland primary and secondary forests, especially along streams and swampy habitats, up to 1,300 m in altitude.						
187	*Prunus grisea var. tomentosa*		VU	CR		An endemic variety to the Philippines						Rates of habitat loss through logging and shifting cultivation have led to considerable population declines.		
188	*Diplospora malaccensis*	Gading-Gading/Ivory tree	Not Assessed	CR		Thailand, Peninsular Malaysia, Sumatra, Borneo (Sarawak, Brunei, Sabah, East-Kalimantan), Singapore	Bukit Timah Nature Reserve, Windor Forest	Sub-canopy tree up to 25 m tall and 28 cm dbh. In undisturbed to slightly disturbed (open) mixed dipterocarp and keranga forests up to 400 m altitude. Usually on hillsides and ridges, but also along rivers and streams, on sandy soils. In secondary forests usually present as a pre-disturbance remnant. Light preference is for full sun or semi-shade. Fruits are fed on by fruitbat species *Balionycteris maculata* (Hodgkison et al. 2004) and birds.						
189	*Gaertnera obesa*		-	EN		Native to Peninsular Malaysia and Singapore		Tropical species. It grows in inland forests and prefers semi-shade and moderate water conditions. Its flowers are insect pollinated.						
190	*Ixora lobbii*	Glossy Ixora	-	EN		Native to Thailand, Peninsular Malaysia and Singapore		Tropical, Subtropical/ Monsoonal species. It grows in inland forests and prefers semi-shade and moderate water conditions. Its flowers are pollinated by birds and butterflies, and its fruits are also eaten by birds.						
191	*Mussaenda glabra*		-	EN		Native to Peninsular Malaysia and Singapore		Tropical species. It grows in open habitats and prefers full sun and moderate water conditions. Its flowers are insect-pollinated. It is also known to be a butterfly food. plant.						
192	*Nauclea officinalis*			CR		Southern China, Indo-China, Thailand, Peninsular Malaysia, Sumatra, Borneo (Sarawak, Sabah, Central- and East-Kalimantan).		In undisturbed mixed dipterocarp and keranga forests up to 600 m altitude. On hillsides and ridges with sandy to clay soils. In secondary forests usually present as a pre-disturbance remnant.						
193	*Psychotria helferiana*		Not Assessed	CR		Singapore, Malaysia	Bukit Timah Nature Reserve, CCNR	Shrub up to 1 m tall.						
194	*Psychotria sarmentosa*	Akar Daldaru	Not Assessed	CR		India, Sri Lanka, Myanmar, Thailand, Peninsular Malaysia, Singapore, Java, and Borneo	Upper Thomson Forest, Admiralty Forest	Climber, often creeping with aerial roots on tree trunks, up to 15 m long. Terrestrial (Primary Rainforest; Secondary Rainforest; Freshwater Swamp Forest). It grows in lowland forests, from sea level to 2300 m altitude. Tropical, Sub-Tropical / Monsoonal. Prefer Moist Soils, Well-Drained Soils, Fertile Loamy Soils. Flowers are insect-pollinated. Fruits are eaten by birds.						
195	*Timonius flavescens*	(Local names in Borneo) Medang suid, Mulung udok, Sebulu	Not Assessed	CR		Seychelles, India into Indochina and Malaysia to New Guinea, Singapore	Bukit Mandai, Kranji, Seletar	Understorey tree up to 12 m tall and 22 cm dbh. In secondary forests and in open sites in swamp, mixed dipterocarp and sub-montane forests up to 1700 m altitude. On ridges and hillsides, but also on alluvial sites and along rivers and streams. In sandy to clay soils. Larvae of the *Meduza procris calidasa* butterfly feed on the leaves (Jayasinghe *et al*., 2014)						
196	*Utricaria longiflora var. pleiopoda*	River-bank grapple plant	Not Assessed	CR		Malay Peninsula, Sumatra, Borneo, and the Philippines (Tan et al., 2013)								
197	*Lueiunga crassifolia*		Not Assessed	CR		Present in peninsular Malaysia (Perak, Singapore), Sumatra, Borneo	Nee Soon Swamp Forest	Climber. Host plant to the banded swallowtail (*Papilio demolion demolion*) caterpillar, which feeds and rests in a gregarious manner in all 5 instars.						
198	*Melicope lunu-ankenda*		Not Assessed	CR		E. Asia - China, India, Sri Lanka, Nepal, Bhutan, Myanmar, Thailand, Cambodia, Vietnam, Malaysia, Indonesia, Philippines	Bukit Batok, Dover Forest	Evergreen shrub or tree that can grow up to 30 m tall Dense primary forest and the more open secondary formation; montane shrubbery; growing in well drained areas and on swampy soils; at elevations from sea level to 2,200 metres Host plant to the banded swallowtail (*Papilio demolion demolion*) caterpillar, which feeds and rests in a gregarious manner in all 5 instars.						
199	*Melicosma simplicifolia ssp. fruticosa*		Not Assessed	CR		Sumatra, South Peninsular Thailand, Peninsular Malaysia, Singapore, Java, Borneo, the Philippines, Lesser Sunda Islands, and Taiwan (Tan et al., 2013).	It can be found in Mandai and Nee Soon Swamp forests (Tan et al., 2013)	It grows in primary rainforests and on many soil types ranging from limestone to volcanic loams (Tan et al., 2013).						
200	*Osmelia philippina*		Not Assessed	EN		Sumatra, Peninsular Malaysia, Singapore, Borneo, the Philippines, North and Central Celebes, Moluccas, and North and Southeast Papua New Guinea (Tan et al., 2013)	It is known locally from Bukit Mandai, Bukit Timah, Kranji, Mandai Road, Nee Soon Swamp Forest, and Seletar (Tan et al., 2013)	It is found in primary forests up to a 500-m altitude (Tan et al., 2013).						
201	*Nephelium lappaceum*	Rambutan	LC	CR		Indonesia, Malaysia, Singapore, Thailand, Vietnam	Upper Thomson Forest	Widely-cultivated fruit tree, 10-25 m height in ground. Bird-attracting, caterpillar food plant. Pollinated mainly by flies, bees and ants, but other pollinators also include butterflies, moths, bees, beetles, thrips and wasps. The tree grows best on deep, clay-loam or rich sandy loam rich in organic matter, or in deep peat, with pH of 5.5 to 6.5 (weakly acidic). It also needs good drainage. It is recommended that the trees be planted at least 33 ft (10 m) apart each way, though 40 ft (12 m) is not too much in rich soil. If the trees are set too close to each other, they will become overcrowded in a few years and production will be seriously affected (Morton, 1987).						

S/N	Species	Common Name	Conservation Status		Listing Rationale	Population		Habitat Requirements	Migration	Endemicity	Congregation	Threats		Stakeholder/Expert Comments
			IUCN	SRDB		Global Population and Range	Local Population and Range					Global Threats	Local Threats	
202	*Pometia pinnata*	Matoa, Taun tree, Island lychee, Tava	Not Assessed	EN		From Sri Lanka and southern China to New Guinea and the western Pacific. In Borneo throughout the island.		In undisturbed mixed dipterocarp forests up to 700 m altitude. Often on alluvial sites and along or near rivers and streams, but also on hillsides. On sandy to clay soils. In secondary forests usually present as a pre-disturbance remnant. Occurs in both primary and secondary forests (Orwa et al., 2009).						
203	*Palaquium hexandrum*		Not Assessed	CR		Peninsular Malaysia, Sumatra, Borneo (throughout the island).		In undisturbed mixed dipterocarp forests up to 1000 m altitude. On alluvial sites, but also on ridges with sandy soils. Also on limestone. In secondary forests usually present as a pre-disturbance remnant.						
204	*Eurycoma longifolia*	Tongkat Ali, Bidara Pahit, Ali's Umbrella, Payong Ali, Penawa Pahit	Not Assessed	CR		Peninsular Malaysia (throughout), Thailand, Laos, Cambodia, Vietnam, Sumatra, Borneo, Myanmar	Tanglin, Bukit Timah, Changi	Understorey of forests and open coastal habitats. Abundant on well-drained, sandy soils. Unbranched, small tree up to 12 m tall Gravity-based seed dispersal						
205	*Gordonia multinervis* *(Polyspora multinervis)*		VU	EN		Peninsular Malaysia, Singapore (Chua, 1998)		In lowland and hill forests (Chua, 1998).				Encroaching settlements are the largest threat to the species (Chua, 1998).		
206	*Cyclosorus opulentus*		Not Assessed	EN		Thailand, Sri Lanka to Malesia, N Australia, Micronesia and Polynesia (Royal Botanic Gardens, 2015). Australia, Burma, China (Hainan), India, Indonesia, Malaysia, Micronesia, Philippines, Sri Lanka, Thailand (Flora of China Editorial Committee, 2013)		On rather dry mountain slopes in light shade usually at low alitudes (Royal Botanic Gardens, 2015).				This species is widespread and not under any known threat (Royal Botanic Gardens, 2015).		
207	*Aquilaria microcarpa*		VU (CITES II)	CR		Indonesia (Kalimantan, Sumatera); Singapore (IUCN) Peninsular Malaysia, Sumatra and Borneo (asianplant.net)		This species grows in lowland forest up to 200 m altitude (IUCN).				The fungi-infected heartwood, characteristic of all members of the genus, has high commercial value in the production of incense, perfume and traditional medicine. Numerous trees are cut down, many uninfected, to harvest just a few kilograms of the diseased wood. The increase in levels of trade over the past decade has resulted in overexploitation throughout its range (IUCN).		http://www.asianplant.net/Theaceae/Gordonia_multinervis.htm
208	*Enkleia malaccensis*		Not Assessed	CR		Peninsular Malaysia, Singapore, Sumatra and Borneo	Windsor Forest, Nee Soon Swamp Forest	Woody climber, up to 30 m long and 30 cm in diameter Occurs in primary forest below 50 m altitude. Flowering and fruiting occur between April and October.						
209	*Gonystylus confusus*		-	EN		Singapore, Sarawak, Borneo (Kew, 1947) Thailand, Malay Peninsula and Indonesia (Niyomdham & Tarumatsawat, 2003) Malaya, Sumatra (Aceh), West Kalimantan (ITTO CITES, 2009).		Peat swamp and evergreen low land dipterocarp forests, up to 600 m altitude (Niyomdham & Tarumatsawat, 2003). Prefers non-inundated rainforest to hill-side habitats (ITTO CITES, 2009).						
210	*Ampelocissus elegans*		-	EN		The species is reported from Myanmar, Thailand, and the Malay Peninsula (Yeo et al., 2013).	Found in various locations in the BTNR and Central Catchment Nature Reserve (CCNR). Ampelocissus elegans has recently been found on Pulau Ubin and Pulau Tekong (offshore islands), while it has been lost from Ang Mo Kio, Jurong Road, Tanglin Road, Singapore Botanic Gardens (SBG), and Bukit Arang (Yeo et al., 2013).	The genus is known to inhabit the fringes of lowland dipterocarp forest, along rivers, and in open spaces. Ampelocissus elegans is usualy found along the fringes of lowland dipterocarp and secondary forests (Yeo et al., 2013).					
211	*Ampelocissus gracilis*		-	EN		The species is found in the Malay Peninsula and Borneo (Yeo et al., 2013).	Found in various locations in the BTNR and Central Catchment Nature Reserve (CCNR). Ampelocissus gracilis has been lost from Sungei Loyang, Choa Chu Kang, Kranji, Upper Tanglin woodlands, Changi, and SBG (Yeo et al., 2013).	The genus is known to inhabit the fringes of lowland dipterocarp forest, along rivers, and in open spaces. Ampelocissus gracilis is usually found along the fringes of both lowland dipterocarp and secondary forests, as well as swamp forests (Yeo et al., 2013).						
212	*Ampelocissus spicifer* *(Nothocissus spicifera)*	False Cissus Vine	Not Assessed	CR	The species merits a nationally endangered status owing to its occurrence being restricted to forests, and has suffered some shrinkage of range owing to deforestation (Yeo et al., 2012).	Thailand, Peninsular Malaysia, Singapore, Sumatra, and Borneo (Yeo et al., 2012).	Bukit Timah, Central Catchment Nature Reserves, Singapore Botanical Gardens, Nee Soon Swamp Forest, Cluny Road, Bukit Mandai, Jurong, Jalan Ulu Sembawang	Woody liana found in the fringes of lowland dipterocarp forest, often along rivers and streams (Yeo et al., 2012). Shows vigour under full sun or light shade.				Shrinkage of its distribution probably caused by deforestation brought about by land use changes in Singapore.	Being a forest species, habitat loss is the only major threat to its continued existence (Yeo et al., 2012).	
213	*Cissus repens*	Cissus	Not Assessed	EN	It seems the coastal Cissus repens is doing relatively well with more open habitats available for colonisation following the deforestation of Singapore, and it has recently been collected on Pulau Ubin, the coastal Khatib Bongsu, and deeper inland at Orchard Boulevard and Jalan Bahar. Previously, it was reported from Fort Canning (SING 0019148) and Pulau Merembong (SING 0019146) by R. W. Hullett and E. J. H. Corner respectively, which are coastal and insular locations. In the light of the current widespread distribution, we propose a change in the conservation status of Cissus repens (from critically endangered) to Endangered (Yeo et al, 2012).	Occurs in Asia and Malesia. Also occurs in Cape York Peninsula and North East Queensland, Australia (CSORO, 2010). India, Myanmar, Kampuchea, Vietnam, Thailand, and Malesia (Yeo et al., 2012).	Pulau Ubin, Khatib Bongsu, Orchard Boulevard and Jalan Bahar (Yeo et al., 2012).	Grows in beach forest, vine thicket and well developed lowland and upland rain forest. Can be found at altitudinal range from near sea level to 1000 m (CSIRO, 2010). Coastal species inhabiting the fringes of lowland dipterocarp and swamp forests and limestone vegetation (Yeo et al., 2012).						
214	*Artabotrys crassifolius*		Not Yet Assessed	CR										
215	*Uvaria leptopoda*		Not Yet Assessed	CR										
216	*Garcinia rostrata*			CR										
217	*Rourea asplenifolia*		-	CR			Mandai, CCNR							
218	*Breynia coronata*		-	EN										
219	*Casthea squamulata*		-	EN										
220	*Dioscorea glabra*			CR										
221	*Dioscorea polyclados*			CR										
222	*Diospyros venosa*			CR										
223	*Dalbergia velutina*		-	CR			CCNR							
224	*Strychnos maingayi*			CR										
225	*Memecylon amplexicaule*			CR										
226	*Oxyceros bispinosus*		-	EN										
227	*Piper muricatum*			CR			Nature reserves							
228	*Tinomiscium petiolare*			EN										
229	*Timonpora macrocarpa*			CR										
230	*Ficus pisocarpa*			CR										
231	*Gymnacranthera bancana*			CR										
232	*Knema malayana*			EN		A species widely distributed in Peninsular Malaysia and Peninsular Thailand.								
233	*Knema intermedia*			EN		West Malaysia.								
234	*Nyssa sinensis pseudoformosum*			CR										
235	*Ventilago lanceata*			CR										

Annex 11.1

Habitat Matrix

S/N	Group	Species		Terrestrial							Managed/Cultivated			Freshwater			Marine/Brackish		Habitats according to Life Cycle				Species Characteristics		
				Primary Forest	Secondary Forest	Swamp Forest	Scrub	Marsh	Grassland	Bamboo	Gardens	Plantations	Parkland	Rivers/Streams	Reservoirs/Ponds/ Lakes/Quarries/ Lagoons	Canal	Mangrove	Coastal	Juvenile phase	Breeding	Foraging/ Feeding	Roosting/ Nesting	Ground dwelling	Riparian dwelling/Water dependent	Arboreal
Fauna																									
1	Terrestrial Vertebrate	*Iomys horsfieldi*	Horsfield's Flying Squirrel																						
2	Terrestrial Vertebrate	*Manis javanica*	Sunda Pangolin	Lowland Dipterocarp; likely to support more pangolins then secondary forest due to more large trees with hollows serving as dens								e.g. oil palm plantations							Forest	Forest	Forest	Forest	Have been known to dig burrows in soil		Can climb trees to access ant nests
3	Terrestrial Vertebrate	*Presbytis femoralis femoralis*	Banded Leaf Monkey																Forest	Forest	Forest; Primarily frugivorous	Forest		Can be found in swamps	
4	Terrestrial Vertebrate	*Prionailurus bengalensis*	Leopard Cat																Cubs are raised in a hollow tree, rock crevice or burrow until they are ready to leave.	Forests	Forests				
5	Terrestrial Vertebrate	*Rusa unicolor*	Sambar Deer																						
6	Terrestrial Vertebrate	*Tragulus kanchil*	Lesser Mouse Deer	Lowland, foothill forests; Dipterocarps & legumes	Lowland, foothill forests; Dipterocarps & legumes																Feeds on shoots, young leaves and fallen fruits in the tall forest of the lowlands			Can be common in riverine areas	
7	Bat	*Tylonycteris pachypus*	Lesser Bamboo Bat	Prime tropical deciduous forests						Prefers to roost in internodal spaces of hollow bamboo		Lowland agricultural areas									Feeds on termites	Prefers to roost in internodal spaces of hollow bamboo and narrow crevices in other tree, 0.25-10 m from the ground			
8	Bat	*Tylonycteris robustula*	Greater Bamboo Bat							Bamboo in both intact and disturbed habitats											Feeds on termites	Roosts in both bamboo and rock crevices			
9	Bird	*Alcedo meninting*	Blue-eared Kingfisher											Streamside habitats										Eats mainly fish	
10	Bird	*Anthracoceros albirostris*	Oriental Pied Hornbill																						
11	Bird	*Arachnothera chrysogenys*	Yellow-eared Spiderhunter	Forages in canopy, descends to feed on flowers	Forages in canopy, descends to feed on flowers															Primary, secondary forests	Forest canopy, descends to flower clumps	Primary, secondary forests			
12	Bird	*Ardea purpurea*	Purple Heron											Preference for dense, flooded, freshwater reedbeds; also utilizes river margins	Utilizes lake shores and brackish water lagoons	Can be found at ditches and canals		Coastal mudflats				Nest is a platform of reeds stems positioned over or beside water up to 3 m high in flooded reedbeds	Utilises lake shores, river margins, ditches, canals, brackish water lagoons, rice-fields, mangroves and coastal mudflats		
13	Bird	*Chrysococcyx xanthorhynchus*	Violet Cuckoo																						
14	Bird	*Copsychus malabaricus*	White-rumped Shama	Forest edge; understorey	Forest edge; understorey																Forest Understorey		Forages on the ground and in the lower strata for arthropods, also taking worms and berries		
15	Bird	*Copsychus saularis*	Oriental Magpie Robin																				Forages from the ground		
16	Bird	*Gallus gallus*	Red Junglefowl										Pasture land										Forage on the ground for seeds, fruits and insects		
17	Bird	*Halcyon coromanda*	Ruddy Kingfisher																		Forest, aquatic env			In aquatic habitats it feeds on crabs, frogs and their tadpoles and fish.	
18	Bird	*Heliopais personatus*	Masked Finfoot	Lowland riverine	Lowland riverine										Including reservoir inlet creeks					aquatic env	aquatic env			Mangroves	
19	Bird	*Ichthyophaga ichthyaetus*	Grey-headed fish eagle		Even secondary scrub dominated by exotics										Forages in waterbodies near urban areas					Tall trees near water (Albizia) - secondary scrubland, old plantations	Urban waterbodies, heavily disturbed secondary forests				
20	Bird	*Ketupa ketupu*	Buffy Fish Owl										Pastureland												
21	Bird	*Loriculus galgulus*	Blue-crowned Hanging Parrot																						
22	Bird	*Nisaetus cirrhatus*	Changeable Hawk Eagle																						
23	Bird	*Nycticorax nycticorax*	Black crowned Night Heron																		Canals, mudflats, mangroves, ponds	Mangroves/waterside vegetation			
24	Bird	*Pitta megarhyncha*	Mangrove Pitta														Associated with Nipa palm. Feeds on crustaceans, molluscs and terrestrial insects in drier mud at the bases of mangroves.				Feeds on crustaceans, molluscs and terrestrial insects in drier mud at the bases of mangroves.				
25	Bird	*Psilopogon rafflesii*	Red-crowned Barbet	Lowland evergreen forest up to 800 m asl, poor-quality Dipterocarp slope forest								Occasionally found in rubber plantations													
26	Bird	*Psittinus cyanurus*	Blue-Rumped Parrot	Dry-land evergreen and semi-evergreen lowland forest	It appears to be more readily observed in areas with some logging activity, possibly preferring secondary and logged forest.																			Occasionally found in mangroves	
27	Bird	*Pycnonotus atriceps*	Black-headed Bulbul	Broadleaf evergreen, mixed deciduous	Broadleaf evergreen, mixed deciduous	Peat swamp forest															Feeds in canopy and forest edge				

S/N	Group	Species		Terrestrial							Managed/Cultivated			Freshwater			Marine/Brackish		Habitats according to Life Cycle				Species Characteristics		
				Primary Forest	Secondary Forest	Swamp Forest	Scrub	Marsh	Grassland	Bamboo	Gardens	Plantations	Parkland	Rivers/Streams	Reservoirs/Ponds/ Lakes/Quarries/ Lagoons	Canal	Mangrove	Coastal	Juvenile phase	Breeding	Foraging/ Feeding	Roosting/ Nesting	Ground dwelling	Riparian dwelling/Water dependent	Arboreal
28	Bird	*Pycnonotus brunneus*	Red-eyed Bulbul																						
29	Bird	*Pycnonotus zeylanicus*	Straw-headed Bulbul																		fruiting trees by forest edge	secondary forests, scrub, plantations along water bodies			
30	Bird	*Rhinomyias brunneata*	Brown-chested Jungle Flycatcher	Low bushes	Low bushes															Breeds in dense bamboo undergrowth or low bushes in evergreen forest					
31	Bird	*Spilornis cheela*	Crested Serpent Eagle																						
32	Bird	*Stachyris erythroptera*	Chestnut-winged Babbler																						
33	Bird	*Strix seloputo*	Spotted Wood Owl																						
34	Bird	*Surniculus lugubris*	Drongo Cuckoo	Resident	Resident		Migrant					Migrant	Migrant												
35	Bird	*Treron curvirostra*	Thick-billed Green Pigeon																						
36	Reptile	*Amyda ornata*	Asian Softshell Turtle											Lowland forest streams											
37	Reptile	*Boiga dendrophila*	Yellow-ringed Cat Snake																						In the day it lies motionless on overhanging branches.
38	Reptile	*Calliophis intestinalis*	Blue Malayan Coral Snake	Moist forests	Moist forests																				
39	Reptile	*Chrysopelia pelias*	Twin-barred Tree Snake																						
40	Reptile	*Coelognathus flavolineatus*	Common Malayan Racer	Pristine forests	Degraded forests	Mangrove swamps						Palm oil plantations, Agricultural areas with remnants of woodlands		Has been found swimming in rivers											
41	Reptile	*Cyrtodactylus majulah*	Singapore Bent-toed Gecko																						
42	Reptile	*Dendrelaphis kopsteini*	Red-necked Bronzeback	Lowland forest	Lowland forest																Feeds on lizards and frogs				
43	Reptile	*Draco melanopogon*	Black Bearded Flying Dragon	Lowland forest	Lowland forest																				
44	Reptile	*Eutropis rugiferus*	Striped Sun Skink	Generally inhabits Primary lowland dipterocarp forests																					
45	Reptile	*Gecko gekko*	Tokay Gecko	On cliffs and trees	On cliffs and trees																				
46	Reptile	*Gonyosoma oxycephalum*	Red-tailed Racer	Arboreal	Appears to prefer edge habitats, secondary growth, plantations and rural gardens																				
47	Reptile	*Hemiphyllodactylus typus*	Lowland Dwarf Gecko	Prefers open margins of forested areas	Prefers open margins of forested areas; larger leaves of low secondary growth																			Mangrove	
48	Reptile	*Lipinia vittigera*	Yellow-striped Tree Skink (Striped Tree Skink)	Lowland forest	Lowland forest																				
49	Reptile	*Macropisthodon rhodomelas*	Blue-necked Keelback	Lowland forest near riparian area																					
50	Reptile	*Notochelys platynota*	Malayan Flatshell Terrapin											Forest streams							Adults feed mainly on aquatic vegetation and fallen forest fruits, while juveniles may also consume aquatic invertebrates				
51	Reptile	*Orlitia borneensis*	Bornean Giant River Terrapin			Semi-aquatic species inhabiting swamps								Slow-flowing rivers	Large lakes										
52	Reptile	*Ophiophagus hannah*	King Cobra	Pristine forests	Degraded forests	Mangrove swamps											Mangrove swamps								
53	Reptile	*Tropidolaemus wagleri*	Wagler's Pit Viper	Wet, lowland forests	Wet, lowland forests	Coastal swamps												Coastal swamps							
54	Reptile	*Cnemaspis peninsularis*	Peninsular Rock Gecko																						
55	Amphibian	*Hylarana baramica*	Golden-eared Rough-sided Frog	Swampy lowland flatland																Breeds in water					
56	Amphibian	*Kalophrynus limbooliati*	Lim's Black-spotted Sticky Frog	Lowland forest	Lowland forest; Dense, broad-leaf forest																				
57	Amphibian	*Nyctixalus pictus*	Spotted Tree Frog	Within shrub and lower tree strata	Within shrub and lower tree strata															Breeds by larval development in arboreal water-filled cavities and in rotting logs.					
58	Odonate	*Agrionoptera sexlineata*	Handsome Grenadier			Leafy ponds in swamp forests													stagnant water puddle	leafy ponds in swampy forests					
59	Odonate	*Camacinia gigantea*	Sultan														Rearward edges of mangrove			Shallow stagnant water					
60	Odonate	*Pseudothemis jorina*	Banded Skimmer											Slow flowing											
61	Butterfly	*Cratilla lineata*	Line Forest-skimmer, or Pale-faced Forest-skimmer	Shaded forest muddy pools	Shaded forest muddy pools									Wide range of lentic forest habitats											
62	Butterfly	*Drupadia rufotaenia rufotaenia*	Pygmy Posy																						
63	Butterfly	*Euripus nyctelius euploeoides*	Courtesan	Wherever *Trema tomentosa* is present																					
64	Butterfly	*Ypthima fasciata torone*	Malayan Six Ring						Under shade										Grassland	Grassland	Grassland				
65	Crab	*Irmengardia johnsoni*	Johnson's freshwater crab											Forest and swamp streams											

S/N	Species	Vegetation Type							Substrate					Shade			Strata				Habit				Host Plant
		Primary Forest	Secondary Forest	Scrubland	Mangrove	Swamp	Coastal	Riverine	Clay	Sandy	Loam	Limestone	Drained	Full shade	Semi shaded	Full Sun	Emergent	Canopy	Mid-canopy	Understorey	Tree	Climber	Herb	Shrub	
Flora																									
1	*Castanopsis wallichii*	Lowland	Lowland																						
2	*Lithocarpus conocarpus*	Mixed Dipterocarp	Forest margins or in disturbed areas																						
3	*Cratoxylum maingayi*	Lowland	Lowland																						
4	*Alseodaphne bancana*	Mixed Dipterocarp	As a pre-disturbance remnant																						
5	*Litsea erectinervia*	Mixed Dipterocarp	As a pre-disturbance remnant																						
6	*Litsea ferruginea*		As a pre-disturbance remnant																						
7	*Byttneria maingayi*																								
8	*Memecylon paniculatum*		As a pre-disturbance remnant																						
9	*Sandoricum beccarianum*		As a pre-disturbance																Under-canopy						
10	*Cyclea laxiflora*																								
11	*Syzygium claviflorum*																								
12	*Syzygium singaporense*	Lowland																							
13	*Aporosa lucida*		Disturbed forests																						
14	*Aporosa lunata*	Lowland	Lowland																						
15	*Baccaurea motleyana*	Mixed-Dipterocarp	Disturbed						Acidic	Acidic															
16	*Piper flavimarginatum*	Lowland																							
17	*Centotheca lappacea*																								
18	*Xanthophyllum ellipticum*	Lowland Mixed dipterocarp	Pre-disturbance remnant or planted																						
19	*Drypetes pendula*	Lowland																	16-30m						
20	*Smythea lanceata*				Back mangrove																	Liana			
21	*Diplospora malaccensis*	Mixed Dipterocarp	Pre-disturbance remnant																						
22	*Psychotria helferiana*																								
23	*Psychotria sarmentosa*																								
24	*Timonius flavescens*	Mixed Dipterocarp																							
25	*Luvunga crassifolia*																								
26	*Melicope lunu-ankenda*																								
27	*Nephelium lappaceum*																			10-25m					
28	*Eurycoma longifolia*																								
29	*Enkleia malaccensis*																								
30	*Ampelocissus spicifer*																								
31	*Anisoptera megistocarpa*	Mixed Dipterocarp, Lowland																							
32	*Agelaea macrophylla*																								
33	*Dasymaschalon dasymaschalum*	Lowland forests																							
34	*Epipremnum pinnatum*																					Can be fast-growing, invasive			
35	*Garcinia forbesii*																								
36	*Pandanus atrocarpus*					Lowland swamps																			
37	*Rourea mimosoides*	Lowland and Hill forests	Lowland and Hill forests				Beach forests, riverbanks															Occasionally takes the form of a small tree	Vigorous climbing shrub		Vigorous climbing shrub	
38	*Salacia grandiflora*	Lowland forests	Lowland forests	Common in woods and open country																					
39	*Salacia korthalsiana*											Sometimes on limestone rock										Climbing shrub		Climbing shrub	
40	*Syzygium ridleyi*																	Up to 30m tall							
41	*Triomma malaccensis*	Undisturbed forest along rivers, hillsides and on ridges	Usually present as a pre-disturbance remnant tree														Up to 56m tall								

Annex 12.0

Survey Effort

A12 BIODIVERSITY SURVEY METHODOLOGY AND EFFORT

Biodiversity surveys have been conducted on site from March 2015 to October 2015. These surveys include both nocturnal and diurnal surveys for target species groups. Various survey methods were utilized according to the target group.

A12.1 SURVEY METHODOLOGY

Survey methodology for the different target species groups followed the method statement stated in Annex 3.0.

A12.2 SURVEY EFFORT

Table A12.1 below summarizes the total survey effort expended for each survey method.

A12.1.1 Evaluation of Survey Effort

Survey effort was evaluated through a generation and review of species accumulation curves. A summary of this evaluation is presented in *Table A12.2*. The respective species accumulation curves can be found in the surveyor reports, or appended in the subsequent parts of this Annex.

Table A12.1: Total Time Spent

Survey	Hours per survey session	Survey Dates (2015)							
		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Vegetation	N. A.		16	2, 10, 11, 28	10, 12, 15, 20, 27	4, 11	3-14^, 22	5, 11, 20, 25	2
Terrestrial Vertebrates +	N. A.	28, 30, 31	1, 5, 25, 26, 27, 28	1, 2, 3, 16, 18, 20, 22	2, 4, 10, 12, 21, 23, 26, 29, 30	16, 17, 22, 27, 30	8, 18, 22, 24, 26, 27, 29, 30	2, 5, 16, 18, 21, 23, 24	14, 15, 16, 17, 25
Herpetofauna	N. A.	28, 30, 31	1, 5, 25, 26, 27, 28	1, 2, 3, 16, 18, 20, 22	2, 4, 10, 12, 21, 23, 26, 29, 30	16, 17, 22, 25, 27, 30	8, 18, 22, 24, 26, 27, 28, 29, 30	2, 5, 16, 18, 23, 24, 25	9, 14, 15, 16, 17, 25
Odonates	N. A.	30, 31	5, 15, 26, 27, 28	2, 18, 20, 22	2, 4, 26, 29, 30	15, 16, 22	17, 20, 22, 26, 27, 28, 30	5, 16, 23, 24	14, 15, 16, 17, 18
Butterflies	N. A.	30, 31	5, 15, 26, 27, 28	2, 18, 20, 22	2, 4, 26, 29, 30	15, 16, 22	17, 20, 22, 26, 27, 28, 30	5, 16, 23, 24	14, 15, 16, 17, 18
Camera Trapping	Camera trap survey effort totaled 475 camera trap nights, with an average of 52.8 trap nights at each trap site								
Aquatic Fauna (Fish, crustacea)	0.5; overnight			18, 19	18, 25	28, 29	5, 13	7, 8, 29	
Hymenoptera	≥ 2.5		19, 26, 29	7*, 10*, 31	21	16, 19, 21, 22*, 23, 25, 30*	2, 9, 11, 14, 17, 23, 24	12, 19, 20, 23, 27, 28, 29*, 30*	13*
Orthoptera	1.5		10, 12, 28	1, 23, 25	23, 25, 27, 30	2, 4, 7, 8, 11, 14, 16, 18, 21, 26, 29	1, 2, 26, 28	2, 4	
Reduviidae	1.5		10, 12, 28	1, 23, 25	23, 25, 27, 30	2, 4, 7, 8, 11, 14, 16, 18, 21, 26, 29	1, 2, 26, 28	2, 4	

Notes:

(1) N.A.: Not available

(2) + Avifauna surveys conducted concurrently.

(3) ^ Two survey sessions were conducted between the period of 3 to 14 Aug 2015

(4) * Two survey sessions were conducted in the morning and afternoon in two different areas

Table A12.2: Evaluation of Survey Effort

Survey	Species Accumulation Curve	Evaluation of Survey Effort
Vegetation	Refer to Figure 19 in *Mandai Vegetation Impact Assessment*	Zones B and D have almost identical species accumulation curves, which start off with a gentle slope and eventually begin to flatten out with increasing sampling effort. In contrast, the curves of zones A and E start off with steeper slopes than zones B and D, indicating that more new species are encountered at each new sampling point that have not been encountered before, as compared to zones B and D. The curves of zones A and E also do not begin to flatten out with increasing sampling effort, suggesting that even more species can be found if the number of sampling points were to be increased. The species accumulation curves suggest a higher diversity and habitat heterogeneity in zones A and E compared to zones B and D.
Terrestrial Vertebrates (Mammals, Birds and Herpetofauna)	*Figures A12.1, A12.2 and A12.3*	For mammals, species accumulation curves for zones A, B, D, E and F appear to flatten out with increasing sampling effort. No plateau was observed for zone H, suggesting that even more species can be found if sampling effort was to be increased. For birds, species accumulation curves for zones A, D and F appear to be approaching a plateau as the slope of the curves decreases with increasing survey effort, suggesting that not many new species will be found with more sampling effort. However, for zones B, E and H, the species accumulation curves do not appear to flatten out, suggesting that even more species can be found if sampling effort was to be increased. For herpetofauna, species accumulation curves for zones B, D and E appear to flatten out with increasing sampling effort. For zones A, F and H, the species accumulation curves do not appear to flatten out, suggesting that even more species can be found if sampling effort was to be increased.
Odonates	*Figure A12.4*	Species accumulation curves for zones D and E appear to flatten out with increasing sampling effort. No plateau was observed for zones A, B and F, suggesting that even more species can be found if sampling effort was to be increased.
Butterflies	*Figure A12.5*	Species accumulation curves for zones A, B, D, E and F appear to flatten out with increasing sampling effort.
Camera Trapping	Refer to Figure 2 in *Mandai Safari Park Biodiversity Survey Camera Trapping Final Report* (Marcus, 2015)	Nine species of terrestrial mammals were recorded by camera traps in the study areas, including humans. Both the species rarefaction curve and Jackknife 2 richness estimator reached an asymptote of nine species by the end of the study. This supports that the survey effort was sufficient to detect

Survey	Species Accumulation Curve	Evaluation of Survey Effort
		all species potentially detectable by camera trapping, and that additional survey effort would not yield additional species.
Aquatic Fauna	N.A.	A species accumulation curve could not be generated for aquatic fauna because a variety of survey methods (e.g. push nets, scoop nets and overnight baited fish traps) were utilized on different survey dates. Therefore survey effort could not be standardized for the purpose of plotting the curve.
Hymenoptera	N.A.	A species accumulation curve could not be generated for Hymenoptera due to nature of the data provided to ERM, i.e. species lists were not provided for individual survey dates. Therefore the accumulation of species identified over time after every survey effort could not be represented.
Orthoptera	Refer to Figure 1 and Table 1 in *Environmental Impact Assessment (EIA) report 2015: Orthoptera (grasshoppers, crickets and katydids) of Mandai forest* (Tan, 2015)	Incidence-based species accumulation curves indicate that there are still many more species that are undiscovered from the sampling effort. Asymptotic species estimation was estimated to be 79-85 for zone A, 165-195 for zone B, 158-168 for zone D and 97-105 for zone E. This suggests that the actual recording of species from the different zones is an underestimation of the diversity in Mandai.
Reduviidae	Refer to Figure 1 and Table 2 in *Report on the Assassin Bugs (Hemiptera: Reduviidae) of Mandai for an Environmental Impact Assessment (EIA)* (Yeo, 2015)	Incidence-based species accumulation curves indicate that there are still many more species that are undiscovered from the sampling effort. Asymptotic species richness was estimated to be 12-13 for zone A and 15-16 for zones B and D. (Asymptotic species richness could not be obtained statistically for zones E and F.)

Note:
(1) N.A.: Not available

A12.1.1.1 TERRESTRIAL VERTEBRATES

Figure A12.1: Species accumulation of Mammals across all zones

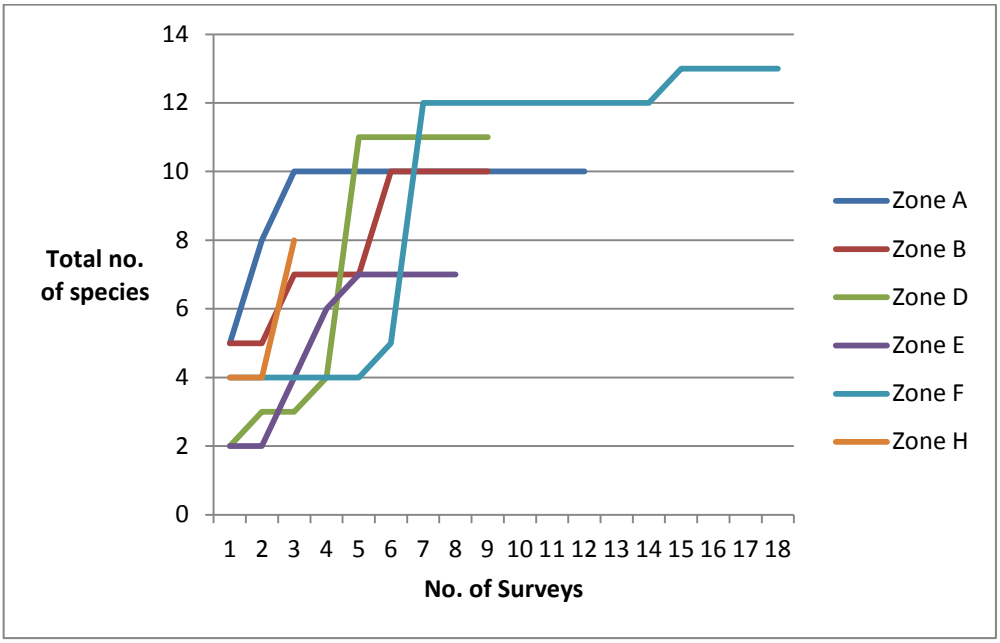


Figure A12.2: Species accumulation of Birds across all zones

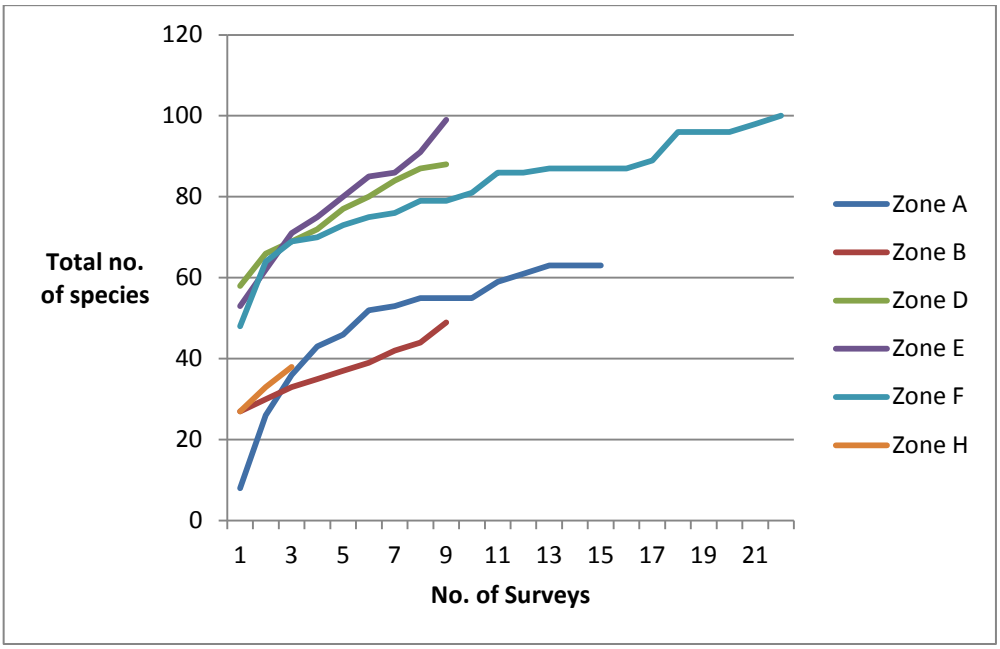
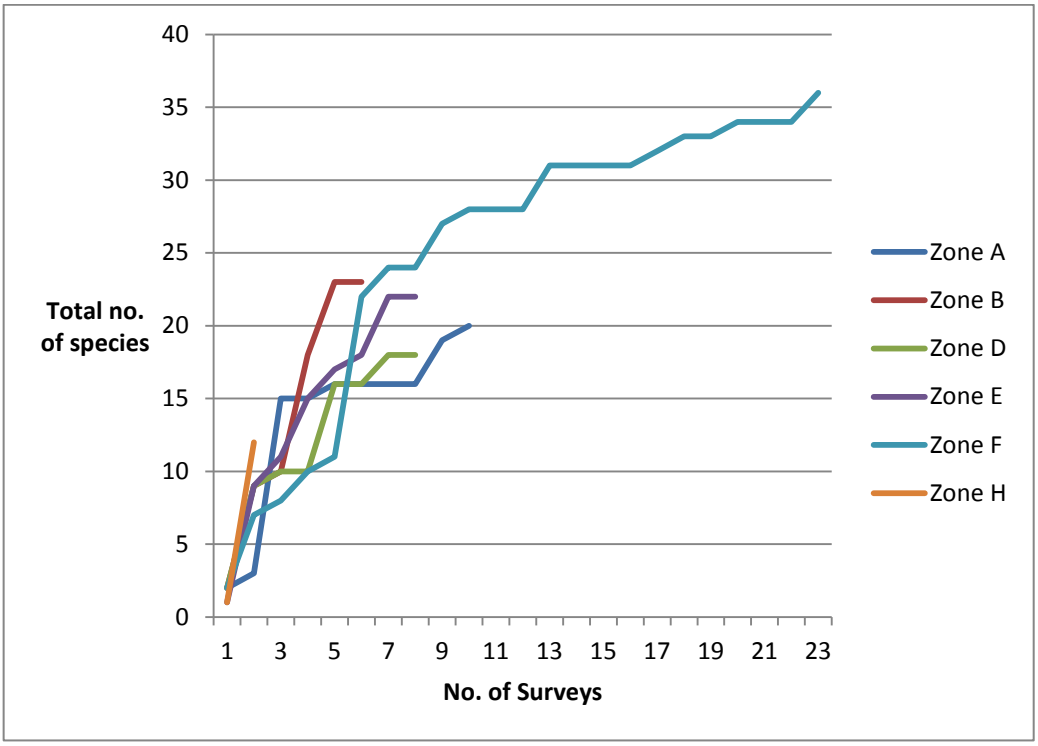
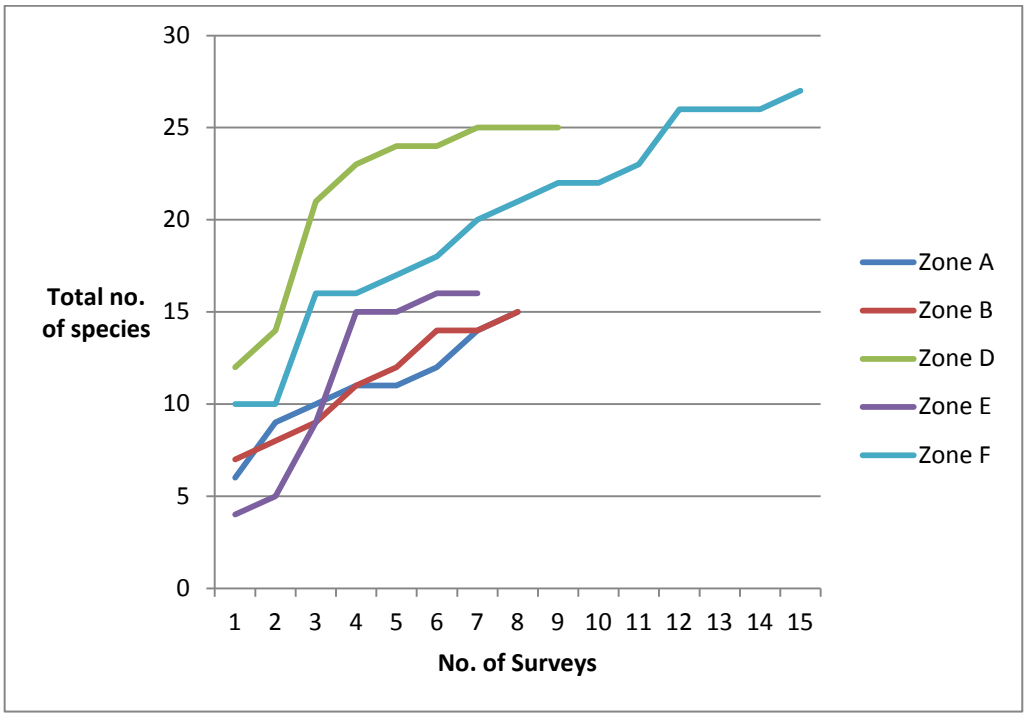


Figure A12.3: Species accumulation of Herpetofauna across all zones



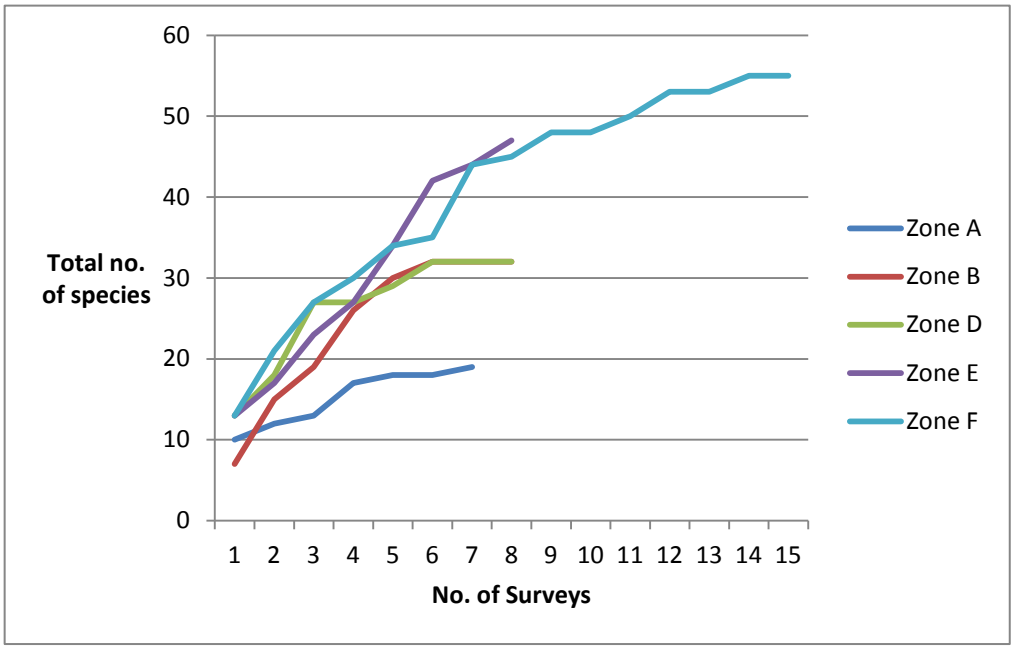
A12.1.1.2 ODONATES

Figure A12.4: Species accumulation of Odonates across all zones



A12.1.1.3 BUTTERFLIES

Figure A12.5: Species accumulation of Butterflies across all zones



Annex 13.0

Invasive Species

S/N	Scientific Name	Common Name	Type	Family	(Probable) Native Range	Invasive Status and Impacts	Presence in Project Area (Y/N)
A. Flora							
Phylum: Filicinophyta							
1	*Adiantum fructuosum*	-	Herb	Adiantaceae	Tropical America	Naturalised exotic	
2	*Adiantum latifolium*	-	Herb	Adiantaceae	Tropical America	Naturalised exotic	
3	*Pityrogramma calomelanos*	Silver Fern, Silverback Fern	Herb	Adiantaceae	Tropical America	Naturalised exotic	
4	*Azolla pinnata*	Mosquito Fern, Water Velvet	Herb	Salviniaceae	Asia to New Guinea	Naturalised exotic	
5	*Salvinia molesta*	Giant Salvinia, Kariba Weed	Herb	Salviniaceae	Tropical America	Naturalised exotic ***Invasive Species (ISSG, 2010)*** This species has been nominated as among 100 of the "World's Worst" invaders. A rapidly growing competitive plant, Salvinia molesta can form dense vegetation mats that reduce water-flow and lower the light and oxygen levels in the water. This stagnant dark environment negatively affects the biodiversity and abundance of freshwater species, including fish and submerged aquatic plants (ISSG, 2010).	
6	*Lygodium japonicum*	Japanese Climbing Fern	Climber	Schizaeaceae	Asia to New Guinea	Naturalised exotic	
Phylum: Magnoliophyta							
7	*Andrographis paniculata*	Creat, Kariyat, Indian Echinacea	Shrub	Acanthaceae	India	Naturalised exotic	
8	*Asystasia gangetica*	Chinese Violet, Creeping Foxglove	Shrub	Acanthaceae	India	Naturalised exotic	Zones A, D and F
9	*Hemigraphis confinis*	-	Herb	Acanthaceae	Asia	Naturalised exotic	
10	*Hemigraphis primulifolia*	Red Flame, Red Lily	Herb	Acanthaceae	Philippines	Naturalised exotic	
11	*Thunbergia alata*	Black-eyed Susan Vine	Climber	Acanthaceae	Africa	Naturalised exotic	
12	*Thunbergia fragrans*	Sweet Clock-Vine, White Lady	Climber	Acanthaceae	Continental Asia	Naturalised exotic	Zone F
13	*Alternanthera bettzickiana*	Calico Plant	Herb	Amaranthaceae	Tropical America	Naturalised exotic	
14	*Alternanthera philoxeroides*	Alligatorweed	Herb	Amaranthaceae	Tropical America	Naturalised exotic ***Invasive Species (ISSG, 2010)*** Alternanthera philoxeroides is a perennial stoloniferous herb that can be found in many parts of the world, infesting rivers, lakes, ponds and irrigation canals, as well as many terrestrial habitats. The aquatic form of the plant has the potential to become a serious threat to waterways, agriculture and the environment. The terrestrial form of *A. philoxeroides* grows into a dense mat with a massive underground rhizomatous root system. The canopy can smother most other herbaceous plant species (ISSG, 2010).	
15	*Amaranthus blitum*	Slender Amaranth, Purple Amaranth	Herb	Amaranthaceae	Indonesia	Naturalised exotic	
16	*Amaranthus spinosus*	Spiny Amaranth, Prickly Amaranth	Herb	Amaranthaceae	Tropical America	Naturalised exotic	
17	*Alstonia macrophylla*	Batino, Hard Alstonia	Tree	Apocynaceae	Tropical Asia	Naturalised exotic	
18	*Asclepias curassavica*	Scarlet Milkweed, Bloodflower	Shrub	Apocynaceae	Tropical America	Naturalised exotic	
19	*Catharanthus roseus*	Madagascar Periwinkle, Rosy Periwinkle	Shrub	Apocynaceae	Madagascar	Naturalised exotic	
20	*Alocasia macrorrhizos*	Giant Taro, Elephant Ear Taro	Shrub	Araceae	Tropical Asia to Tropical Australia	Naturalised exotic	Zone F
21	*Lemna perpusilla*	Duckweed	Herb	Araceae	Central America	Naturalised exotic	
22	*Pistia stratiotes*	Water Cabbage, Water Lettuce	Herb	Araceae	Pantropical	Naturalised exotic	
23	*Syngonium podophyllum*	White Bbutterfly, Arrowhead Vine	Climber	Araceae	Central America	***Potential Invasive Species*** Because of its tolerance for deep shade, and its strong vegetative growth, it is able to spread over large areas in old secondary forest (Rifle Range Road, Old Thomson Road, and Sime Road) along the peripheral areas of the nature reserves. ***Invasive Species (ISSG, 2010)*** Established population in Singapore *Syngonium podophyllum* can establish dense populations that displace surrounding vegetation. It has the ability to form a dense mat on the forest floor as well as climb trees. The stems by which it climbs are thick and fleshy giving them a weight much heavier than most native vines, thus making trees top heavy and more susceptible to toppling in strong wind (ISSG, 2010).	Zones B, D, E and F
24	*Typhonium trilobatum*	Bengal Arum, Lobed Leaf Typhonium	Herb	Araceae	Tropical Asia	Naturalised exotic	
25	*Archontophoenix cunninghamiana*	Bangalow palm, King palm, Illawara palm	Tree	Arecaceae	Australia	***Invasive Species (ISSG, 2010)*** Uncertain if population is established *Archontophoenix cunninghamiana* is extremely tolerant of shade and is able to grow in a range of soils. It is monoecious, a prolific seeder, and can germinate fairly quickly (1 - 3 months), all of which contribute to its invasiveness (ISSG, 2010).	
26	*Arenga westerhoutii*	Westerhout's Sugar Palm	Shrub	Arecaceae	Tropical Asia	Naturalised exotic	
27	*Cocos nucifera*	Coconut Palm	Tree	Arecaceae	Tropical Asia to Tropical Australia	Naturalised exotic	Zone D
28	*Metroxylon sagu*	Sago Palm	Tree	Arecaceae	Tropical Asia to New Guinea	Naturalised exotic	
29	*Ptychosperma macarthurii*	MacArthur Palm	Tree	Arecaceae	New Guinea to Tropical Australia	***Potential Invasive Species*** It has been observed around many of the secondary forest areas in the BTNR and CCNR, and thrives here because it shares the same habitat and climatic niche as its native range. Recruitment for this palm, even in urban areas, is strong because it often attracts with its bright red infructescences numerous frugivorous birds, which disperse its seeds (Lok et al., 2010).	
30	*Agave americana*	Century plant,maguey, American aloe	Herb	Asparagaceae	Mexico, Southern United States (= Tropical America?)	***Invasive Species (ISSG, 2011)*** Established (= naturalised?) exotic One of the major impacts of Agave americana is its large leaves shading out native plant species. A. americana also has a very dense network of rhizome offshoots, which could draw resources away from native species. The rhizomatous nature of A. americana could also alter the nutrient status of the soil. (ISSG, 2011)	
31	*Acanthospermum australe*	Bristly Starbur, Goat's head, Creeping Starbur	Herb	Asteraceae	Tropical America	Naturalised exotic	
32	*Ageratum conyzoides*	Billygoat-weed, Goatweed, Whiteweed	Herb	Asteraceae	Tropical America	Naturalised exotic ***Invasive Species (ISSG, 2009)*** *Ageratum conyzoides* is a weed distributed in many tropical and subtropical countries and is often difficult to control. It has been found that *A. conyzoides* significantly reduces total biomass and species number, i.e. biodiversity. It also changes vegetation community structure and modifies the soil regime (ISSG, 2009).	Present
33	*Bidens pilosa*	Black-jack, Beggar-ticks, Spanish Needle	Herb	Asteraceae	South America	Naturalised exotic	Present
34	*Chromolaena odorata*	Paraffin Weed, Siam Weed	Herb	Asteraceae	Tropical America	Naturalised exotic ***Invasive Species (ISSG, 2006)*** Chromolaena odorata forms dense stands that prevent the establishment of other plant species. It is an aggressive competitor and may have allelopathic effects. It is also a nuisance weed in agricultural land and commercial plantations (ISSG, 2006).	Present

S/N	Scientific Name	Common Name	Type	Family	(Probable) Native Range	Invasive Status and Impacts	Presence in Project Area (Y/N)
35	*Crassocephalum crepidioides*	Ebolo, Redflower Ragleaf, Fireweed	Herb	Asteraceae	Tropical Africa to Madagascar	Naturalised exotic	
36	*Eclipta prostrata*	False Daisy, Bhringraj	Herb	Asteraceae	North to South America	Naturalised exotic	
37	*Eleutheranthera ruderalis*	Ogiera, Pakaka	Herb	Asteraceae	South America	Naturalised exotic	Zone D
38	*Erechtites hieracifolius*	Fireweed, American Burnweed, Pilewort	Herb	Asteraceae	South America	Naturalised exotic	
39	*Erechtites valerianifolius*	Brazilian Fireweed, Fireweed Daisy	Herb	Asteraceae	South America	Naturalised exotic	Lorong Asrama
40	*Mikania micrantha*	Bitter Vine, Climbing Hemp Vine	Climber	Asteraceae	South America	Naturalised exotic	Zones B, D and F
41	*Porophyllum ruderale*	Poreleaf, Summer Cilantro	Herb	Asteraceae	North to South America	Naturalised exotic	Lorong Asrama
42	*Sphagneticola trilobata*	Creeping Ox-Eye, Creeping Daisy, Singapore Daisy	Shrub	Asteraceae	Tropical America	Naturalised exotic	Zone D
43	*Struchium sparganophorum*	Yerba De Faja	Herb	Asteraceae	Tropical America	Naturalised exotic	
44	*Synedrella nodiflora*	Cinderella Weed	Herb	Asteraceae	Tropical America	Naturalised exotic	Zone B
45	*Tridax procumbens*	Coat Buttons, Tridax Daisy	Shrub	Asteraceae	Tropical America	Naturalised exotic	Zone D
46	*Youngia japonica*	Japanese Hawkweed	Herb	Asteraceae	Tropical Asia	Naturalised exotic	
47	*Hydrocera triflora*	Marsh Henna	Herb	Balsaminaceae	Tropical Asia	Naturalised exotic	
48	*Jacaranda obtusifolia*	Fernleaf Jacaranda, Jacaranda	Tree	Bignoniaceae	Tropical America	***Potential Invasive Species*** Many individuals were observed to be recruited under closed canopy forest, at forest sites that are considered old secondary and adjacent to primary growth (Lok et al., 2010). Lok et al. (2008) also reported that the populations of Jacaranda obtusifolia showed a "reversed J" curve or positive stand table, indicating strong recruitment.	
49	*Spathodea campanulata*	African Tulip Tree	Tree	Bignoniaceae	Tropical Africa	Naturalised exotic	Mandai East Camp, Mandai Firing Range, Lorong Asrama; Zones B, D and F
50	*Carmona retusa*	Fukien Tea Tree, Philippine Tea Tree	Shrub	Boraginaceae	Tropical Asia to Pacific	Naturalised exotic	
51	*Cordia cylindristachya*	String Bush	Shrub	Boraginaceae	Tropical America	Naturalised exotic	Present
52	*Rorippa heterophylla*	Variable Leaf Yellowcress	Herb	Brassicaceae	Continental Asia	Naturalised exotic	
53	*Hippobroma longiflora*	Madamfate, Star of Bethlehem	Herb	Campanulaceae	Tropical Asia	Naturalised exotic	
54	*Lobelia chinensis*	Chinese Creeping Lobelia	Shrub	Campanulaceae	Continental Asia	Naturalised exotic	
55	*Canna indica*	Saka Siri, Indian Shot	Shrub	Cannaceae	Tropical America	Naturalised exotic	Mandai Firing Range
56	*Drymaria cordata*	Tropical Chickweed	Herb	Caryophyllaceae	North to South America	Naturalised exotic	
57	*Chrysobalanus icaco*	Coco Plum	Shrub	Chrysobalanaceae	Tropical America	Naturalised exotic	
58	*Cleome aculeata*	Spider Flower	Shrub	Cleomaceae	Tropical America	Naturalised exotic	
59	*Cleome gynandra*	Shona Cabbage, African Cabbage	Shrub	Cleomaceae	Africa to Asia	Naturalised exotic	
60	*Cleome rutidosperma*	Fringed Spider Flower	Shrub	Cleomaceae	Tropical Africa	Naturalised exotic	Present
61	*Cleome viscosa*	Asian Spider Flower	Shrub	Cleomaceae	Continental Asia	Naturalised exotic	
62	*Aniseia martinicensis*	Whitejacket	Climber	Convolvulaceae	Tropical America	Naturalised exotic	
63	*Ipomoea cairica*	Coastal Morning Glory	Climber	Convolvulaceae	Pantropical	Naturalised exotic	Mandai East Camp, Mandai Firing Range, Zone D
64	*Ipomoea quamoclit*	Cardinal Climber, Cupid's Flower, Cypress Vine	Climber	Convolvulaceae	Pantropical	Naturalised exotic	
65	*Ipomoea triloba*	Littlebell, Aiea Morning Glory	Climber	Convolvulaceae	Tropical America	Naturalised exotic	Present
66	*Coccinia grandis*	Ivy Gourd	Climber	Cucurbitaceae	Asia	Naturalised exotic	F
67	*Cucumis maderaspatanus*	Madras Sea Pumpkin, Bristly Bryony	Climber	Cucurbitaceae	India	Naturalised exotic	Present
68	*Cyperus rotundus*	Nut grass, Purple nut sedge	Herb	Cyperaceae	Eurasia	***Invasive Species (ISSG, 2009)*** Established (Naturalised) invasive *Cyperus rotundus* is a weed in over 90 countries and the world's worst invasive weed based on its distribution and effect on crops. Its complex underground network of tubers, basal bulbs, roots and rhizomes ensure its ability to survive and reproduce during adverse conditions. Further biological features, such as its adaptation to high temperatures, solar radiation and humidity, have turned this weed into a serious problem in subtropical and even arid regions (ISSG, 2009).	
69	*Cyperus sphacelatus*	Pale Galingale, Tall Flatsedge	Herb	Cyperaceae	South America to Tropical Africa	Naturalised exotic	
70	*Kyllinga polyphylla*	Navua Sedge	Herb	Cyperaceae	East Africa to Madagascar	Naturalised exotic	B, D
71	*Dioscorea sansibarensis*	Zanzibar Yam	Climber	Dioscoreaceae	Tropical Africa	Naturalised exotic	F
72	*Chamaesyce hirta*	Euphorbia Hirta	Herb	Euphorbiaceae	Tropical America	Naturalised exotic	
73	*Chamaesyce hypericifolia*	Graceful Spurge, Beach Spurge	Herb	Euphorbiaceae	Tropical America	Naturalised exotic	
74	*Croton bonplandianus*	Bonpland's Croton	Tree	Euphorbiaceae	South America	Naturalised exotic	
75	*Croton hirtus*	Hairy Croton	Tree	Euphorbiaceae	South America	Naturalised exotic	
76	*Euphorbia heterophylla*	Fireplant, Japanese Poinsettia, Milkweed	Herb	Euphorbiaceae	South America	Naturalised exotic	
77	*Flueggea virosa*	Common Bushweed, White Berry-bush	Shrub	Euphorbiaceae	Africa to Australia	Naturalised exotic	
78	*Hevea brasiliensis*	Rubber Tree	Tree	Euphorbiaceae	Tropical America	Naturalised exotic	
79	*Manihot carthagenesis*	Tree Cassava, Ceara Rubber Tree	Shrub	Euphorbiaceae	Tropical America	Naturalised exotic	Lorong Asrama; Zones E and F
80	*Manihot esculenta*	Cassava, Brazilian Arrowroot, Manioc	Shrub	Euphorbiaceae	Tropical America	Naturalised exotic	Mandai East Camp, Mandai Firing Range, Lorong Asrama; Zone F
81	*Ricinus communis*	Castor Oil Plant	Shrub	Euphorbiaceae	Tropical Africa	Naturalised exotic	
82	*Abrus precatorius*	Crab's eye, Rosary Pea, Indian Licorice	Climber	Fabaceae	Pantropical	Naturalised exotic	

S/N	Scientific Name	Common Name	Type	Family	(Probable) Native Range	Invasive Status and Impacts	Presence in Project Area (Y/N)
83	*Acacia auriculiformis*	Earleaf Acacia	Tree	Fabaceae	New Guinea to Tropical Australia	Naturalised exotic	Mandai Firing Range, Lorong Asrama; Zones D and F
84	*Acacia mangium*	Black Wattle, Hickory Wattle, Mangium	Tree	Fabaceae	New Guinea to Tropical Australia	Naturalised exotic	
85	*Adenanthera pavonina*	Saga Tree, Red Sandalwood	Tree	Fabaceae	Tropical Asia	Naturalised exotic	
86	*Aeschynomene americana*	American Jointvetch, Thornless Mimosa	Shrub	Fabaceae	Tropical America	Naturalised exotic	
87	*Aeschynomene indica*	Indian Jointvetch	Shrub	Fabaceae	Central America	Naturalised exotic	
88	*Calopogonium mucunoides*	Calopo, Wild Ground Nut	Herb	Fabaceae	Tropical America	Naturalised exotic	Lorong Asrama; Zone D
89	*Centrosema pubescens*	Butterfly Pea	Herb	Fabaceae	Tropical America	Naturalised exotic	
90	*Chamaecrista leschenaultiana*	-	Shrub	Fabaceae	Continental Asia	Naturalised exotic	
91	*Chamaecrista mimosoides*	Tea Senna, Japanese Tea	Shrub	Fabaceae	Continental Asia	Naturalised exotic	
92	*Clitoria laurifolia*	Laurel-leaf Pigeonwings	Shrub	Fabaceae	Tropical America	Naturalised exotic	
93	*Clitoria ternatea*	Butterfly Pea, Blue Pea	Climber	Fabaceae	Tropical Africa	Naturalised exotic	
94	*Crotalaria alata*	Winged-Stem Rattlepod	Shrub	Fabaceae	Asia to Australia	Naturalised exotic	
95	*Crotalaria incana*	Rattlebox Plant	Shrub	Fabaceae	North to South America	Naturalised exotic	
96	*Crotalaria juncea*	Sunn Hemp	Shrub	Fabaceae	India	Naturalised exotic	
97	*Crotalaria pallida*	Rattlebox	Shrub	Fabaceae	Continental Asia	Naturalised exotic	Present
98	*Desmanthus virgatus*	Acacia Courant, Acacia Savane	Shrub	Fabaceae	Tropical America	Naturalised exotic	
99	*Falcataria moluccana*	Albizia	Tree	Fabaceae	New Guinea	Naturalised exotic ***Interim Profile (ISSG, 2008)*** *Falcataria moluccana* is an invasive, nitrogen-fixing tree species. Its rapid growth habit allows it to outcompete slow-growing native trees, and its abundant, high-quality litter alters nutrient dynamics in the soil. This affects decomposition rates and microorganism and invertebrate community composition. Ecosystem processes may be altered in both terrestrial and aquatic environments where *F. moluccana* invades riparian area (ISSG, 2008).	Mandai East Camp, Mandai Firing Range; Zones B, D and F
100	*Indigofera hirsuta*	Hairy Indigo	Shrub	Fabaceae	Africa to Pacific	Naturalised exotic	
101	*Indigofera spicata*	Creeping Indigo	Herb	Fabaceae	Africa	Naturalised exotic	
102	*Indigofera suffruticosa*	Guatemalan indigo	Shrub	Fabaceae	North to South America	Naturalised exotic	
103	*Indigofera tinctoria*	True Indigo	Shrub	Fabaceae	Africa to Australia	Naturalised exotic	
104	*Leucaena leucocephala*	White Leadtree, White Popinac	Tree	Fabaceae	Tropical America	Naturalised exotic ***Invasive Species (ISSG, 2010)*** This species has been nominated as among 100 of the "World's Worst" invaders. This fast-growing, nitrogen-fixing tree is cultivated as a fodder plant, for green manure, as a windbreak, for reforestation, as a biofuel crop etc. It has become an aggressive invader in disturbed areas in many tropical and sub-tropical locations. This thornless tree can form dense monospecific thickets and is difficult to eradicate once established. It renders extensive areas unusable and inaccessible and threatens native plants (ISSG, 2010).	Lorong Asrama; Zone F
105	*Macroptilium atropurpureum*	Siratro	Herb	Fabaceae	Tropical America	Naturalised exotic	
106	*Macroptilium lathyroides*	Phasey Bean	Herb	Fabaceae	South America	Naturalised exotic	Present
107	*Mimosa bimucronata*	Brazil Macca	Tree	Fabaceae	South America	Naturalised exotic	
108	*Mimosa diplotricha*	Giant Sensitive Plant	Shrub	Fabaceae	Tropical America	Naturalised exotic ***Invasive Species (ISSG, 2006)*** *Mimosa diplotricha* is a major weed of cultivated areas and has the ability to climb over other plants. In the Kaziranga National Park in northeast India, the weed forms a thorny mat over the natural vegetation, preventing animals from accessing and utilising natural vegetation. In Australia the weed chokes out cane, other crops and grassland, causing crop and pasture loss (ISSG, 2006).	D
109	*Mimosa pigra*	Giant Sensitive Tree, Catclaw Mimosa	Shrub	Fabaceae	Tropical America	Naturalised exotic	Present
110	*Mimosa pudica*	Touch-me-not	Shrub	Fabaceae	Tropical America	Naturalised exotic ***Invasive Species (ISSG, 2010)*** *Mimosa pudica* forms a dense ground cover, preventing reproduction of other species. It has become a serious weed in fields of corn, soybeans, tomatoes, cotton, bananas, sugarcane, coffee, oil palms, coconuts, and rubber in many tropical areas (ISS, 2010).	D
111	*Neptunia oleracea*	Water Mimosa	Herb	Fabaceae	Continental Asia	Naturalised exotic	
112	*Neptunia plena*	Dead and Awake	Shrub	Fabaceae	Tropical America	Naturalised exotic	
113	*Ohwia caudata*	-	Shrub	Fabaceae	Asia	Naturalised exotic	
114	*Pseudarthria viscida*	-	Shrub	Fabaceae	Tropical Asia	Naturalised exotic	
115	*Pueraria phaseoloides*	Tropical Kudzu	Climber	Fabaceae	Asia to Pacific	Naturalised exotic	
116	*Senna alata*	Ringworm Bush, Seven Golden Candlesticks	Tree	Fabaceae	South America	Naturalised exotic	Present
117	*Senna hirsuta*	Hairy Senna	Shrub	Fabaceae	South America	Naturalised exotic	
118	*Senna obtusifolia*	Chinese Senna, Sicklepod	Shrub	Fabaceae	Pantropical	Naturalised exotic	
119	*Senna occidentalis*	Coffee Senna, Coffee Weed	Shrub	Fabaceae	Tropical America	Naturalised exotic	
120	*Senna tora*	Sickle Wild Sensitive-plant	Shrub	Fabaceae	Asia to Pacific	Naturalised exotic	
121	*Sesbania cannabina*	Sesbania Pea, Canicha, Prickly Sesban	Shrub	Fabaceae	Asia to Australia	Naturalised exotic	
122	*Stylosanthes guianensis*	Brazilian Stylo	Shrub	Fabaceae	Tropical America	Naturalised exotic	
123	*Stylosanthes humilis*	Townsville Stylo	Herb	Fabaceae	Tropical America	Naturalised exotic	
124	*Tephrosia noctiflora*	South African Hoarypea	Shrub	Fabaceae	Africa	Naturalised exotic	
125	*Uraria crinita*	Asian Foxtail	Shrub	Fabaceae	Tropical Asia	Naturalised exotic	
126	*Vigna unguiculata*	Cowpea	Herb	Fabaceae	Africa	Naturalised exotic	
127	*Zornia diphylla*	-	Herb	Fabaceae	India	Naturalised exotic	
128	*Trimezia martinicensis*	Yellow Walking Iris, Forenoon Yellow Flag	Shrub	Iridaceae	Tropical America	Naturalised exotic	
129	*Hyptis brevipes*	Lesser Roundweed	Herb	Lamiaceae	South America	Naturalised exotic	
130	*Hyptis capitata*	Knobweed, False Ironwort, Buttonweed	Herb	Lamiaceae	Tropical America	Naturalised exotic	D
131	*Hyptis suaveolens*	Pignut	Herb	Lamiaceae	Tropical America	Naturalised exotic	
132	*Leonotis nepetifolia*	Lion's Ear	Herb	Lamiaceae	Tropical Africa	Naturalised exotic	
133	*Leonurus sibiricus*	Siberian Motherwort	Herb	Lamiaceae	Temperate Asia	Naturalised exotic	

S/N	Scientific Name	Common Name	Type	Family	(Probable) Native Range	Invasive Status and Impacts	Presence in Project Area (Y/N)
134	*Limnocharis flava*	Yellow Velvetleaf, Yellow Burr Head	Shrub	Limnocharitaceae	South America	Naturalised exotic ***Invasive Species (ISSG, 2005)*** If allowed to grow unchecked, *L. flava* may become a very invasive environmental weed of streams and wetlands. It has become a serious weed in rice fields, irrigation canals and wetlands in South-East Asia. Clumps of the weed provide a congenial breeding sites for disease-vectors, including mosquitoes, which encourages the spread of diseases such as Japan fever and dengue fever (ISSG, 2005).	Present
135	*Lindernia nummulariifolia*	Round-leaved False Pimpernel	Herb	Linderniaceae	India	Naturalised exotic	
136	*Ammannia baccifera*	Monarch Redstem	Herb	Lythraceae	India	Naturalised exotic	
137	*Cuphea carthagenesis*	Colombian Waxweed	Shrub	Lythraceae	South America	Naturalised exotic	
138	*Corchorus aestuans*	Jute	Herb	Malvaceae	Tropical America	Naturalised exotic	
139	*Muntingia calabura*	Jamaica Cherry, Calabur Tree	Tree	Malvaceae	Tropical America	Naturalised exotic	Southwest, Central South of Mandai Lake Road, Lorong Asrama; Zones D and F
140	*Triumfetta rhomboidea*	Triumfetta Burr	Shrub	Malvaceae	Tropical America	Naturalised exotic	
141	*Triumfetta tomentosa*	-	Shrub	Malvaceae	Tropical Africa	Naturalised exotic	
142	*Clidemia hirta*	Koster's Curse	Shrub	Melastomataceae	Tropical America	***Invasive Species (& ISSG, 2006)*** It has a short life cycle which allows it to spread in a short period over a large area. It is also successful in spreading into forested areas because native forest bird species have developed a liking for its fruits and disperse them throughout the forest (Lok et al., 2011). This species has been nominated as among 100 of the "World's Worst" invaders. Clidemia hirta is a problem in tropical forest understories in its introduced range, where it invades gaps in the forest, preventing native plant species from regenerating. The spread of Clidemia hirta has been linked to soil disturbances, particularly that caused by the wild pig, another invasive species (ISSG, 2006).	North, Central South, Southeast of Mandai Lake Road, Mandai East Camp, Mandai Firing Range; Zones A, B, D, E, F and Zone F Fragment 1
143	*Ficus religiosa*	Sacred Fig	Tree	Moraceae	Asia	Naturalised exotic	Present
144	*Horsfieldia parviflora*	-	Tree	Myristicaceae	Moluccas	Naturalised exotic	
145	*Psidium guajava*	Guava, Lemon Guava	Tree	*Myrtaceae*	Southern Mexico through to Central America	***Invasive Species (ISSG, 2010)*** Uncertain if population is established Due in part to its ability to grow on a variety of soils and across a range of climates, *P. guajava* has become invasive. Pastures and fields are overrun and native plants are outcompeted by this species, which has the ability to form dense thickets (ISSG, 2010).	Present
146	*Syzygium cumini*	Java Plum, Black Plum	Tree	Myrtaceae	Tropical Africa to Tropical Asia	Naturalised exotic	
147	*Ludwigia peruviana*	Peruvian Primrose-willow	Shrub	Onagraceae	South America	Naturalised exotic	
148	*Striga asiatica*	Asiatic Witchweed	Herb	Orobanchaceae	Africa and Asia	***Invasive Species (ISSG, 2006)*** Uncertain if population is established *Striga asiatica* is an annual parasitic weed of agricultural crops. It robs nutrients and moisture by tapping directly into a host's root system. The host expends energy supporting the growth of *Striga asiatica* at its own expense (ISSG, 2006).	
149	*Oxalis barrelieri*	Barrelier's Woodsorrel, Lavender Sorrel	Shrub	Oxalidaceae	Tropical America	Naturalised exotic	Southwest, Central South of Mandai Lake Road, Lorong Asrama
150	*Oxalis corniculata*	Creeping Woodsorrel, Yellow Woodsorrel	Shrub	Oxalidaceae	Tropical America	Naturalised exotic	
151	*Oxalis debilis*	Pink Woodsorrel	Herb	Oxalidaceae	South America	Naturalised exotic	
152	*Passiflora foetida*	Stinking Passionfruit	Climber	Passifloraceae	North to South America	Naturalised exotic	Central South of Mandai Lake Road
153	*Passiflora laurifolia*	Water Lemon, Jamaican Honeysuckle, Bell Apple	Climber	Passifloraceae	Tropical America	Naturalised exotic	Northeast, Central South of Mandai Lake Road; Zone F
154	*Passiflora suberosa*	Corky Stemmed Passionflower	Climber	Passifloraceae	North to South America	Naturalised exotic	Zone F
155	*Sesamum indicum*	Sesame	Herb	Pedaliaceae	Africa	Naturalised exotic	
156	*Sesamum radiatum*	Benniseed	Shrub	Pedaliaceae	Tropical Africa	Naturalised exotic	
157	*Phyllanthus amarus*	Chanca Piedra	Shrub	Phyllanthaceae	South America	Naturalised exotic	
158	*Phyllanthus debilis*	Leafflower	Herb	Phyllanthaceae	India	Naturalised exotic	Southwest of Mandai Lake Road
159	*Phyllanthus urinaria*	Chamberbitter, Leafflower	Shrub	Phyllanthaceae	India	Naturalised exotic	
160	*Rivina humilis*	Pigeonberry, Bloodberry	Herb	Phytolaccaceae	South America	Naturalised exotic	
161	*Peperomia pellucida*	Pepper Elder, Shining Bush	Herb	Piperaceae	Tropical America	Naturalised exotic	Southeast of Mandai Lake Road; Zones B and F
162	*Piper aduncum*	Spanish Pepper	Tree	Piperaceae	Tropical America	Naturalised exotic	South, Northwest of Mandai Lake Road; Mandai East Camp; Mandai Firing Range; Zones B, D and F
163	*Bacopa monnieri*	Waterhyssop, Brahmi, Thyme-leafed Gratiola	Herb	Plantaginaceae	Tropical Asia	Naturalised exotic	
164	*Plantago major*	Broadleaf Plantain, Greater Plantain	Herb	Plantaginaceae	Europe	Naturalised exotic	
165	*Plumbago zeylanica*	Leadwort	Shrub	Plumbaginaceae	Asia	Naturalised exotic	
166	*Axonopus compressus*	Savannah Grass, Carpet Grass, Blanket Grass	Herb	Poaceae	North to South America	Naturalised exotic	Central South, Southwest of Mandai Lake Road; Mandai Firing Range; Zones B, D and F
167	*Axonopus fissifolius*	Caratao grass, Common Carpet Grass,	Herb	Poaceae	North to South America	Naturalised exotic	
168	*Cenchrus brownii*	-	Herb	Poaceae	Central America	Naturalised exotic	
169	*Cenchrus echinatus*	Southern Sandbur, Spiny sandbur	Herb	Poaceae	Pantropical	Naturalised exotic	Central South, Southeast of Mandai Lake Road
170	*Chloris barbata*	Swollen Finger Grass, Purpletop Chloris	Herb	Poaceae	Tropical America	Naturalised exotic	Central South, Southwest of Mandai Lake Road

S/N	Scientific Name	Common Name	Type	Family	(Probable) Native Range	Invasive Status and Impacts	Presence in Project Area (Y/N)
171	*Coix lacryma-jobi*	Job's Tears, Tear Grass	Herb	Poaceae	Asia	Naturalised exotic	Central South, Southwest of Mandai Lake Road
172	*Cynodon dactylon*	Bermuda grass, Dog's tooth grass	Herb	Poaceae	Middle East (Farsani et al., 2012); Old world, Southern Europe (ISSG, 2010)	***Interim Profile (ISSG, 2010)*** Established invasive (Naturalised exotic) *Cynodon dactylon* is adapted to survive both extended dry periods and flooding conditions. It is a potential agricultural weed and a commonly used as a lawn grass (ISSG, 2010).	
173	*Dichanthium annulatum*	Marvel Grass, Bluestem	Herb	Poaceae	Africa to Asia	Naturalised exotic	
174	*Digitaria didactyla*	Queensland Blue Couch Grass	Herb	Poaceae	Tropical Africa	Naturalised exotic	
175	*Eleusine indica*	Indian Goosegrass	Herb	Poaceae	Africa	Naturalised exotic	Southwest of Mandai Lake Road
176	*Megathyrsus maximus*	Guinea Grass	Herb	Poaceae	Africa	Naturalised exotic	
177	*Melinis repens*	Rose Natal Grass	Herb	Poaceae	Africa	Naturalised exotic	
178	*Paspalum conjugatum*	Buffalo Grass	Herb	Poaceae	Tropical Africa	Naturalised exotic	Central South of Mandai Lake Road
179	*Pennisetum polystachion*	Mission Grass	Herb	Poaceae	Tropical Africa	Naturalised exotic	
180	*Pennisetum purpureum*	Napier Grass, Elephant Grass	Herb	Poaceae	Tropical Africa	Naturalised exotic	Northwest, Southwest, Central South of Mandai Lake Road, Mandai East Camp, Mandai Firing Range
181	*Rottboellia cochinchinensis*	Itch Grass	Herb	Poaceae	Africa to Asia	Naturalised exotic	
182	*Saccharum spontaneum*	Kans Grass, Wild Sugarcane	Herb	Poaceae	Asia	Naturalised exotic	
183	*Setaria barbata*	Foxtail Grass, Corn Grass	Herb	Poaceae	Tropical Africa	Naturalised exotic	Northwest of Mandai Lake Road
184	*Sorghum propinquum*	-	Herb	Poaceae	Tropical Asia	Naturalised exotic	
185	*Sporobolus tenuissimus*	Tropical Dropseed	Herb	Poaceae	South America to India	Naturalised exotic	
186	*Steinchisma laxa*	-	Herb	Poaceae	South America	Naturalised exotic	
187	*Stenotaphrum secundatum*	Buffalo Grass, St Augustine Grass	Herb	Poaceae	Africa	Naturalised exotic	Southwest of Mandai Lake Road
188	*Thysanolaena latifolia*	Tiger Grass	Herb	Poaceae	Asia	Naturalised exotic	
189	*Urochloa mutica*	Para Grass	Herb	Poaceae	Tropical Africa	Naturalised exotic ***Interim Profile (ISSG, 2010)*** The species can form dense monotypic stands by layering of trailing stems and can overgrow shrubs and native vegetation. It can tolerate brackish water and interfere with stream flow due to its highly aggressive habit (ISSG, 2010).	
190	*Polygala paniculata*	Orosne	Herb	Polygalaceae	North to South America	Naturalised exotic	
191	*Persicaria chinensis*	Chinese Knotweed	Herb	Polygonaceae	Asia	Naturalised exotic	
192	*Persicaria orientalis*	Prince's Feather	Herb	Polygonaceae	Asia to Australia	Naturalised exotic	
193	*Eichhornia crassipes*	Common Water Hyacinth	Shrub	Pontederiaceae	Tropical America	Naturalised exotic ***Invasive species (ISSG, 2006)*** This species has been nominated as among 100 of the "World's Worst" invaders. Water hyacinth is a very fast growing plant, with populations known to double in as little as 12 days. Infestations of this weed block waterways, limiting boat traffic, swimming and fishing. Water hyacinth also prevents sunlight and oxygen from reaching the water column and submerged plants. Its shading and crowding of native aquatic plants dramatically reduces biological diversity in aquatic ecosystems (ISSG, 2006).	
194	*Portulaca oleracea*	Common Purslane	Shrub	Portulacaceae	Pantropical	Naturalised exotic	
195	*Portulaca quadrifida*	Small-leaved Purslane	Herb	Portulacaceae	Asia	Naturalised exotic	
196	*Talinum paniculatum*	Jewels of Opar	Shrub	Portulacaceae	North to South America	Naturalised exotic	
197	*Duchesnea indica*	Indian Strawberry	Climber	Rosaceae	Asia	Naturalised exotic	
198	*Diodia ocymifolia*	Slender Buttonweed	Herb	Rubiaceae	Tropical America	Naturalised exotic	
199	*Diodia sarmentosa*	Tropical Buttonweed	Herb	Rubiaceae	Tropical America	Naturalised exotic	
200	*Mitracarpus hirtus*	Tropical Girdlepod	Herb	Rubiaceae	South America	Naturalised exotic	
201	*Oldenlandia corymbosa*	Diamond Flower, Two-flowered Oldenlandia,	Shrub	Rubiaceae	India	Naturalised exotic	
202	*Spermacoce assurgens*	Woodland False Buttonweed	Herb	Rubiaceae	Tropical America	Naturalised exotic	
203	*Spermacoce laevis*	-	Herb	Rubiaceae	Tropical America	Naturalised exotic	Northwest, Southwest of Mandai Lake Road
204	*Spermacoce latifolia*	Broad-leaved Buttonweed	Herb	Rubiaceae	Tropical America	Naturalised exotic	
205	*Spermacoce ocymoides*	Purple-leaved Buttonweed	Shrub	Rubiaceae	Tropical Asia to Pacific	Naturalised exotic	
206	*Uncaria gambir*	Hook Vine	Climber	Rubiaceae	Tropical Asia	Naturalised exotic	
207	*Flacourtia jangomas*	Indian Plum, Coffee Plum	Tree	Salicaceae	India	Naturalised exotic	
208	*Cardiospermum halicacabum*	Balloon Vine, Love-in-a-puff, Heart Pea	Climber	Sapindaceae	South America	Naturalised exotic	
209	*Scoparia dulcis*	Licorice Weed	Herb	Scrophulariaceae	North to South America	Naturalised exotic	
210	*Solanum lasiocarpum*	-	Shrub	Solanaceae	Tropical Asia to New Guinea	Naturalised exotic	
211	*Solanum nigrum*	Black Nightshade	Herb	Solanaceae	Tropical Africa to India	Naturalised exotic	
212	*Solanum sarmentosum*	-	Shrub	Solanaceae	Tropical Asia	Naturalised exotic	
213	*Solanum torvum*	Turkeyberry, Thai Pea Eggplant	Shrub	Solanaceae	Tropical America	Naturalised exotic	Southwest of Mandai Lake Road, Mandai East Camp, Mandai Firing Range, Lorong Asrama; Zones B and D
214	*Wikstroemia ridleyi*	-	Shrub	Thymelaeaceae	Asia	Naturalised exotic	
215	*Turnera subulata*	White Buttercup, Sulphur Alder, White Alder	Shrub	Turneraceae	Tropical America	Naturalised exotic	
216	*Turnera ulmifolia*	Yellow Alder, Yellow Buttercups	Shrub	Turneraceae	Tropical America	Naturalised exotic	

S/N	Scientific Name	Common Name	Type	Family	(Probable) Native Range	Invasive Status and Impacts	Presence in Project Area (Y/N)
217	*Typha angustifolia*	Narrowleaf Cattail	Shrub	Typhaceae	Temperate America to Temperate Asia	Naturalised exotic	
218	*Boehmeria nivea*	Chinese Grass, Ramie	Shrub	Urticaceae	Asia	Naturalised exotic	
219	*Cecropia pachystachya*	Ambay Pumpwood	Tree	Urticaceae	Tropical America	***Potential Invasive Species*** It grows relatively fast, fruiting at 3m in height, and has become very attractive to secondary forest birds, which disperse their seeds through the reserves. It also has the potential to replace Macaranga species as pioneer species at forest edges, or in the gap formation (tree fall) process within primary forests, thus affecting the succession process (Lok et al., 2010).	North, South West of Mandai Lake Road; Mandai East Camp, Mandai Firing Range; Zones B, D and F
220	*Cecropia peltata*	Trumpet Tree, Snakewood	Tree	Urticaceae	Tropical America	***Potential Invasive Species*** It grows relatively fast, fruiting at 3m in height, and has become very attractive to secondary forest birds, which disperse their seeds through the reserves. It also has the potential to replace Macaranga species as pioneer species at forest edges, or in the gap formation (tree fall) process within primary forests, thus affecting the succession process (Lok et al., 2010). It is also nominated as being among "100 of the World's Worst Invasive Alien Species" by the Global Invasive Species Database (ISSG, 2005).	
221	*Pilea microphylla*	Military Fern, Artillery Plant	Climber	Urticaceae	North to South America	Naturalised exotic	Zone F
222	*Pipturus argenteus*	Native Mulberry, Australian Mulberry	Shrub	Urticaceae	Tropical Asia to Tropical Australia	Naturalised exotic	South Central of Mandai Lake Road; Zone F
223	*Lantana camara*	Wild Sage, Red Sage, Common Lantana	Shrub	Verbenaceae	Tropical America	Naturalised exotic	Zone D
224	*Lantana indica*	Mysore Lantana	Shrub	Verbenaceae	India	Naturalised exotic	
225	*Stachytarpheta cayennensis*	Blue Snakeweed, Cayenne Snakeweed	Herb	Verbenaceae	South America	Naturalised exotic	
226	*Stachytarpheta indica*	Indian Snakeweed, Blue snakeweed	Shrub	Verbenaceae	Tropical Africa	Naturalised exotic	Mandai East Camp
227	*Stachytarpheta jamaicensis*	Indian Snakeweed, Nettle-leaved Vervain	Shrub	Verbenaceae	Central America	Naturalised exotic	South Central of Mandai Lake Road
228	*Stachytarpheta mutabilis*	Pink Snakeweed	Shrub	Verbenaceae	Tropical America	Naturalised exotic	
B. Fauna							
Invertebrates							
Higher Classification **Arthropoda: Insecta**							
229	*Nauphoeta cinerea*	Cinereous Cockroach, Grey Cockroach	Cockroach	Blattidae	Africa	Established population in Singapore; Known to be invasive elsewhere	
230	*Periplaneta americana*	American Cockroach	Cockroach	Blattidae	Africa	Established population in Singapore; Known to be invasive elsewhere	
231	*Periplaneta australasiae*	Australian Cockroach	Cockroach	Blattidae	Africa	Established population in Singapore; Known to be invasive elsewhere	
232	*Periplaneta brunnea*	Brown Cockroach	Cockroach	Blattidae	Africa	Established population in Singapore; Known to be invasive elsewhere	
233	*Supella longipalpa*	Brown-banded cockroach	Cockroach	Pseudophyllodromiidae	Africa	Established population in Singapore; Known to be invasive elsewhere	
234	*Brontispa longissima*	Coconut leaf beetle, Hispid palm leaf beetle	Beetle	Chrysomelidae	Melanesia, Indonesia and Papau New Guinea	***Invasive Species (ISSG, 2009)*** Uncertain if population is established The coconut beetle infects and even kills seedlings, mature coconut trees and ornamental palms (ISSG, 2009).	
235	*Quadrastichus erythrinae*	Erythrina Gall Wasp	Wasp	Eulophidae	Africa	***Invasive Species (ISSG, 2010)*** Uncertain if population is established The Erythrina gall wasp infests *Erythrina* spp. by inserting its eggs inside young leaf and stem tissue. Severe infestations can cause defoliation and death of trees. The Erythrina gall wasp has caused approximately 95% mortality of Erythrina endemic to Hawai'i (ISSG, 2010).	
236	*Paratrechina longicornis*	*Crazy Ant, Longhorn Crazy Ant*	Ant	Formicidae	Africa and Asia	***Invasive Species (ISSG, 2010)*** Uncertain if population is established *Paratrechina longicornis* is a tramp ant, which, by definition, is an ant that is widely dispersed through commerce and other human-assisted avenues. The species is highly adaptable to various environments and can be a major pest. It occurs in large numbers in homes or outdoors and is capable of displacing other ants and possibly other invertebrates. It forages over long distances away from its nest, making the nest hard to find and the ants difficult to control (ISSG, 2010).	
237	*Pheidole megacephala*	Big-headed Ant, Brown House-ant, Coastal Brown-ant	Ant	Formicidae	Southern Africa	***Invasive Species (ISSG, 2011)*** Uncertain if population is established This species has been nominated as among 100 of the "World's Worst" invaders. This ant displaces most native invertebrate faunas directly through aggression, and as such is a serious threat to biodiversity. Effects on plants and horticultural crops can be direct through the likes of seed harvesting, or indirect through the likes of harbouring phytophagous insects which reduce plant productivity. It is known to facilitate the invasion of introduced plant species. (ISSG, 2011).	
238	*Solenopsis invicta*	Red Imported Fire Ant	Ant	Formicidae	South America	***Invasive Species (ISSG, 2010)*** Uncertain if population is established This species has been nominated as among 100 of the "World's Worst" invaders. *Solenopsis invicta* is an aggressive generalist forager ant that occurs in high densities and can thus dominate most potential food sources. Their stinging ability allows them to subdue prey and repel even larger vertebrate competitors from resources. *S. invicta* reduces biodiversity among invertebrates and reptiles, and may also kill or injure frogs, lizards or small mammals (ISSG, 2010).	
239	*Tapinoma melanocephalum*	Ghost Ant	Ant	Formicidae	African or Oriental origin	***Invasive Species (ISSG, 2010)*** Uncertain if population is established Tapinoma melanocephalum is known as a tramp ant and is a household pest. It is highly flexible in the habitats it occupies, provided there is some form of disturbance allowing it to establish ahead of more dominant ant species, and it nests readily outdoors or indoors (ISSG, 2010).	
240	*Diaphorina citri*	Asian citrus psyllid	Psylllid	Psyllidae	Tropical and subtropical Asia	***Invasive Species (ISSG, 2009)*** Uncertain if population is established *Diaphorina citri* is one of the most serious pests of citrus in the world. It causes damage through direct feeding and its toxic saliva, leading to leaf distortion and curling in young tender growth. However it is the ability of *D. citri* to vector the Asian and American forms of the huanglongbing (HLB) disease which makes this so damaging. Trees usually die after several years and entire orchards may be devastated.	
Higher Classification **Onychophora**							
241	*Paraperipatus papuaensis*	-	Velvet worm	Peripatopsidae	Australasia	Uncertain if population is established in Singapore; Not known to be invasive	
Higher Classification **Annelida: Oligochaeta**							
242	*Pontoscolex corethrurus*	-	Earthworm	Glossoscolecidae	Central to South America	Established population in Singapore; Known to be invasive elsewhere	
243	*Amynthas gracilis*	Alabama Jumpers	Earthworm	Megascolecidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
244	*Amynthas minimus*	Segmented Earthworm	Earthworm	Megascolecidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
245	*Polypheretima taprobanae*	-	Earthworm	Megascolecidae	Asia	Established population in Singapore; Known to be invasive elsewhere	

S/N	Scientific Name	Common Name	Type	Family	(Probable) Native Range	Invasive Status and Impacts	Presence in Project Area (Y/N)
246	*Ocnerodrilus occidentalis*	-	Earthworm	Ocnerodrilidae	Central to South America	Established population in Singapore; Known to be invasive elsewhere	
247	*Dichogaster saliens*	-	Earthworm	Octochaetidae	Africa	Established population in Singapore; Known to be invasive elsewhere	
Higher Classification **Mollusca: Bivalvia**							
248	*Mytilopsis sallei*	Black-striped Mussel, Caribbean False Mussel	Mussel	Dreissenidae	Central to South America	Established population in Singapore; Known to be invasive elsewhere ***Invasive Species (ISSG, 2007)*** *Mytilopsis sallei* is an extremely prolific and fecund species. It has been responsible for massive fouling on wharves and marinas, seawater systems and marine farms. In preferred habitats, it forms dense monospecific groups that exclude most other species, leading to a substantial reduction in biodiversity in infected areas (ISSG, 2007).	
249	*Brachidontes striatulus*	-	Mussel	Mytilidae	Asia	Established population in Singapore; Not known to be invasive	
250	*Anodonta woodiana*	Chinese Pond Mussel	Mussel	Unionidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
251	*Pilsbryoconcha exilis*	Thai Aquaria Mussel, Swan Mussel	Mussel	Unionidae	Asia	Established population in Singapore; Not known to be invasive	
252	*Pseudodon vondembuschianus*	-	Mussel	Unionidae	Asia	Established population in Singapore; Not known to be invasive	
Higher Classification **Arthropoda: Crustacea**							
253	*Cherax quadricarinatus*	Australian Red Claw Crayfish	Crayfish	Parastacidae	Asia	Established population in Singapore; Known to be invasive elsewhere	Zones A and F
254	*Macrobrachium lanchesteri*	Freshwater Prawn	Prawn	Palaemonidae	Asia	Established population in Singapore; Known to be invasive elsewhere	Zone H
255	*Macrobrachium aff. inflatum*	-	Prawn	Palaemonidae	Asia	Established population in Singapore; Not known to be invasive	
256	*Macrobrachium nipponense*	Oriental River Prawn	Prawn	Palaemonidae	Asia	Established population in Singapore; Known to be invasive elsewhere	Zones A and F
Higher Classification **Mollusca: Gastropoda**							
257	*Pomacea canaliculata*	Channeled Applesnail	Snail	Ampullaridae	Central to South America	Established population in Singapore; Known to be invasive elsewhere	
258	*Amerianna carinata*	-	Snail	Planorbidae	Australasia	Established population in Singapore; Known to be invasive elsewhere	
259	*Taia polyzonata*	-	Snail	Viviparidae	Asia	Established population in Singapore; Not known to be invasive	
260	*Achatina fulica*	Giant African Snail	Snail	Achatinidae	Africa	Established population in Singapore; Known to be invasive elsewhere. ***Invasive Species (ISSG, 2010)*** This species has been nominated as among 100 of the "World's Worst" invaders. *Achatina fulica* feeds on a wide variety of crop plants and may present a threat to local flora. Costs to the natural environment may include herbivory; altered nutrient cycling associated with large volumes of plant material that pass through the achatinid gut; adverse effects on indigenous gastropods that may arise via competition; and indirect adverse effects on indigenous gastropods that may arise via control of the snail or use of chemical pesticides applied against achatinids. (ISSG, 2010)	
261	*Pomacea canaliculata*	Golden Apple Snail, Channeled Apple Snail	Snail	Ampullariidae	Temperate Argentina northwards to Amazon basin	***Invasive Species (ISSG, 2005)*** Uncertain if population is established This species has been nominated as among 100 of the "World's Worst" invaders. *Pomacea canaliculata* has a voracious appetite for water plants including lotus, water chestnut, taro and rice. It poses a serious threat to many wetlands around the world through potential habitat modification via destruction of native aquatic vegetation as well as competition with native species including native snails (ISSG, 2005).	
Vertebrates							
Higher Classification **Chordata: Amphibia**							
262	*Kaloula pulchra*	Banded Bullfrog	Frog	Microhylidae	Asia	Established population in Singapore; Known to be invasive elsewhere	South of Mandai Lake Road; Zone F
263	*Microhyla fissipes*	-	Frog	Microhylidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
264	*Lithobates catesbeianus*	American Bullfrog	Frog	Ranidae	North America	Established population in Singapore; Known to be invasive elsewhere ***Invasive Species (ISSG, 2009)*** This species has been nominated as among 100 of the "World's Worst" invaders. The American bullfrog has been held responsible for outbreaks of the chytrid fungus found to be responsible for declining amphibian populations in Central America and elsewhere. They are also important predators and competitors of endangered native amphibians and fish (ISSG, 2009).	Present
Higher Classification **Chordata: Aves**							
265	*Columba livia*	Rock Dove, Rock Pigeon	Bird	Columbidae	Europe	Established population in Singapore; Known to be invasive elsewhere ***Invasive species (ISSG, 2008)*** The species can cause considerable damage to buildings and monuments because of their corrosive droppings. They also pose a health hazard, since they are capable of transmitting a variety of diseases to humans and to domestic poultry and wildlife. (ISSG. 2008)	
266	*Streptopelia tranquebarica*	Red Turtle Dove	Bird	Columbidae	Asia	Established population in Singapore; Not known to be invasive	
267	*Corvus splendens*	House Crow	Bird	Corvidae	Asia	Established population in Singapore; Known to be invasive elsewhere ***Invasive Species (ISSG, 2007)*** The house crow causes problems across a range of areas, including crop and livestock sustainability and poses a risk to native avifauna. It also carries a range of human pathogens but a link with human disease is yet to be established (ISSG, 2007).	Zones D, F
268	*Dendrocygna arcuata*	Wandering Whistling Duck	Bird	Dendrocygnidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
269	*Megalaima lineata*	Lineated Barbet	Bird	Megalaimidae	Asia	Established population in Singapore; Not known to be invasive	Zones D, F
270	*Amandava amandava*	Red Avadavat, Red Munia	Bird	Passeridae	Asia	Established population in Singapore; Not known to be invasive	
271	*Lonchura ferruginosa*	White-capped Munia	Bird	Passeridae	Asia	Established population in Singapore; Not known to be invasive	
272	*Lonchura leucogastroides*	Javan Munia	Bird	Passeridae	Asia	Established population in Singapore; Known to be invasive elsewhere	
273	*Padda oryzivora*	Java Sparrow	Bird	Passeridae	Asia	Established population in Singapore; Known to be invasive elsewhere	
274	*Passer domesticus*	House Sparrow	Bird	Passeridae	Eurasia	Established population in Singapore; Known to be invasive elsewhere	
275	*Passer montanus*	Eurasian Tree Sparrow	Bird	Passeridae	Eurasia	Established population in Singapore; Known to be invasive elsewhere	
276	*Ploceus manyar*	Streaked Weaver	Bird	Passeridae	Asia	Established population in Singapore; Not known to be invasive	
277	*Cacatua goffini*	Tanimbar Corella, Goffin's Cockatoo	Bird	Psittacidae	Asia	Established population in Singapore; Not known to be invasive	
278	*Cacatua sulphurea*	Yellow-crested Cockatoo	Bird	Psittacidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
279	*Psittacula alexandri*	Red-breasted Parakeet	Bird	Psittacidae	Asia	Established population in Singapore; Known to be invasive elsewhere	Zone D
280	*Psittacula krameri*	Rose-ringed Parakeet	Bird	Psittacidae	Africa and Asia	Established population in Singapore; Known to be invasive elsewhere ***Interim Profile (ISSG, 2010)*** This species is known as one of the most successful avian invaders in the world, with established populations in over 35 countries outside its native range. *P. krameri* has been shown to have adverse impacts on native bird species and carry diseases. It is thought that its reproductive success, establishment and range expansion in non-native areas is related to climate similarities of non-native areas to that of its native range (ISSG, 2010).	Present
281	*Trichoglossus haematodus*	Rainbow Lorikeet	Bird	Psittacidae	Asia and Australasia	Established population in Singapore; Not known to be invasive	
282	*Pycnonotus aurigaster*	Sooty-headed Bulbul	Bird	Pycnonotidae	Asia	Established population in Singapore; Not known to be invasive	
						Established population in Singapore; Known to be invasive elsewhere	

S/N	Scientific Name	Common Name	Type	Family	(Probable) Native Range	Invasive Status and Impacts	Presence in Project Area (Y/N)
283	*Pycnonotus jocosus*	Red-whiskered Bulbul	Bird	Pycnonotidae	Asia	***Invasive Species (ISSG, 2008)*** *Pycnonotus jocosus* has been found to damage commercial crops, compete with and displace native passerines, prey on endemic young birds and arthropods, and spread invasive plant species. On Mauritius *P. jocosus* has reduced populations of endemic passerine native white-eyes (Zosterops spp.), spiders of the genus *Neophilia* and geckos. *P. jocosus* is also known to distribute invasive alien plant species such as Koster's curse (*Clidemia hirta*) and largeleaf lantana (*Lantana camara*) (ISSG, 2008).	South of Mandai Lake Road; Zones D and E
284	*Pycnonotus melanicterus*	Black-capped Bulbul	Bird	Pycnonotidae	-	Established population in Singapore; Not known to be invasive	
285	*Acridotheres cristatellus*	Crested Myna	Bird	Sturnidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
286	*Acridotheres javanicus*	Javan Myna	Bird	Sturnidae	Asia	Established population in Singapore; Known to be invasive elsewhere	North and South of Mandai Lake Road, Mandai East Camp, Mandai Firing Range, Lorong Asrama
287	*Acridotheres tristis*	Common Myna	Bird	Sturnidae	Asia	Established population in Singapore; Known to be invasive elsewhere. ***Invasive Species (ISSG, 2011)*** This species has been nominated as among 100 of the "World's Worst" invaders (ISSG, 2011). *Acridotheres tristis* is known to compete for nesting cavities with hole-nesting bird species, contributing to the decline of native hole-nesting oriental magpie robin (Lim et al., 2003). Its population in Singapore, however, is declining (Lim et al., 2003) and there is debate as to whether the species is alien or native to Singapore (SRD).	Zones E and F
288	*Sturnus melanopterus*	Black-winged Starling	Bird	Sturnidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
289	*Garrulax canorus*	Chinese hwamei	Bird	Sylviidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
290	*Garrulax leucolophus*	White-crested Laughingthrush	Bird	Sylviidae	Asia	Established population in Singapore; Not known to be invasive	Lorong Asrama; Zones B, E and F
291	*Zosterops palpebrosus*	Oriental White-eye	Bird	Zosteropidae	Asia	Established population in Singapore; Known to be invasive elsewhere	Zones E, F and H
Higher Classification **Chordata: Osteichthyes**							
292	*Parambassis siamensis*	Siamese Glassfish	Fish	Ambassidae	Asia	Established population in Singapore; Not known to be invasive	
293	*Hemibagrus nemurus*	Asian Redtail Catfish	Fish	Bagridae	Asia	No established population in Singapore; Not known to be invasive	
294	*Mystus castaneus*	-	Fish	Bagridae	Asia	No established population in Singapore; Not known to be invasive	
295	*Mystus wolffii*	Bagrid Catfish	Fish	Bagridae	Asia	Established population in Singapore; Not known to be invasive	
296	*Chromobotia macracanthus*	Clown Loach	Fish	Botiidae	Asia	No established population in Singapore; Not known to be invasive	
297	*Channa micropeltes*	Giant Snakehead	Fish	Channidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
298	*Piaractus brachypomus*	Red-bellied Pacu	Fish	Characidae	Central to South America	No established population in Singapore; Known to be invasive elsewhere	
299	*Acarichthys heckelii*	Threadfin Acara	Fish	Cichlidae	Central to South America	Established population in Singapore; Not known to be invasive	Upper Seletar Reservoir inlet stream (shallow creek, surrounded by mature secondary forest); Zone A
300	*Amphilophus citrinellus*	Midas Cichlid	Fish	Cichlidae	Central to South America	Established population in Singapore; Known to be invasive elsewhere	
301	*Apistogramma* sp.	-	Fish	Cichlidae	Central to South America	Uncertain if population is established in Singapore; Not known to be invasive	
302	*Cichla ocellaris*	Butterfly peacock Bass	Fish	Cichlidae	Tropical America	***Invasive Species (ISSG, 2006)*** Uncertain if population is established This species is a voracious piscivore capable of greatly modifying ecosystems where introduced. It is a highly adapted and quickly proliferating predator that can cause serious damage within the introduced communities by predation, competition, and cascade effects throughout the whole trophic chain (ISSG, 2006).	
303	*Cichla orinocensis*	Orinoco Peacock Bass	Fish	Cichlidae	Central to South America	Established population in Singapore; Known to be invasive elsewhere	
304	*Cichlasoma hybrid*	Flowerhorn	Fish	Cichlidae	Hybrid (local ornamental fish trade)	Established population in Singapore; Not known to be invasive	
305	*Cichlasoma urophthalmus*	Mayan Cichlid	Fish	Cichlidae	Central to South America	Established population in Singapore; Known to be invasive elsewhere ***Invasive Species (ISSG, 2011)*** It is a generalist predator, and tolerates a wide range of salinities, temperatures and habitat types; factors which have contributed to its range expansion throughout the Florida peninsula. It can reach high densities and may compete with and predate upon native fish, possibly reducing biodiversity and ecosystem function (ISSG, 2011).	
306	*Etroplus suratensis*	Green Chromide	Fish	Cichlidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
307	*Geophagus altifrons*	-	Fish	Cichlidae	Central to South America	Established population in Singapore; Not known to be invasive	
308	*Heros severus*	Banded Cichlid	Fish	Cichlidae	Central to South America	No established population in Singapore; Not known to be invasive	
309	*Oreochromis aureus*	Israeli Tilapia, Blue Tilapia	Fish	Cichlidae	[Parts of Africa and Middle East] Cameroon, Chad, Egypt, Israel, Jordan, Mali, Niger, Nigeria, Saudi Arabia, Senegal	***Invasive Species (ISSG, 2008)*** Established population in Singapore *Oreochromis aureus* competes with native fishes for food, spawning area, and space, and exhibits aggressive behavior. They have become the dominant species in many of their introduced ranges. Several introductions have correlated with and are believed to cause reductions in abundance of native fishes and even molluscs. Blue tilapia structure phytoplankton communities by their feeding preference of specific algae, having significant effects on the entire community ecology. Some reports maintain certain introduced areas have lost most and nearly all native fishes (ISSG, 2008).	
310	*Oreochromis mossambicus*	Mozambique Tilapia	Fish	Cichlidae	Africa	Established population in Singapore; Known to be invasive elsewhere ***Invasive Species (ISSG, 2006)*** This species has been nominated as among 100 of the "World's Worst" invaders. *Oreochromis mossambicus* is omnivorous and feeds on almost anything, from algae to insects. When introduced, the species may be a possible threat to native species through competition for food and nest space. Juveniles have been documented to feed on other fish (ISSG, 2006).	
311	*Oreochromis niloticus*	Nile Tilapia	Fish	Cichlidae	Africa	Established population in Singapore; Known to be invasive elsewhere	
312	*Parachromis managuensis*	Jaguar Cichlid	Fish	Cichlidae	Central to South America	Established population in Singapore; Known to be invasive elsewhere	
313	*Paratheraps synspilus*	Redheaded Cichlid	Fish	Cichlidae	Central to South America	Established population in Singapore; Not known to be invasive	
314	*Satanoperca jurupari*	Demon eartheater	Fish	Cichlidae	Central to South America	Established population in Singapore; Not known to be invasive	
315	*Tilapia buttikoferi*	Zebra Tilapia	Fish	Cichlidae	Africa	Established population in Singapore; Known to be invasive elsewhere	
316	*Vieja synspila*	Quetzel Cichlid, Redhead Cichlid	Fish	Cichlidae	Central to South America	Established population in Singapore; Known to be invasive elsewhere	
317	*Clarias gariepinus*	African Sharptooth Catfish	Fish	Clariidae	Africa	Established population in Singapore; Known to be invasive elsewhere ***Interim profile (ISSG, 2013)*** The pan-African/Asian Clarias gariepinus is a threat to endemic aquatic fish, particularly in South Africa and India. It is known to have a dietary overlap with endemic fish (ISSG, 2013).	
318	*Clarias macrocephalus*	Broadhead Catfish	Fish	Clariidae	Asia	No established population in Singapore; Known to be invasive elsewhere	
319	*Barbonymus altus*	Red Tailed Tinfoil	Fish	Cyprinidae	Asia	No established population in Singapore; Not known to be invasive	
320	*Barbonymus schwanenfeldii*	Tinfoil Barb	Fish	Cyprinidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
321	*Carassius auratus*	Goldfish	Fish	Cyprinidae	Asia	No established population in Singapore; Known to be invasive elsewhere ***Invasive Species (ISSG, 2010)***	

S/N	Scientific Name	Common Name	Type	Family	(Probable) Native Range	Invasive Status and Impacts	Presence in Project Area (Y/N)
321	*Carassius auratus*	Goldfish	Fish	Cyprinidae	Asia	*Carassius auratus* has many adverse impacts on its introduced aquatic community, including increasing turbidity, predation upon native fish, and helping to facilitate algal blooms (ISSG, 2010).	
322	*Ctenopharyngodon idella*	Glass carp	Fish	Cyprinidae	China, Russia	No established population in Singapore; Known to be invasive elsewhere ***Invasive Species (ISSG, 2005)*** The species is a large cyprinid introduced worldwide as a biological control of aquatic vegetation as well as a food fish. It is a voracious feeder which is incredibly efficient at removing aquatic weeds. However they can completely eliminate vegetation from water systems, resulting in widespread ecological effects. Grass carp are also known to compete with native fish, carry parasites such as Asian tapeworm (*Bothriocephalus opsarichthydis*), and induce other harmful effects to introduced waters (ISSG, 2005).	
323	*Cyprinus carpio*	Common Carp	Fish	Cyprinidae	Eurasia	No established population in Singapore; Known to be invasive elsewhere ***Invasive species (ISSG, 2010)*** On every continent where *C. carpio* has been introduced it has reduced water quality and degraded aquatic habitats. The Common carp negatively affects macrophyte abundance by reduction of light availability, increase of siltation rates, ingestion of plant matter and uprooting during feeding activity. The loss of rooted macrophytes due to carp activity is intuitively likely to lead to a decline in biological diversity, in endemic fish, amphibians and reptiles in Mexico. In California, carp have been implicated in the gradual disappearance of native fishes (ISSG, 2010).	
324	*Esomus metallicus*	Striped Flying Barb	Fish	Cyprinidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
325	*Hampala macrolepidota*	Hampala Barb	Fish	Cyprinidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
326	*Hypophthalmichthys molitrix*	Silver Carp	Fish	Cyprinidae	China and Russia	***Invasive Species (ISSG, 2006)*** Uncertain if population is established *Hypophthalmichthys molitrix* have been introduced around the world for aquaculture purposes and also for controlling excessive growth of phytoplankton in natural waters. It has the potential to reduce native diversity by competing for and depleting zooplankton populations, altering the food web. *H. molitrix* have also been found to carry and transmit the disease Salmonella typhimurium (ISSG, 2006).	
327	*Hypophthalmichthys nobilis*	Bighead Carp	Fish	Cyprinidae	Asia	No established population in Singapore; Known to be invasive elsewhere ***Invasive Species (ISSG, 2005)*** Because bighead carp are planktivorous and attain a large size, these carp have the potential to deplete zooplankton populations. A decline in the availability of plankton can lead to reductions in populations of native species that rely on plankton for food, including all larval fishes, some adult fishes, and native mussels. *H. nobilis* is also a carrier of several different fish diseases that can be spread through its escape and introduction (ISSG, 2005).	
328	*Labeo rohita*	Rohu, Roho Labeo	Fish	Cyprinidae	Asia	No established population in Singapore; Known to be invasive elsewhere	
329	*Leptobarbus rubripinna*	Saltan Fish, Red-finned Cigar Shark	Fish	Cyprinidae	Asia	No established population in Singapore; Not known to be invasive	
330	*Metzia lineata*	Chinese Minnow	Fish	Cyprinidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
331	*Neolissochilus* sp.	Mahseer	Fish	Cyprinidae	Asia	No established population in Singapore; Uncertain if species is invasive	
332	*Osteochilus hasselti*	Hard-lipped Barb	Fish	Cyprinidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
333	*Puntius semifasciolatus*	Gold Barb, Golden Barb, Green Barb, Half-striped Barb	Fish	Cyprinidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
334	*Rasbora borapetensis*	Red-tailed Rasbora, Blackline Rasbora	Fish	Cyprinidae	Asia	Established population in Singapore; Known to be invasive elsewhere	Zone D
335	*Systomus partipentazona*	Indochinese Tiger Barb	Fish	Cyprinidae	Asia	Established population in Singapore; Not known to be invasive	
336	*Systomus rhombeus*	Indochinese Spotted Barb	Fish	Cyprinidae	Asia	Established population in Singapore; Not known to be invasive	
337	*Systomus tetrazona*	Sumatran Tiger Barb	Fish	Cyprinidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
338	*Tor tambra*	Mahseer	Fish	Cyprinidae	Asia	No established population in Singapore; Not known to be invasive	
339	*Datnioides microlepis*	Indonesian Tigerfish, Finescale Tigerfish	Fish	Datnioididae	Asia	No established population in Singapore; Not known to be invasive	
340	*Oxyeleotris marmorata*	Marbled Goby	Fish	Eleotridae	Asia	Established population in Singapore; Known to be invasive elsewhere	Upper Seletar Reservoir inlet stream (shallow creek, surrounded by mature secondary forest); Zone A
341	*Rhinogobius giurinus*	Barcheek Goby	Fish	Gobiidae	Asia	Established population in Singapore; Not known to be invasive	
342	*Atractosteus spatula*	Alligator Gar	Fish	Lepisosteidae	North America	No established population in Singapore; Not known to be invasive	
343	*Pterygoplichthys disjunctivus*	Vermiculated Sailfin Catfish	Fish	Loricariidae	Central to South America	Established population in Singapore; Known to be invasive elsewhere ***Invasive Species (ISSG, 2010)*** In locations where *Pterygoplichthys spp.* are introduced and abundant, their feeding and burrowing behaviours can cause considerable disturbance. They may alter or reduce food availability for aquatic insects eaten by other native and non-native fishes, or compete directly with native species. They are believed to displace several species of minnow in Texas including the Federally threatened and 'Vulnerable (VU)' Devils River minnow (ISSG, 2010).	
344	*Pterygoplichthys joselimaianus*	Gold Spot Common Pleco	Fish	Loricariidae	Central to South America	No established population in Singapore; Not known to be invasive	
345	*Pterygoplichthys multiradiatus*	Long-fin Armoured Catfish, Orinoco Sailfin Catfish	Fish	Loricariidae	South America	***Invasive Species (ISSG, 2010)*** Established population in Singapore Thousands of nesting tunnels excavated by *P. multiradiatus* have contributed to siltation problems in Hawai'i. Because of their abundance in Hawai'i, *P. multiradiatus* may compete with native stream species for food and space. The burrowing behaviour and overpopulation of *P. multiradiatus* may also displace native fish in Puerto Rico where they have been reported as detrimental to reservoir fishes (ISSG, 2010).	
346	*Pterygoplichthys pardalis*	Common Pleco	Fish	Loricariidae	Central to South America	Established population in Singapore; Known to be invasive elsewhere	
347	*Macrognathus zebrinus*	Zebra Spiny Eel	Fish	Mastacembelidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
348	*Synodontis euptera*	Featherfin Squeaker	Fish	Mochokidae	Africa	No established population in Singapore; Not known to be invasive	
349	*Chitala ornata*	Clown Featherback, Clown Knifefish	Fish	Notopteridae	Asia	Established population in Singapore; Known to be invasive elsewhere	
350	*Notopterus notopterus*	Bronze Featherback	Fish	Notopteridae	Asia	Established population in Singapore; Known to be invasive elsewhere	
351	*Osphronemus goramy*	Giant Gouramy	Fish	Osphronemidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
352	*Trichogaster pectoralis*	Snakeskin Gourami	Fish	Osphronemidae	Asia	Established population in Singapore; Known to be invasive elsewhere	
353	*Trichopsis schalleri*	Threestripe Gourami, Mekong Croaking Guaramy	Fish	Osphronemidae	Asia	No established population in Singapore; Not known to be invasive	
354	*Osteoglossum bicirrhosum*	Silver Arowana	Fish	Osteoglossidae	Central to South America	No established population in Singapore; Not known to be invasive	
355	*Scleropages formosus*	Asian Arowana	Fish	Osteoglossidae	Asia	Established population in Singapore; Not known to be invasive	Zone A
356	*Phractocephalus hemioliopterus*	Redtail Catfish	Fish	Pimelodidae	Central to South America	No established population in Singapore; Not known to be invasive	
357	*Gambusia affinis*	(Western) Mosquitofish	Fish	Poeciliidae	North America	Established population in Singapore; Known to be invasive elsewhere	
					Southern Alabama,	***Invasive Species (ISSG, 2010)*** Established population in Singapore	

S/N	Scientific Name	Common Name	Type	Family	(Probable) Native Range	Invasive Status and Impacts	Presence in Project Area (Y/N)
358	*Gambusia holbrooki*	(Eastern) Mosquitofish, Eastern gambusia, Plague minnow	Fish	Poeciliidae	throughout Florida and northward along the Atlantic Seaboard	*Gambusia holbrooki* predate on amphibian eggs, and predate and compete with tadpoles, resulting in injury or death. They have been shown to predate upon the eggs and tadpoles of the 'Critically Endangered (CR)' yellow-spotted tree frog; the 'Endangered (EN)' green and gold frog; and the 'Vulnerable (VU)' golden bell frog. Gambusia spp. have been implicated in the decline in the range and abundance of native fish species worldwide via predation and interference competition (ISSG, 2010).	
359	*Poecilia reticulata*	Guppy	Fish	Poeciliidae	Central to South America	Established population in Singapore; Known to be invasive elsewhere ***Invasive Species (ISSG, 2006)*** *Poecilia reticulata* is a very small opportunistic benthopelagic fish that can inhabit both fresh and brackish water. It is considered a hazard to native cyprinids and killifishes in the United States and has been implicated in the decline of native fishes in Nevada and Wyoming, and of native damselflies in Hawaii. It eats the eggs of native fish species and acts as a host for the parasitic nematode *Camallanus cotti* , and the Asian tapeworm *Bothriocephalus acheilognathi* in Hawaii (ISSG, 2006).	Unnamed Stream Parallel to the Project Western Boundary (artificial bank waterway flowing through secondary forest); Lorong Asrama; Zone D
360	*Poecilia sphenops*	Molly	Fish	Poeciliidae	Central to South America	Established population in Singapore; Known to be invasive elsewhere	
361	*Salmo salar*	Atlantic Salmon	Fish	Salmonidae	Rivers and northern Atlantic Ocean bound by North America, Scandinavia and Europe	***Invasive Species (ISSG, 2008)*** Uncertain if population is established *Salmo salar* ranks among the most popularly cultivated fish in the world. Commercial stocks have inflicted significant impacts of wild populations of wild salmon and other fish by way of competition, hybridization, and spread of disease. Escaped *S. salar* compete with wild populations and other native fishes for resources. Farm juveniles are generally more aggressive and grow faster than wild fish, which may give them a competitive advantage at some life stages (ISSG, 2008).	
362	*Potamotrygon motoro*	Ocellate River Stingray, Peacock-eye Stingray	Stingray	Potamotrygonidae	Central to South America	Established population in Singapore; Not known to be invasive	
Higher Classification **Chordata: Mammalia**							
363	*Rattus norvegicus*	Brown Rat	Rat	Muridae	Asia	Established population in Singapore; Known to be invasive elsewhere	
364	*Callosciurus finlaysoni*	Variable Squirrel, Finlayson's Squirrel	Squirrel	Sciuridae	Asia	Established population in Singapore; Known to be invasive elsewhere	
Higher Classification **Chordata: Reptilia**							
365	*Calotes versicolor*	Changeable Lizard	Lizard	Agamidae	Asia	Established population in Singapore; Known to be invasive elsewhere	South of Mandai Lake Road; Zones B, D, E and F
366	*Batagur baska*	Northern River Terrapin	Terrapin	Bataguridae	Asia	No established population in Singapore; Not known to be invasive	
367	*Callagur borneoensis*	Painted Terrapin	Terrapin	Bataguridae	Asia	No established population in Singapore; Not known to be invasive	
368	*Orlitia borneensis*	Bornean River Turtle, Malaysian Giant Turtle	Turtle	Bataguridae	Asia	No established population in Singapore; Not known to be invasive	Zone F
369	*Carettochelys insculpta*	Pig-Nosed Turtle	Turtle	Carettochelyidae	Australasia	No established population in Singapore; Not known to be invasive	
370	*Chelus fimbriatus*	Mata mata	Turtle	Chelidae	Central to South America	No established population in Singapore; Not known to be invasive	
371	*Chelydra serpentina*	Common Snapping Turtle	Turtle	Chelydridae	North America	No established population in Singapore; Not known to be invasive	
372	*Macrochelys temminckii*	Alligator Snapping Turtle	Turtle	Chelydridae	North America	No established population in Singapore; Not known to be invasive	
373	*Tomistoma schlegelii*	False Gharial	Crocodile	Crocodylidae	Asia	No established population in Singapore; Not known to be invasive	
374	*Trachemys decussata*	Cuban Slider	Turtle	Emydidae	Central to South America	No established population in Singapore; Not known to be invasive	
375	*Trachemys scripta elegans*	Red-eared Slider	Turtle	Emydidae	North America	Uncertain if population is established in Singapore; Known to be invasive ***Invasive Species (ISSG, 2010)*** This species has been nominated as among 100 of the "World's Worst" invaders. Their omnivorous diet and ability to adapt to various habitats, gives them great potential for impacting indigenous habitats. Biological competitive advantages include lower age at maturity, higher fecundity and larger adult body size. In Washington, they are a potential threat to the declining endemic Pacific pond turtle (ISSG, 2010).	South of Mandai Lake Road; Zones A and H (Less than 10 individuals); Zones A and F
376	*Heosemys grandis*	Giant Asian Pond Turtle	Turtle	Geoemydidae	Asia	No established population in Singapore; Not known to be invasive	Zone D
377	*Mauremys sinensis*	Chinese Stripe-Necked Turtle	Turtle	Geoemydidae	Asia	No established population in Singapore; Not known to be invasive	
378	*Siebenrockiella crassicollis*	Black Marsh Turtle	Turtle	Geoemydidae	Asia	Established population in Singapore; Not known to be invasive	
379	*Iguana iguana*	Common Green Iguana	Lizard	Iguanidae	Central to South America	No established population in Singapore; Known to be invasive elsewhere	
380	*Sternotherus carinatum*	Razor-Backed Musk Turtle, Keeled Musk Turtle	Turtle	Kinosternidae	North America	No established population in Singapore; Not known to be invasive	
381	*Xenochrophis flavipunctatus*	Yellow-Spotted Keelback	Snake	Natricidae	Asia	No established population in Singapore; Not known to be invasive	
382	*Xenochrophis vittatus*	Striped Keelback	Snake	Natricidae	Asia	Established population in Singapore; Not known to be invasive	
383	*Pareas margaritophorus*	Spotted Slug Snake	Snake	Pareatidae	Asia	Established population in Singapore; Not known to be invasive	
384	*Manouria emys*	Asian Forest Tortoise	Tortoise	Testudinidae	Asia	No established population in Singapore; Not known to be invasive	
385	*Lissemys punctata*	Indian Flapshell Turtle	Turtle	Trionychidae	Asia	No established population in Singapore; Not known to be invasive	
386	*Pelodiscus sinensis*	Chinese Softshell Turtle	Turtle	Trionychidae	Asia	No established population in Singapore; Known to be invasive elsewhere	

Annex 14.0

Biodiversity Final Reports

Annex 14.1

Vegetation

FINAL REPORT
OF THE
FLORISTIC AND VEGETATION SURVEYS OF THE MANDAI LAKE ROAD AREA
FOR MANDAI PARK HOLDINGS

1. EXECUTIVE SUMMARY

1.1. Scope of work
Identify plant species within the study area and characterize the main vegetation types, and highlight native species of conservation significance, and non-native and potentially-invasive species.

1.2. Methodology
The study area was divided into five zones, which were further subdivided into three categories for survey, according to the expected impact of the proposed developments on each zone. Plant species names, nativeness, and conservation statuses were obtained from a checklist of the total vascular plant flora of Singapore by Chong et al. (2009) and supplemented with other sources or personal field experience. Species of conservation significance are defined as species native to Singapore that are nationally vulnerable, nationally endangered, nationally critically endangered, or erroneously extinct and rediscovered according to the Singapore Red Data Book. These are supplemented with IUCN Red List statuses where available and relevant.

a. **Zones of the proposed development sites:** Point sampling at intervals of 100 m was carried out, and all vascular plant species within the observers' visual perimeter at each point were recorded. Native trees of ≥ 30 cm in diameter-at-breast-height and species of conservation significance were identified throughout the zone for conservation. The main vegetation types of each zone were characterized and mapped out on Google Earth.

b. **Zones of the nature reserve area:** Point sampling at intervals of 100 m was carried out, and all vascular plant species within the observers' visual perimeter at each point were recorded. Twenty-six 20 × 20 m permanent vegetation plots are in the process of being established for long-term monitoring of the impacts of the development and the efficacy of mitigation measures.

c. **Wildlife Reserves Singapore (WRS) area:** Vegetation surveys were carried out for spontaneous vegetation only, within the Night Safari and Singapore Zoo back-of-house areas. Walking surveys were carried out along paved trails, and opportunistically into spontaneous vegetation. Vascular plant species lists were generated for the overall area and for selected fragments of spontaneous vegetation within the area.

1.3. Results and Discussion
The zones of the proposed development sites have a greater proportion of non-native and potentially-invasive plant species as compared to the zones of the nature reserve area, which are high in native plant species richness and diversity and are of a rare vegetation type in Singapore. We plotted species accumulation curves, which showed that more species are likely to be discovered with even greater sampling effort in the zones of the nature reserve areas, but not so for the zones of the proposed development sites, suggesting higher species richness and habitat heterogeneity in the zones of the nature reserves that are worthy of preservation. Despite this, Zones B and D have value as buffers to the nature reserves, and as additional habitats for some native species and species of conservation significance, by extending tree cover beyond the nature reserve areas. Two small fragments were also identified within the WRS area, which have dipterocarp species of high conservation significance.

a. **Zones of the proposed development sites:** The main vegetation types of these zones are young secondary forest that has arisen from abandoned cultivation and open canopy scrubland. These types of vegetation have a high proportion of non-native species both in the understory and tree layer. However, there are parts of these zones that border the nature reserve areas that are noticeably higher in native plant species richness and diversity than the rest of the zone. From Zone B, we recorded 124 plant species, of which 39 species (31.45%) are of conservation significance, and identified 83 large native trees, of which ten trees are of species of conservation significance. From Zone D, we recorded 150 plant species, of which 43 species (28.67%) are of conservation significance, and identified 69 large native trees, of which nine trees are of species of conservation significance. Despite the high proportion of non-native species, it is clear that these zones have also been able to harbor species of conservation significance.

b. **Zones of the nature reserve area:** The main vegetation type of these zones is old secondary forest, which is a rare habitat in Singapore that is high in native plant species richness and diversity. From Zone A, we recorded 214 plant species, of which 136 species (63.55%) are of conservation significance. From Zone E, we recorded 101 plant species, of which 49 species (48.51%) are of conservation significance.

c. **Wildlife Reserves Singapore area zone:** We recorded a total of 225 plant species, of which 78 species (34.67%) are of conservation significance. Outside of the compounds of the Night Safari, Zoo and River Safari, we identified three small fragments of spontaneous vegetation of interest, which are likely to be similar to the zones of the nature reserve area in species composition and forest structure. Two of these fragments, north of Mandai Lake Road, contain mature dipterocarp trees (merawan and meranti species), which are of high conservation significance. One species, meranti kepong (*Shorea ovalis* ssp. *ovalis*), is listed as endangered on the IUCN Red List of Threatened Species.

2. AIMS AND OBJECTIVES OF VEGETATION IMPACT ASSESSMENT

a. To identify and characterize the main vegetation types within each survey zone

b. To identify and highlight native species of conservation significance ('Critically Endangered', 'Endangered', or 'Vulnerable' in the IUCN Red List of Species or Singapore Red Data Book), within each survey zone, but especially within the zones of proposed development for conservation or transplantation

c. To identify and highlight non-native and/or invasive species within the study area

d. To discuss how to minimize the impacts of the proposed developments on flora diversity, particularly on sensitive areas such as the Nature Reserves

3. METHODOLOGY

3.1. Sampling methods

The study area was divided into five zones for surveying (Figure 1). The five zones were further subdivided into three categories according to the expected impact of the proposed developments on the zone: proposed development sites (Zones B and D), nature reserve area (Zones A and E), and Wildlife Reserves Singapore (Zone F). Survey methodology and intensity of effort in each zone differed.

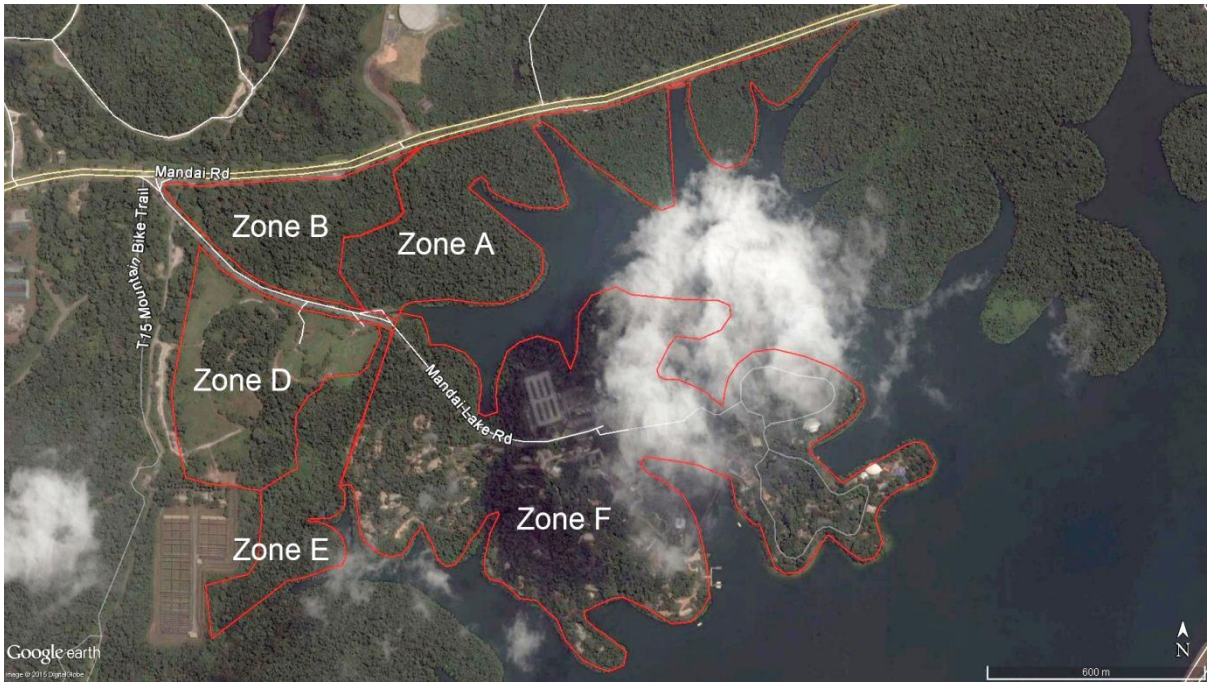


Figure 1. Overall study area and the survey zones.

3.1.1. Zones of the proposed development sites

The overall assessment of vegetation types and floristics in Zones B and D was carried out by walking through the entire zone and stopping at sampling points that were spaced 100 m apart. The locations and number of the sampling points in each zone were determined by using the software ArcGIS to overlay a 100 × 100 m grid on top of a geo-referenced map of the zone, and then taking the center of each grid square as a sampling point. The paths taken by the observers in Zones B and D are shown in Figure 2. Only species present within the observers' visual perimeter at each sampling point were recorded. Point sampling also allowed for a quick assessment of the spatial homogeneity of the

vegetation. However, if native species of conservation significance or introduced species with invasive potential were opportunistically encountered in between sampling points, they were also recorded, and their GPS coordinates noted down. On top of this, an intensive search was carried out within each zone for mature native trees $\geqslant$ 30 cm in diameter at breast height (tree trunk measured at 1.3 m above the ground), and the species identities of the trees were determined, their GPS locations were marked down, and the trees were physically marked with yellow and black tape. Large native trees were a focus of the surveys because their conservation can be important for preserving Singapore's native natural heritage, and large trees are also especially important for native animal wildlife if they have already reached reproductive maturity.

The delineation of vegetation types was carried out with Google Earth images based on a combination of the experience from the field surveys and an analysis of canopy texture from the Google Earth satellite images.

A Google Earth file containing the vegetation type delineated for Zones B and D, and the GPS coordinates of native trees and species of conservation significance, is provided in accompaniment to this report. Some species which have only been identified to genus or family, but which are nevertheless most likely to be native, are also included in this file.

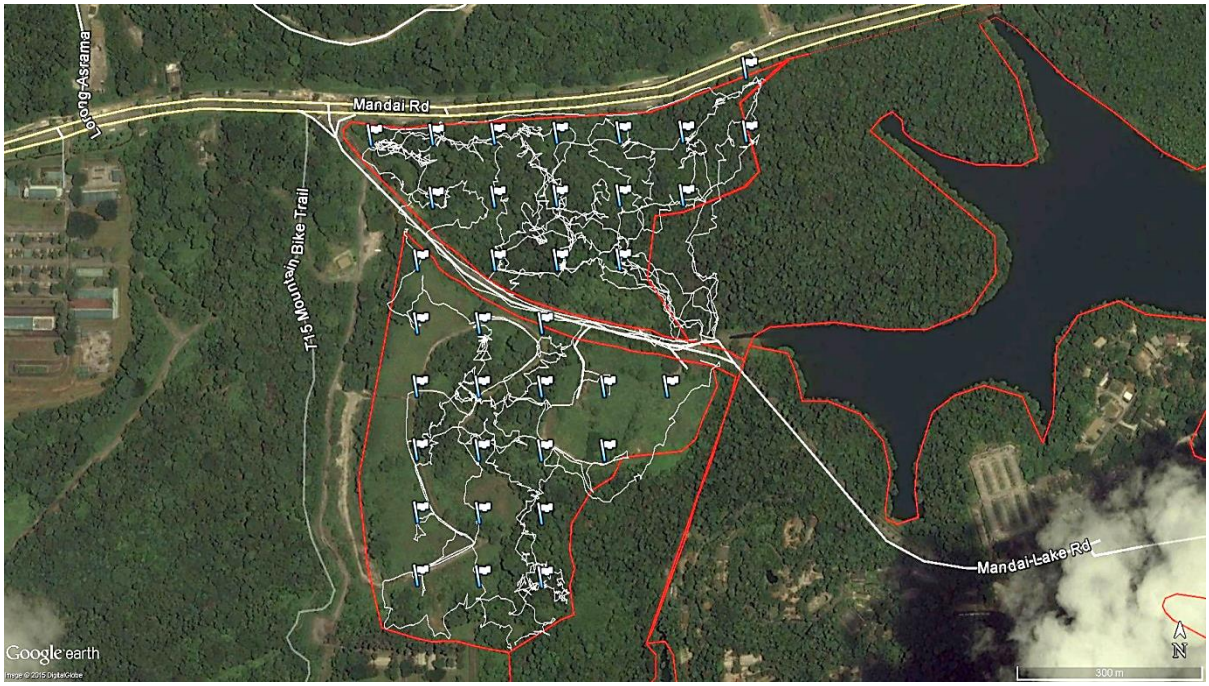


Figure 2. Walking paths taken by observers in Zone B and Zone D are shown in white. The flags represent the sampling points spaced 100 m apart.

3.1.2. Zones of the nature reserve area

The overall assessment of vegetation types and floristics in Zones A and E was also carried out by walking through the entire area and stopping at sampling points that were spaced 100 m apart. The locations and number of the sampling points in each zone were similarly determined using ArcGIS. The paths taken by the observers in Zones A and E are shown in Figure 3. Only species present within the observers' visual field at each sampling point were recorded.

Permanent vegetation plots were set up in Zones A and E to assess the long-term impacts of the proposed development on the nature reserve zones, and the efficacy of mitigation measures. The survey methodology of the vegetation plots follows the Before-After-Control-Impact (BACI) Design, which recommends the collection of baseline data in a 'Before' development phase, and subsequently

edge of the boundary between a zone of proposed development and its adjacent nature reserve zone (i.e., at the boundary of Zones B and A, and of Zones D and E). These plots hence lie immediately adjacent to the two zones of the proposed development sites, and we would expect to be able to detect any impacts that the developments may have on biodiversity within these plots first. The other half of the plots are 'Control' plots which were established elsewhere within the two nature reserve area zones. The location of each plot was randomly generated using a tool in the ArcGIS software. By February 2016, a total of 16 plots will be established in Zone A, and 10 plots will be established in Zone E (Figure 4). Each vegetation plot is 20 × 20 m in size. Within each plot, average canopy cover is estimated using a spherical densiometer, all vascular plant species present recorded, the diameters at breast height of all trees ≥ 5 cm in diameter recorded, and the trees tagged. Data collection from the vegetation plots is still incomplete at the time of this report.

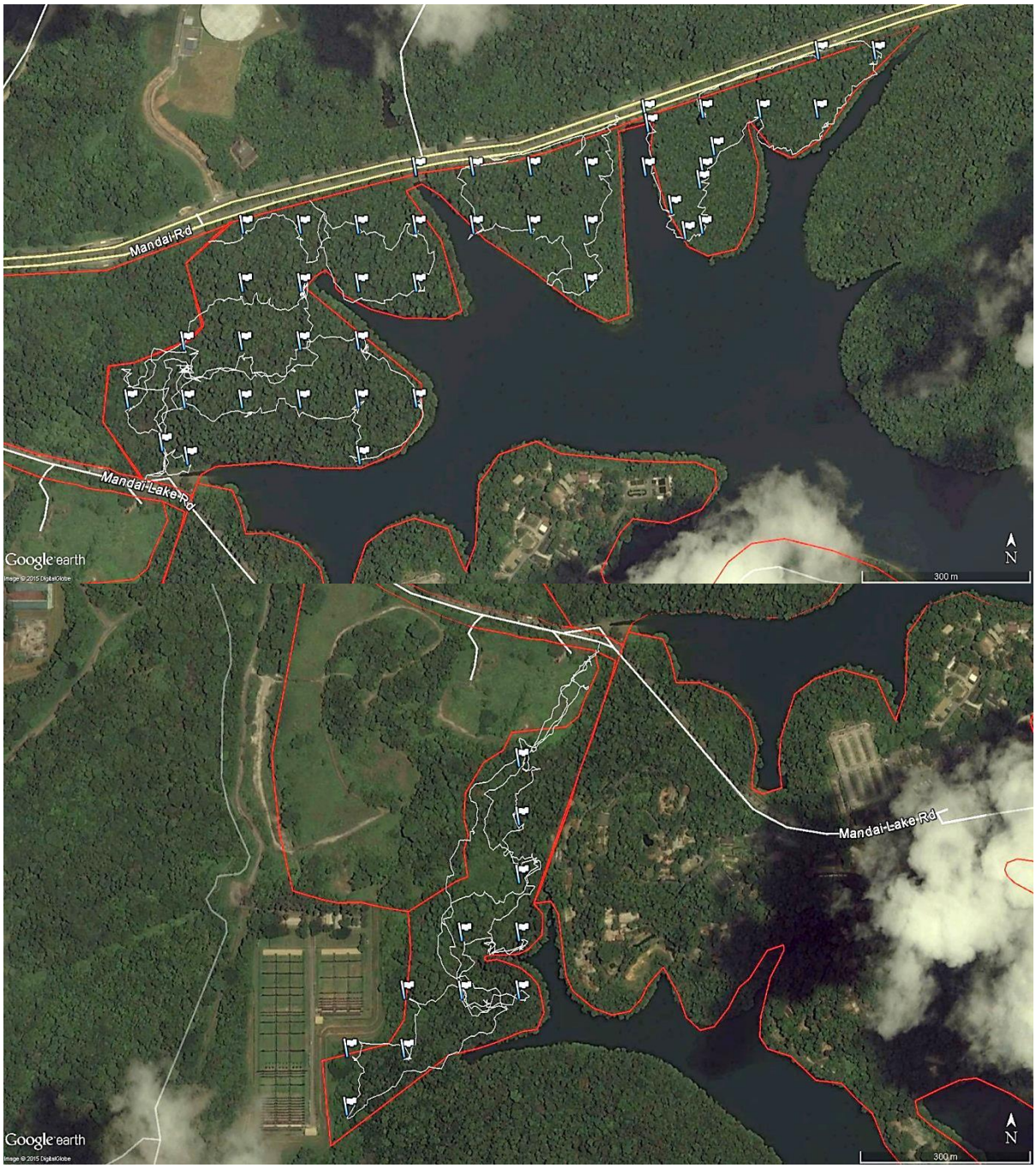


Figure 3. Walking paths taken by observers in Zones A and E are shown in white. The flags represent the sampling points spaced 100 m apart.

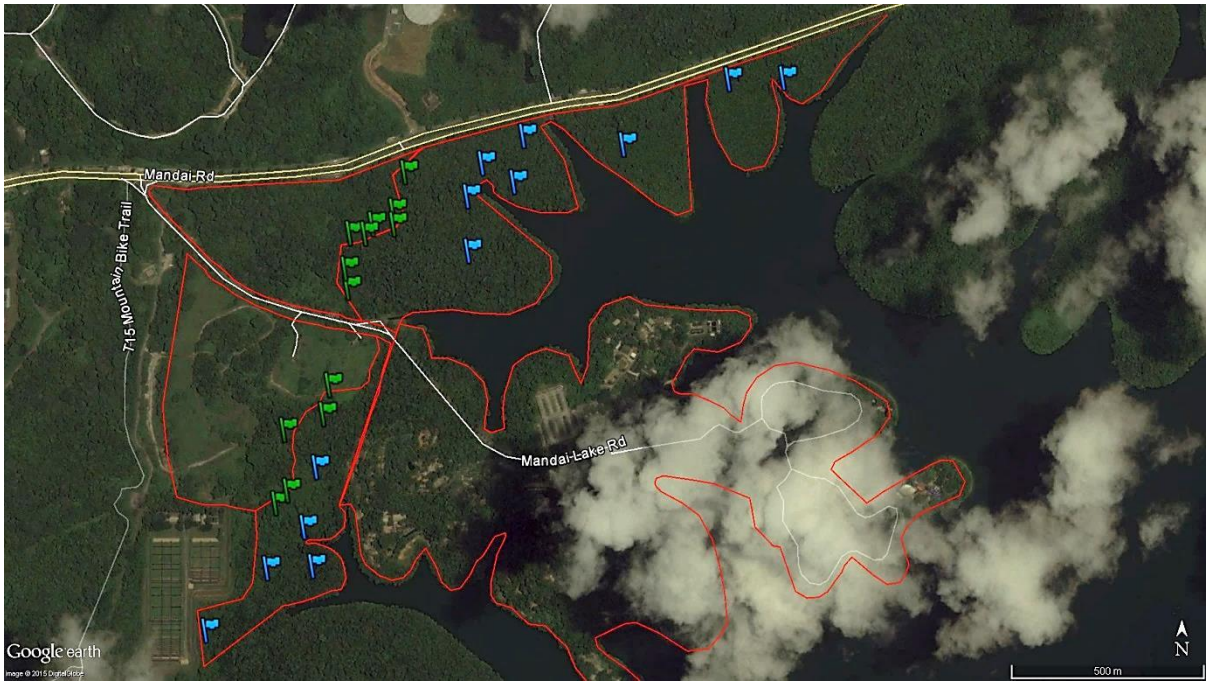


Figure 4. Locations of 26 permanent vegetation plots within the nature reserve area zones. 'Impact' plots are indicated by the green flags, and 'Control' plots are indicated by the blue flags.

3.1.3. Wildlife Reserves Singapore area zone

In Zone F, surveys were carried out in the Night Safari and Singapore Zoo back-of-house areas only. These areas were prioritized because they were identified to be the main extents of spontaneous vegetation within Zone F. Where there were paved walking trails, observers walked along the trails and recorded all vascular plant species deemed to be spontaneously occurring that were visible from the trail. Where there were sizeable and continuous patches of vegetation off the paved trails, observers walked through the forest understory, and recorded a separate list of species for these areas.

3.2. Nomenclature and species identification

Vascular plant species names used in this report are based mostly on a checklist of the total vascular plant flora of Singapore by Chong et al. (2009), and supplemented by updates found in the published literature or in the online international database of plant species names, The Plant List (2013). The identification of plant species was done where possible in the field, and where identification could not be done in the field, specimens were collected back for identification in the laboratory or herbarium. Where identifications could not be completed in time, individuals were morpho-typed to genus or family level only. These species will not be included in the final species count for each zone, but will be included in the species lists in the appendices. The nativeness of each species and their local conservation status categories were compiled based on Chong et al. (2009), which was in turn based on the Singapore Red Data Book seed plant checklist (Tan et al., 2008). These were also supplemented and updated with changes in statuses recorded in the published literature or in recent collections deposited in the Singapore Botanic Gardens' Herbarium, or from our personal field experience. We use the umbrella term 'species of conservation significance' to refer to native species that are nationally vulnerable, nationally endangered, nationally critically endangered, and erroneously presumed nationally extinct and rediscovered in Singapore. IUCN Red List statuses are supplemented where available and relevant.

4. RESULTS

4.1. Zones of the proposed development sites

4.1.1. Zone B

One hundred and twenty-four vascular plant species were recorded from 16 sampling points in Zone B. Of these, 27 are non-native species, 93 are native species, one species is native but probably not of native provenance, and three species are cryptogenic weeds. Of the native species, 54 are common, and 39 are of conservation significance (Figure 5): 13 are nationally critically endangered, 11 are nationally endangered, 13 are nationally vulnerable, and two are rediscovered species erroneously thought to be nationally extinct. The nationally critically endangered species include *Aporosa lucida* var. *lucida* (two locations), *Horsfieldia punctatifolia* (a single individual), *Syzygium pseudoformosum* (a single individual), and a single large *Ficus stricta* tree (Yeo et al., 2012; Figure 6). The full list of species recorded from Zone B is presented in Appendix 1.

We identified 83 native trees for conservation within Zone B (Figure 5). Of these, two are of nationally critically endangered species, eight are of nationally vulnerable species, and 68 are of common species. Five trees have only been identified to species but are likely to be native species. The native trees range from the relatively fast-growing and short-lived pioneer species (e.g., *Macaranga gigantea*) to slow-growing and longer-lived forest interior species (e.g., *Elaeocarpus salicifolius*), and the decision to retain the trees should be prioritized based on their life history strategy and also the national conservation status of the species.

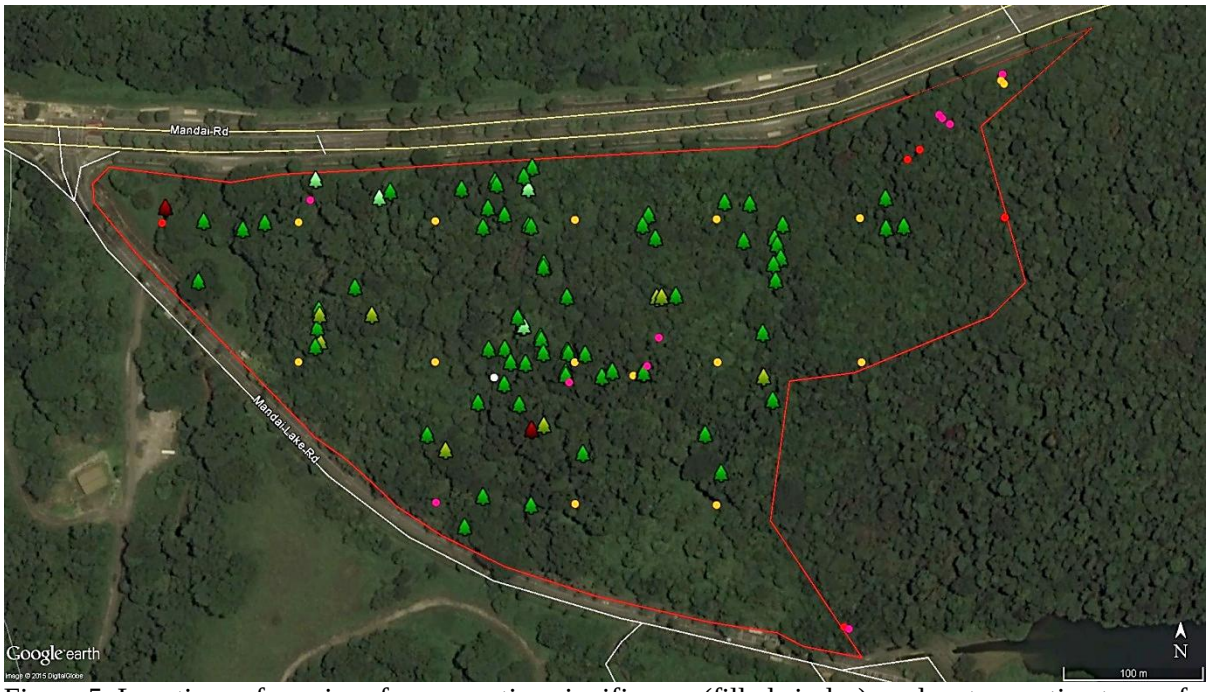


Figure 5. Locations of species of conservation significance (filled circles), and mature native trees of $\geqslant$ 30 cm in diameter at breast height (tree symbols) in Zone B. Nationally critically endangered species and trees are shown in red, nationally endangered species and trees are shown in pink, nationally vulnerable species and trees are shown in yellow, and common species and trees are shown in green. Species and trees which have only been identified to genus or family and thus have not been assessed are shown in white or pale green.


Figure 6. The mature *Ficus stricta* tree, a nationally critically endangered strangler fig.

The predominant forest type of Zone B is young secondary forest that has arisen from abandoned cultivation (Figure 7A). Secondary forest can be defined as forest which has regrown on land that has undergone some form of disturbance, which is distinct in structure and species composition from the original forest of the area. We checked historical topographic maps to confirm that there was miscellaneous cultivation at this site in the past. The 'abandoned cultivation' type of secondary forest in Singapore is characterized by a high local abundance of non-native species persisting from past cultivation, especially those grown for food or ornamental purposes. In Zone B, this forest type is heterogeneous. For the most part, the tree canopy is dominated by fruit tree species such as *Durio zibethinus* (durian), *Nephelium lappaceum* (rambutan), *Artocarpus heterophyllus* (jackfruit), and *Dimocarpus longan* (longan), non-native weedy species such as *Spathodea campanulata* (African tulip), and early-successional native species such as *Macaranga gigantea*, *Litsea elliptica*, and *Campnosperma auriculatum* (terentang). In the understory, it is common to see large patches of ornamental or economically-valuable species that have naturalized, such as *Dracaena fragrans* (Figure 7A), *Heliconia psittacorum*, and *Elaeis guineensis* (oil palm), as well as the saplings of the fruit tree species regenerating under their parent trees. However, there are areas within Zone B that are more typical of the local 'scrubland' type vegetation, where the canopy is more open, and is either dominated by the weedy non-native tree species *Falcataria moluccana* (albizia), or there are only a few scattered trees of non-native weedy species such as *Spathodea campanulata* and *Cecropia pacyhstachya*, and non-native grass species, weedy climber species, or weedy fern species such as *Nephrolepis auriculata* make up the dense ground cover between them (Figure 7B). Species such as *Cecropia pachystachya* are potentially invasive and have been shown to spread and establish rapidly within a short period of time, thus an implication for management would be to remove such species from the area as much as possible. The 'scrubland' type of vegetation occurs in small patches in the western part of Zone B. There are also areas within Zone B where native plant species diversity is higher, and the forest structure is closer to that of later-successional-stage secondary forest in Singapore, where the understory is more open, and the trees are of mixed stem diameters (Figure 7C). Tree species commonly found in this type of native-species-dominated forest include *Garcinia parvifolia*, *Syzygium borneense*, *Syzygium lineatum*, *Gironniera nervosa*, and *Elaeocarpus salicifolius*. This type of vegetation occurs in a small patch in the middle of Zone B, and is found especially along the boundary between Zones B and A. The different vegetation types in Zone B are mapped out approximately in Figure 8.

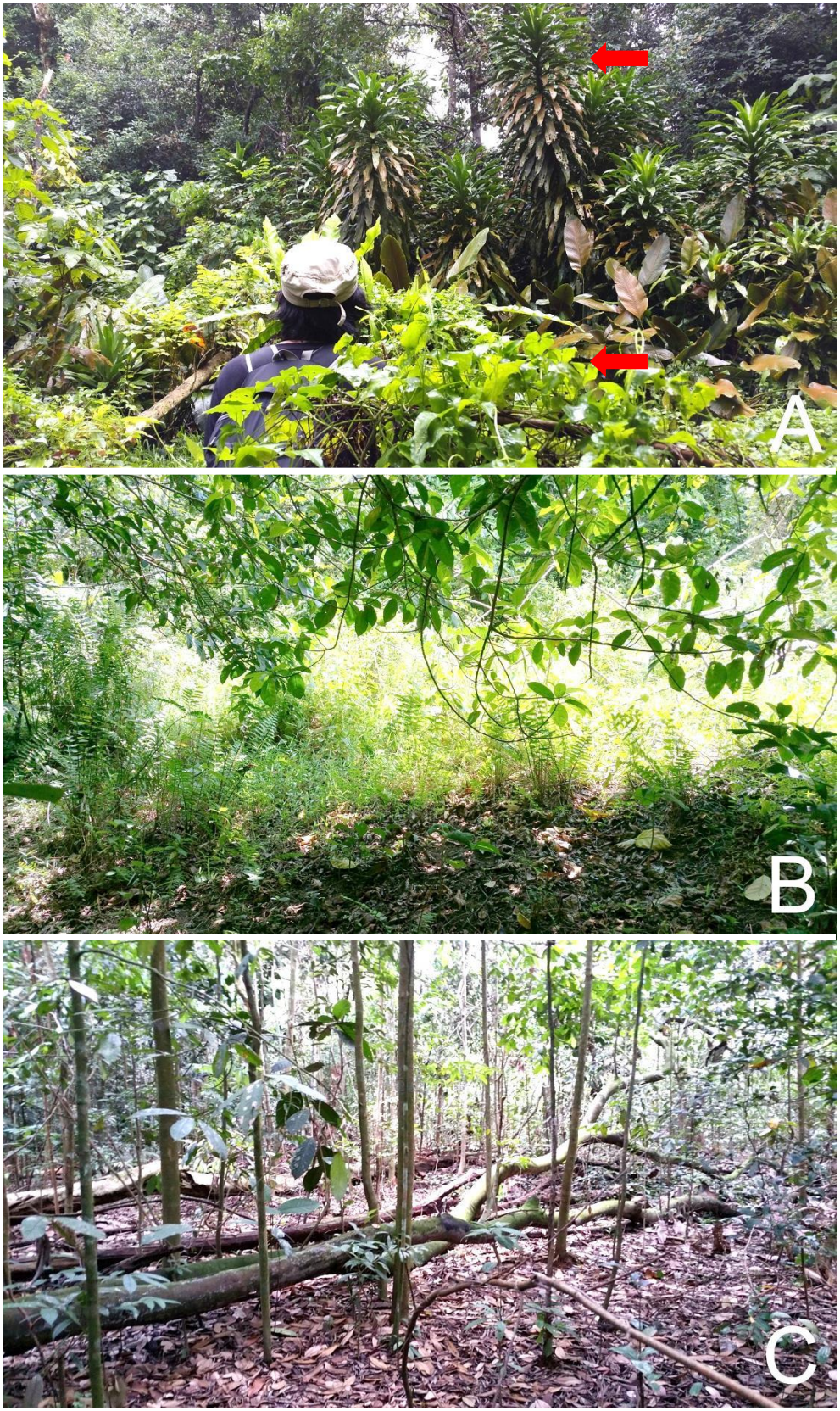


Figure 7. Main vegetation types in Zone B: (A) closed canopy ‘abandoned cultivation’ secondary forest, with stands of the non-native ornamental escapee *Dracaena fragrans* in the background (arrowed) and vegetation smothered by the non-native weedy climber *Mikania micrantha* in the foreground (arrowed); (B) open canopy ‘scrubland’ vegetation under sunlight, dominated by the cryptogenic weedy fern *Nephrolepis auriculata*; (C) closed canopy native-species-dominated secondary forest, with native tree species of different stem diameters.

Figure 8. The main vegetation types of Zone B: abandoned cultivation is shown in blue, scrubland in yellow, native-species-dominated secondary forest in green, and managed vegetation in purple.

4.1.2. Zone D

One hundred and fifty vascular plant species were recorded from 18 sampling points in Zone D. Of these, 51 are non-native species, 93 are native species, one species is native but probably not of native provenance, and five species are cryptogenic weeds. Of the native species, 50 are common, and 43 are of conservation significance (Figure 9): 13 are nationally critically endangered, eight are nationally endangered, 21 are nationally vulnerable, and one is a rediscovered species erroneously thought to be nationally extinct. The nationally critically endangered species include *Castanopsis wallichii* (one location), *Dioscorea polyclados* (one location), *Ficus obscura* var. *borneensis* (one location; Fig. 10), *Ficus pisocarpa* (one large tree), and *Stephania capitata* (one location). The full list of species recorded from Zone D is presented in Appendix 2.

We identified 69 native trees for conservation within Zone D (Figure 9). Of these, one is of a nationally critically endangered species, two are of nationally endangered species, six are of nationally vulnerable species, and 57 are of common species. Three trees have only been identified to species but are likely to be native species. The native trees range from the relatively fast-growing and short-lived pioneer species (e.g., *Campnosperma auriculata*) to slow-growing and longer-lived forest interior species (e.g., *Litsea castanea*), and the decision to retain the trees should be prioritized based on their life history strategy and also the national conservation status of the species. In Zone D, the large native trees occur as a more-or-less continuous stretch of the canopy (Figure 9), and are quite closely spatially-associated with species of conservation significance.

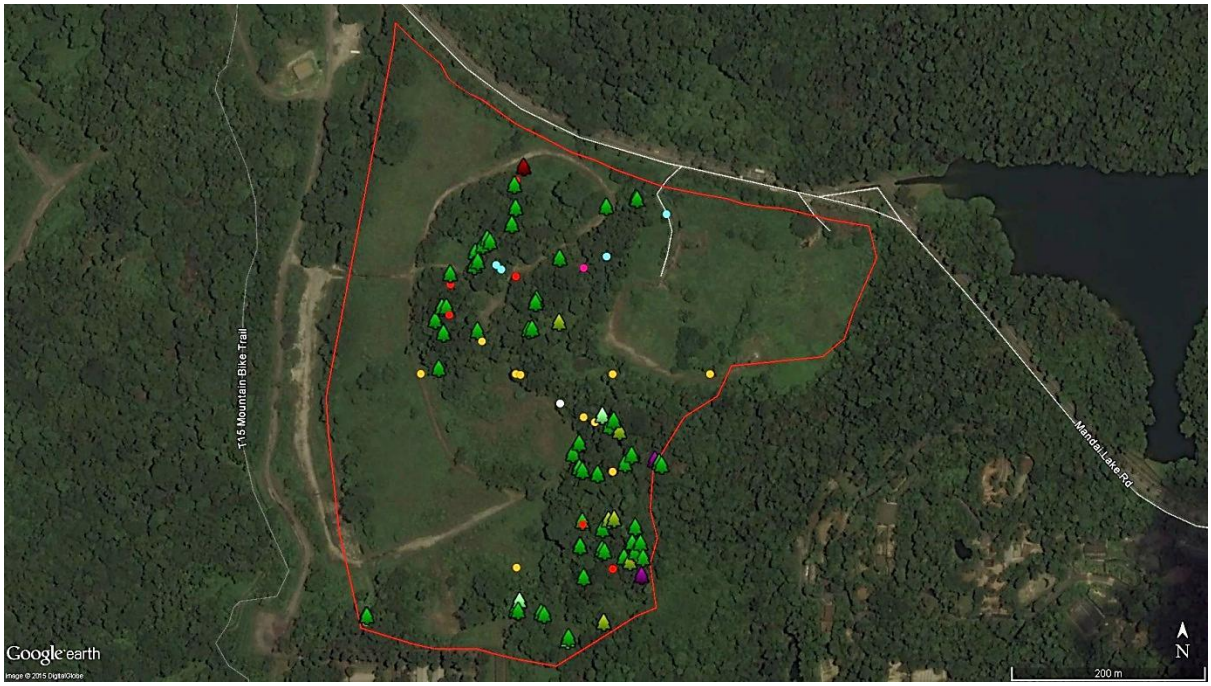


Figure 9. Locations of species of conservation significance (filled circles), and mature native trees of ⩾ 30 cm in diameter at breast height (tree symbols) in Zone D. Nationally critically endangered species and trees are shown in red, nationally endangered species and trees are shown in pink, nationally vulnerable species and trees are shown in yellow, and common species and trees are shown in green. Species and trees which have only been identified to genus or family and thus have not been assessed are shown in white or pale green.

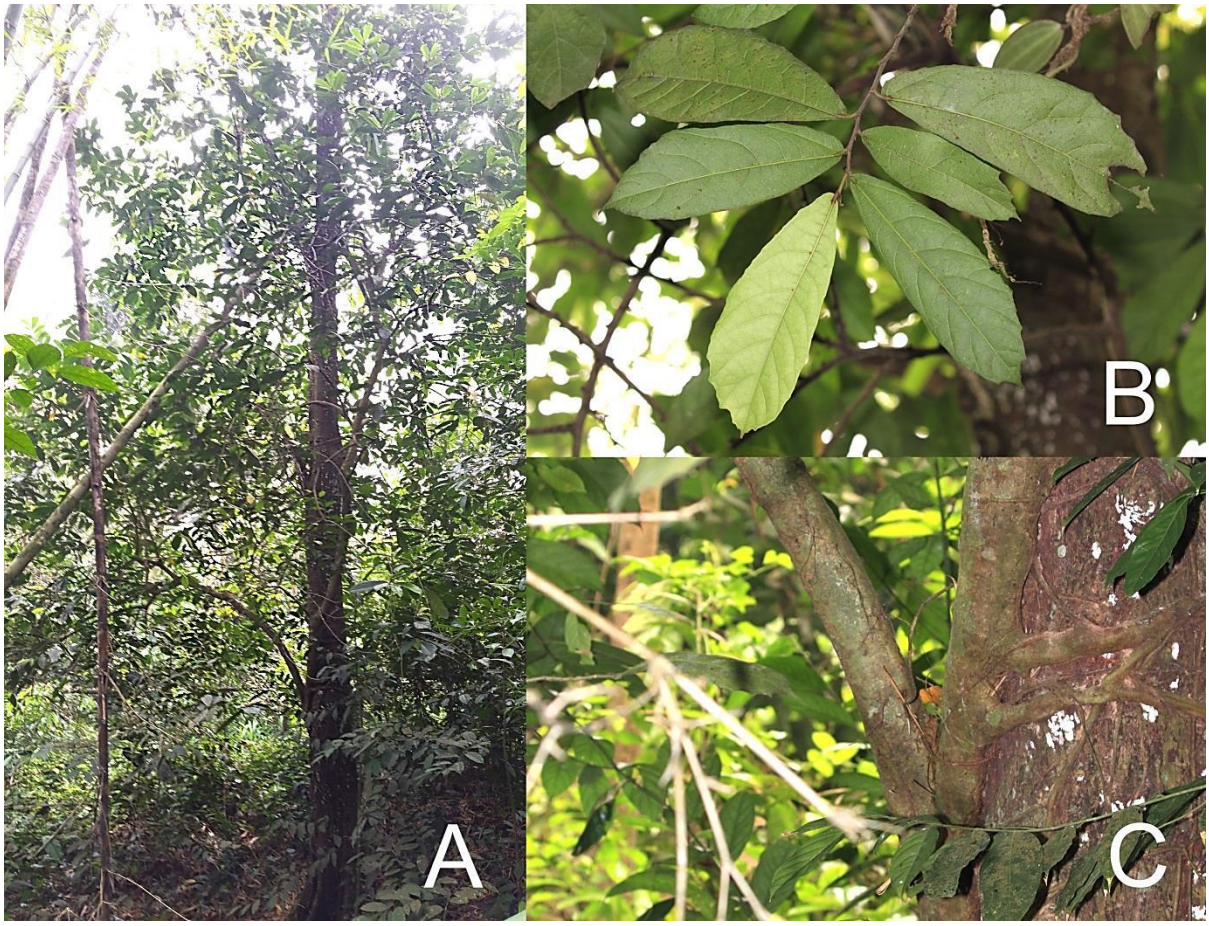


Figure 10. *Ficus obscura* var. *borneensis*, a nationally critically endangered strangler fig. (A) An individual was found growing on a rotting tree trunk; (B) a close up of the leaves and stipules; (C) a close up of the strangling roots.

In Zone D, the forested area occurs as a continuous patch down the center and the eastern side of the zone (Figure 9). The vegetation under tree canopy in Zone D is characteristic of the 'abandoned cultivation' type of forest, where the canopy is dominated by fruit tree species such as *Durio zibethinus* (durian; Figure 10A), *Nephelium lappaceum* (rambutan), and *Artocarpus heterophyllus* (jackfruit), and some other non-native weedy species such as *Spathodea campanulata* (African tulip) and *Cecropia pachystachya* (Figure 11). Species such as *Cecropia pachystachya* are potentially invasive and have been shown to spread and establish rapidly within a short period of time, thus an implication for management would be to remove such species from the area as much as possible. Within this stretch, some large trees of early-successional native species such as *Macaranga gigantea*, *Campnosperma auriculatum* (terentang), *Claoxylon indicum*, and *Dillenia suffruticosa* were also found. In the understory, it is common to see large patches of ornamental species that have naturalized, such as *Heliconia psittacorum*, *Dracaena fragrans* (Figure 10A), and *Dieffenbachia seguine*, large stands of bamboo (*Bambusa* sp.), as well as the saplings of the fruit tree species regenerating under their parent trees. Like in Zone B, there are areas within the forest of Zone D where native species diversity is higher, and this occurs in the southeastern part of the Zone, especially in the area bordering Zone E (Figure 12). In this area, we recorded tree species more often found in native-dominated later-successional-stage forests in Singapore, such as *Rhodamnia cinerea*, *Calophyllum tetrapterum*, *Cratoxylum arborescens*, and *Ixonanthes icosandra*.

The second dominant vegetation type in Zone D is 'scrubland' type of vegetation (Figure 10B), and this is found along the western edge, and in the northeastern corner of Zone D (Figure 12). There is little tree canopy in these areas, and the ground is mostly covered densely with non-native grass species such as *Pennisetum* sp., *Panicum* sp., and *Imperata cylindrica* (lalang). Some tree species that occur in these areas include the non-native weedy species *Acacia auriculiformis*, and native early-

successional species such as *Dillenia suffruticosa* (simpoh ayer) and *Claoxylon indicum*. The different vegetation types in Zone D are mapped out approximately in Figure 12.

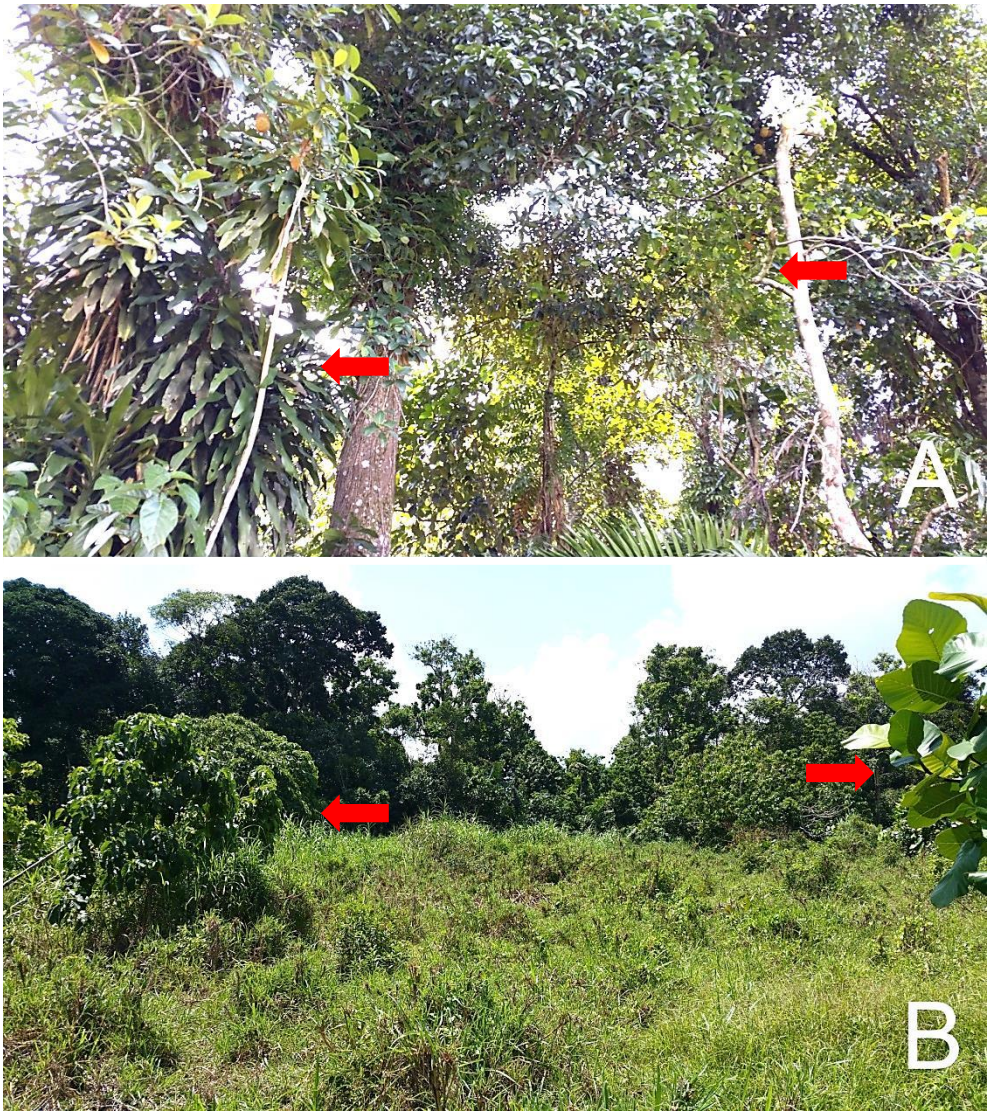


Figure 10. Main vegetation types in Zone B: (A) closed canopy 'abandoned cultivation' secondary forest, with the non-native ornamental escapee *Dracaena fragrans* in the foreground (arrowed), and shown in the background are the non-native fruit trees of *Durio zibethinus* (durian) that make up the canopy, which are easily recognizable by their leaves that are golden below (arrowed); (B) open canopy 'scrubland' vegetation with a dense ground cover of grasses and scattered trees of species such as *Claoxylon indicum* on the left (arrowed) and *Dillenia suffruticosa* (simpoh ayer) on the right (arrowed).

Figure 11. A large tree of *Cecropia pacyhstachya*, a naturalized, weedy species in Singapore, with its distinctive crown of large leaves with deeply-lobed leaf blades. Large individuals of this species can be found making up the canopy in parts of Zone D.

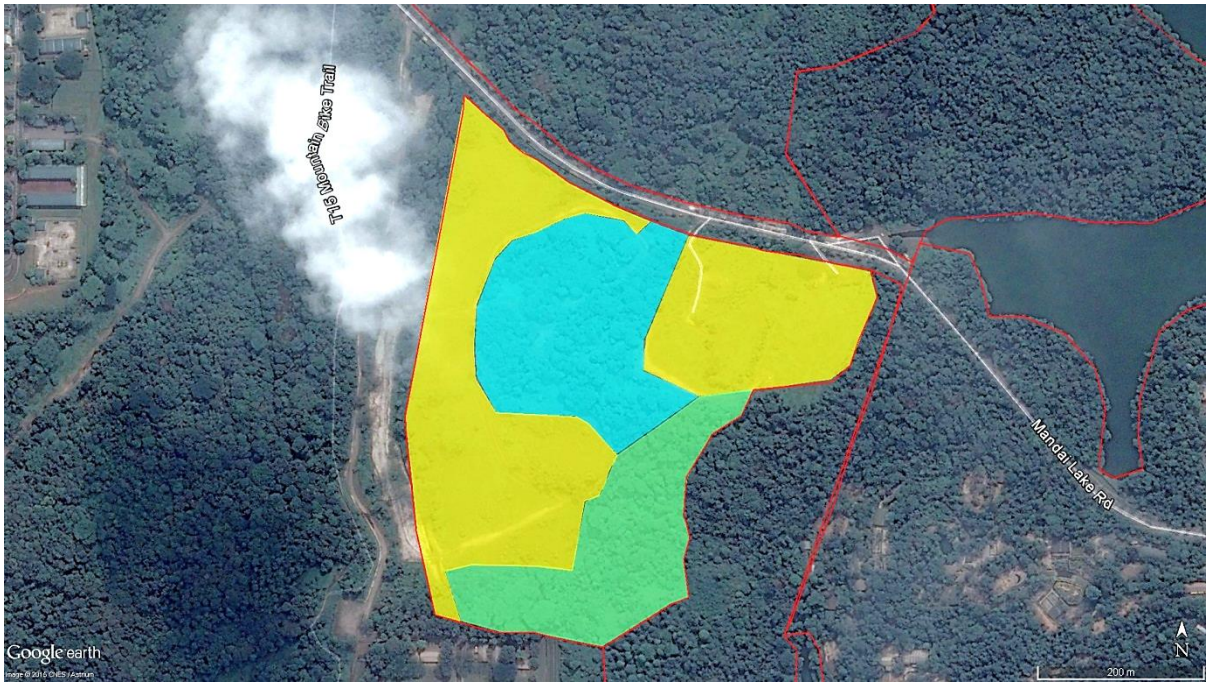


Figure 12. The main vegetation types of Zone D: abandoned cultivation is shown in blue, scrubland in yellow, and native-species-dominated secondary forest in green.

4.1.3. Habitat value of Zones B and D

While the main vegetation types of Zones B and D have a high proportion of non-native plant species, and are in themselves not uncommon in Singapore, they have served as 'extensions' to the CCNR, in that they have extended the tree cover beyond the nature reserves. In doing so, they have had a role in protecting the nature reserves from degradation, for instance, by acting as vegetated buffers from the surrounding roads, they can ameliorate the impacts that edge effects can have on the forest in the nature reserve zones (e.g., forest edges are associated with hotter and drier conditions, and are also where invasive species can thrive). Zones B and D have also had value as additional habitats for native species and species of conservation significance. Even though fruit tree species of non-native provenance make up most of the canopy layer, they can provide shade for forest interior or later-successional-stage native species, which are found in the understory. Since they lie directly adjacent to the nature reserve with no physical boundary between them, they are accessible to species that may otherwise be isolated by habitat fragmentation or dispersal-limitation. The value of the 'abandoned cultivation' type of forest as refuges for old growth forest plant species has been shown for several patches of abandoned rubber plantation in Singapore (Neo et al., 2013a, 2013b, etc.). In particular, patches just outside of the CCNR were found to have an especially high proportion of native species diversity compared to the others (Neo et al., 2014a, 2014b). The ability of secondary forest that has regenerated on abandoned agricultural land to support the re-colonization of native species has also been shown elsewhere in the world (e.g., Lugo & Helmer, 2004), and these forests are also known to be places where animals may transit or forage (McShea et al., 2009) outside of the protected areas.

4.2. Zones of the nature reserve area

4.2.1. Zone A

Two hundred and fourteen vascular plant species were recorded from 35 sampling points in Zone A. Of these, nine are non-native species, 200 are native species, one species is native but probably not of native provenance, three species are cryptogenic weeds, and one species has not been assessed. Of the native species, 64 are common, and 136 are of conservation significance: 37 are nationally critically endangered, 40 are nationally endangered, 54 are nationally vulnerable, and five are rediscovered species erroneously thought to be nationally extinct. The nationally critically endangered species include *Dacryodes longifolia*, *Drypetes pendula*, *Magnolia villosa*, *Meliosma simplicifolia* ssp. *fruticosa*, and *Gymnacranthera bancana*. The full list of species recorded from Zone A is presented in Appendix 3.

Zone A consists of three main 'islets' of forest that are connected to one another only by a narrow strip of vegetation along the pedestrian footpath parallel to Mandai Road. They form part of the northern boundary of the Central Catchment Nature Reserve (CCNR) of Singapore, and are separated from the northernmost limit of the CCNR by the six-lane dual carriageway of Mandai Road. The three 'islets' of forest that make up Zone A were characterized as old or late-successional secondary forest in an updated map of the vegetation of Singapore by Yee et al. (2011) (Figure 13A). Old secondary forest is a rare habitat in Singapore, making up only 1.37% of the total land area of Singapore (Yee et al., 2011). This type of forest is dominated by tree species from the plant families Myrtaceae (e.g., *Syzygium lineatum, Syzygium filiforme* var. *filiforme*, *Syzygium borneense*), Clusiaceae (e.g., *Garcinia parvifolia*, *Garcinia griffithii, Garcinia rostrata*), Calophyllaceae (e.g., *Calophyllum pulcherrimum, Calophyllum tetrapterum*, *Calophyllum wallichianum* var. *incrassatum,*), Lauraceae (e.g., *Lindera lucida*, *Litsea firma*, *Litsea castanea*), and Elaeocarpaceae (e.g., *Elaeocarpus mastersii*, *Elaeocarpus salicifolius*, *Elaeocarpus petiolatus*), and is characteristic of the 'tall secondary forest' described by Corlett (1991). There are many woody climber species, and some common ones include *Fibraurea tinctoria*, *Oxyceros longiflorus*, and *Willughbeia coriacea*, as well as members of the families Annonaceae and Connaraceae.

As Zone A was badly affected by a windstorm event in the year 2011, a large area of the forest is currently undergoing natural regeneration. The two eastern 'islets' of the zone were especially affected. In these areas, many mature canopy trees were damaged, and the undergrowth is now extremely dense with many young saplings, and tangles of woody climbers (Figure 13B). Large amount of decaying woody debris may also be found on the ground. There are also tree-fall gaps where the canopy is open and the resam fern (*Dicranopteris* spp.) forms a dense covering over the ground (Figure 13C).

Figure 13. Forest structure of Zone A: (A) open understory with native tree species of different stem diameters; (B) areas where the windstorm damaged the forest have a dense undergrowth with many young saplings growing closely together and a high abundance of woody climbers; (C) forest gaps or forest edges with a dense ground cover of the resam fern (*Dicranopteris* spp.).

4.2.2. Zone E

One hundred and one vascular plant species were recorded from 11 sampling points in Zone E. Of these, six are non-native species, 94 are native species, and one species is native but probably not of native provenance. Of the native species, 45 are common, and 49 are of conservation significance: 16 are nationally critically endangered, 11 are nationally endangered, 21 are nationally vulnerable, and one is likely to be a nationally extinct species that has been recently rediscovered. The nationally critically endangered species include *Anodendron candolleanum*, *Aporosa lucida* var. *lucida*, *Ficus sagittata*, and *Memecylon paniculatum*. The nationally extinct species is *Baccaurea macrophylla*, and is likely to have been erroneously thought to be nationally extinct. The full list of species recorded from Zone E is presented in Appendix 4.

Zone E is a very narrow (slightly over 200 m-wide at its widest) strip of forest that is sandwiched between the Wildlife Reserves Singapore zone to the east, Zone D (mainly a mixture of abandoned cultivation and scrubland vegetation) to the west, and a special use area to the southwest. However, it is connected to a larger area of the CCNR to its south, and it forms part of the northwestern boundary of the CCNR. The vegetation of Zone E was characterized as young or early-successional secondary forest by Yee et al. (2011). Zone E has a subset of the species found in Zone A that are typical of old secondary forest. These include tree species from the plant families Myrtaceae (e.g., *Syzygium borneense*, *Syzygium grande*, *Syzygium zeylanicum*, *Rhodamnia cinerea*, *Pternandra* spp.), Clusiaceae (e.g., *Garcinia parvifolia*), Calophyllaceae (e.g., *Calophyllum pulcherrimum*, *Calophyllum tetrapterum*, *Calophyllum wallichianum* var. *incrassatum*), and Lauraceae (e.g., *Lindera lucida*). On the other hand, some characteristics of later-successional-stage forest can also be found, such as a fairly open understory, trees of mixed stem diameters, including a few large mature trees of nationally critically endangered species such as *Myristica lowiana* and *Cratoxylum maingayi*, and stands of the nibong palm, *Oncosperma horridum* (Figure 14A). However, the western edge of Zone E where it borders Zone D and the special use area, is more disturbed, and a greater number and abundance of non-native species (including a non-native climber species, *Caesalpinia minax*, which is locally abundant at the site and a new record to Singapore; Figure 14B), as well as disturbance-adapted native

species (e.g., *Dillenia suffruticosa* [Figure 14C], *Claoxylon indicum*, *Ficus fistulosa*) were recorded here.

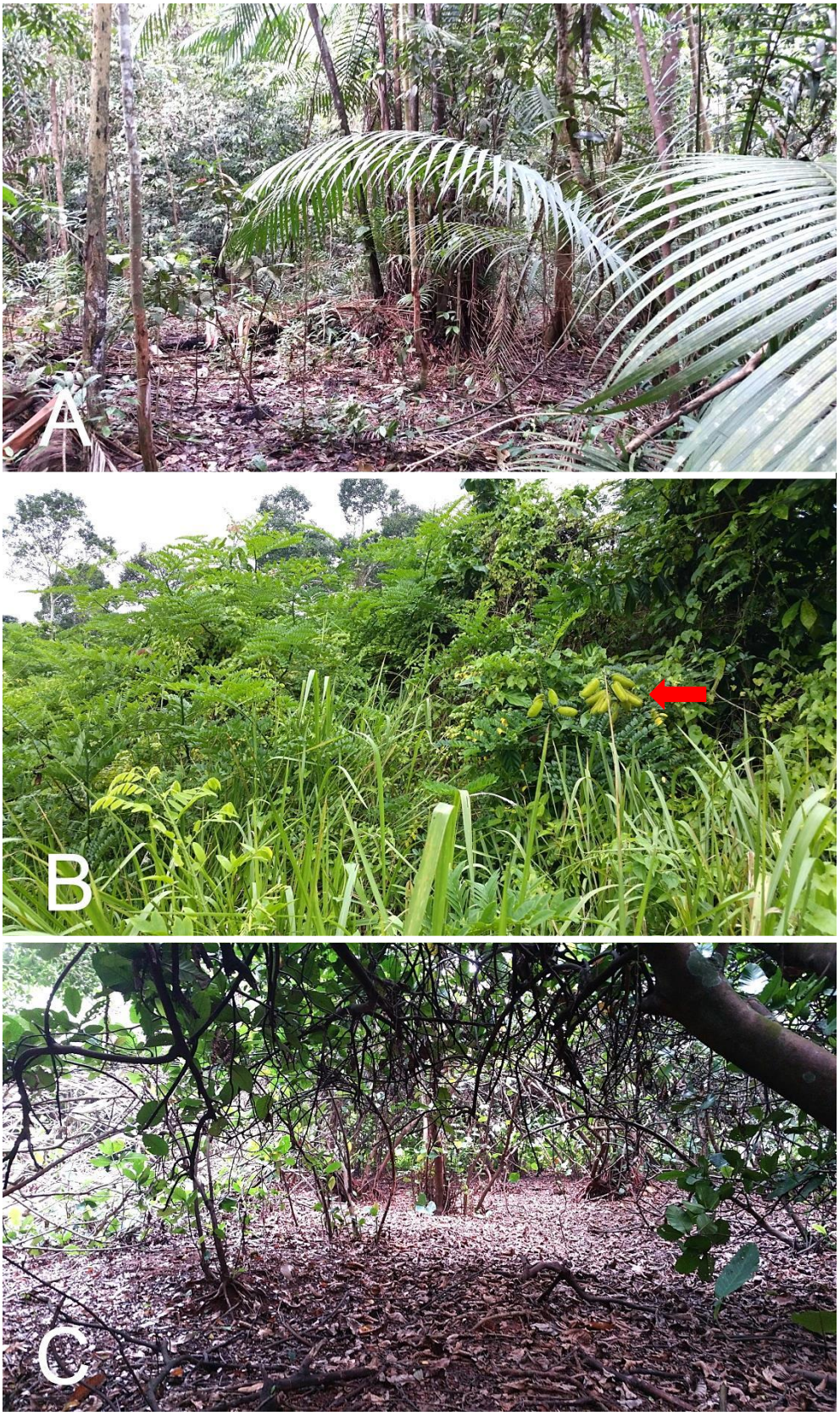


Figure 14. Some characteristics of the vegetation of Zone E: (A) open understory and a stand of nibong palm (*Oncosperma horridum*); (B) locally abundant non-native climber *Caesalpinia minax*,

which has very spiny stems, climbing over other vegetation along the border between Zone E and Zone D (its spiny fruit pods are arrowed); (C) dense stands of *Dillenia suffruticosa* can be found along the western edge of Zone E.

4.3. Wildlife Reserves Singapore (WRS) area zone

Two hundred and twenty-five vascular plant species were recorded from walking along the paved trails within the Night Safari compound and Singapore Zoo back-of-house areas, and through continuous fragments of spontaneous vegetation where access was allowed. Of these, 51 are non-native species, 170 are native species, one species is native but probably not of native provenance, and three species are cryptogenic weeds. Of the native species, 92 are common, and 78 are of conservation significance: 16 are nationally critically endangered, 22 are nationally endangered, 36 are nationally vulnerable, and two are rediscovered species erroneously thought to be extinct. Two nationally extinct species were also recorded: *Dillenia indica* and *Leea rubra*, although these individuals are likely to have spread from mature individuals planted elsewhere in the WRS area, and are not likely to be of local provenance. The nationally critically endangered species include *Horsfieldia punctatifolia*, *Breynia discigera*, *Eurycoma longifolia*, and *Dioscorea glabra*. A Dipterocarp species, *Shorea macroptera* (meranti melantai), was also found in a sizeable forested area located between Points I and J (Figure 15). The full list of species recorded from the WRS area is presented in Appendix 5. The Night Safari compound appears to be a positive example of how the retention of patches of spontaneous vegetation within a developed site can provide habitats and greater connectivity for wildlife that may substitute those that have been lost from the process of development, and also facilitate the recruitment of some native species, including species of conservation significance.

Figure 15. Walking trails of surveys within WRS area (Night Safari and Singapore Zoo back-of-house areas) are shown in yellow, and notable fragments of spontaneous vegetation along the trails are flagged out from A−L. The site where at least one a mature *Shorea macroptera* (Dipterocarpaceae) tree was found is flagged in red.

In addition, there are three fragments of forest outside of the Night Safari and Singapore Zoo attractions that may require more intensive field survey (highlighted in green in Figure 16). We did not have sufficient time for more thorough surveys of these three fragments at the time of this report, but visual perimeter surveys of these areas from within the Night Safari compound and along Mandai Lake Road suggest that these are fragments of spontaneous vegetation with plant species compositions and forest structures that may resemble Zone A and Zone E. We also learned from

another survey team of mature dipterocarp trees (*Hopea* spp. [merawan]) along the reservoir's edge in the two fragments north of Mandai Lake Road (approximate locations flagged in red in Figure 16).

Figure 16. Three fragments within the WRS area that are worthy of more intensive surveys. The approximate locations of mature dipterocarp trees are flagged in red. A single brief survey was undertaken in Fragment 1, and the trail walked is shown in yellow.

We conducted a single walk through a small section of Fragment 1, and recorded three additional large individuals of dipterocarp trees of another species, *Shorea ovalis* ssp. *ovalis* (meranti kepong; flagged in red in Figure 16), which is nationally critically endangered, and listed as endangered in the IUCN Red List of Threatened Species. The largest of these three individuals that we observed was an emergent tree of about 50 cm in diameter at breast height (Figure 17). It is likely that there are more mature individuals of this species in the area, as the fallen leaves of this species are abundant in the leaf litter.

Figure 17. A large individual of about 50 cm in diameter at breast height of nationally critically endangered and IUCN Red List Endangered *Shorea ovalis* ssp. *ovalis* found in Fragment 1. This species can be identified by its: (A) straight, round trunk with shallowly fissured bark and dammar resin stains, (B) broad oblong leaves with large triangular stipules, (C) fallen leaves that dry distinctly concave in shape, and which are abundant in the leaf little of the area.

From the single walk through this small section of the fragment, we recorded 109 vascular plant species, of which 106 are native, two are non-native, and one is not assessed, suggesting a very high native plant species diversity in this patch of forest. Of the native species, 26 are common, and 80 are of conservation significance: 26 are nationally critically endangered, 20 are nationally endangered, 31 are nationally vulnerable, two are rediscovered species erroneously thought to be extinct, and one is likely to be a nationally extinct species that has been recently rediscovered. The nationally extinct species is *Syzygium glabratum*, and is likely to have been erroneously thought to be nationally extinct. The full list of species recorded from Fragment 1 is presented in Appendix 6.

The vegetation of Fragments 1−3 was classified as young secondary forest in Yee et al. (2011). However, based on our observations in the field, we would like to suggest a revision of this classification. For Fragment 1 in particular, the plant species community and forest structure of at least the area that we surveyed is highly suggestive of old growth forest. In addition to the *Shorea ovalis* ssp. *ovalis* trees, large trees of *Dialium platysepalum* (also nationally critically endangered) from the family Fabaceae also reach the emergent layer, and the dominance of members of these families in the canopy or emergent layer of the forest is known to be typical of primary lowland dipterocarp forest in Malaya. The presence of large emergent trees is evident also from Google Earth satellite imagery of Fragment 1, which shows a rough-textured canopy that is composed of a layer of trees with larger and fuller crowns, emerging from a surrounding layer of trees with smaller crowns (Figure 15). Members of the families Burseraceae (e.g., *Dacyodes longifolia*, *Santiria griffithii*), Myrtaceae (*Syzygium filiforme* var. *filiforme*, *Syzygium ridleyi*, *Syzygium glabratum*), Phyllanthaceae (*Aporosa lucida* var. *lucida*, *Aporosa symplocoides*, *Antidesma cuspidatum*), Calophyllaceae (*Calophyllum wallichianum* var. *incrassatum*, *Calophyllum tetrapterum*, *Calophyllum teysmannii*) are

quite common in the canopy and sub-canopy layer, and there is a high abundance of *Agrostistachys borneensis* (leaf litter plant) in the understory shrub layer. A number of members of the families Meliaceae, Myristicaceae, Annonaceae, Ebenaceae, Sapotaceae, Ixonanthaceae, Theaceae, and Olacaceae were also found. There is also a high diversity of climber species from the families Annonaceae, Connaraceae, Rubiaceae, Dilleniaceae, etc. The forest understory is fairly open (Figure 18), with medium-sized to large trees well-spaced apart, and an understorey layer that is not very dense. It is possible that this old growth forest was preserved as part of the Municipal Catchment Area since it was gazetted in the 1870s.

Figure 18. Fairly open understory inside Fragment 1, with well-spaced medium-sized trees, and distinct understory shrub layer.

The vegetation of these three fragments require more detailed assessment. However, based on current knowledge, Fragment 1 and Fragment 2 appear to be of high conservation value. Threatened species are generally more sensitive to disturbances, and prefer interior habitats where they are buffered from edge effects. Hence, given that the two fragments are already extremely small in size (Fragment 1 is not even 100 m wide), and are fairly isolated from other patches of old growth forest, they are likely to be highly vulnerable to further degradation. All dipterocarp species have national conservation statuses of 'nationally vulnerable' and above (Tan et al., 2008; Chong et al., 2009), and large, mature trees of species of conservation significance are irreplaceable if lost.

4.4. Comparison across zones

Species accumulation curves were plotted for Zones A−E from the data gathered from the sampling points (Figure 19), to compare how the number of plant species detected increased with increasing sampling effort in each zone. For a fair comparison, the slopes of the curves should be interpreted within the shaded blue region of the graph, which is limited by the zone with the smallest number of sampling points, i.e., Zone E. It is clear that there are differences in the slopes of the curves of Zones

sampling effort in each zone. For a fair comparison, the slopes of the curves should be interpreted within the shaded blue region of the graph, which is limited by the zone with the smallest number of sampling points, i.e., Zone E. It is clear that there are differences in the slopes of the curves of Zones B and D compared to Zones A and E. Zones B and D have almost identical species accumulation curves, which start off with a gentle slope and eventually begin to flatten out with increasing sampling effort. In contrast, the curves of Zones A and E start off with steeper slopes than Zones B and D, indicating that more new species are encountered at each new sampling point that have not been encountered before, as compared to Zones B and D. The curves of Zones A and E also do not begin to flatten out with increasing sampling effort, suggesting that even more species can be found if the number of sampling points were to be increased. The species accumulation curves suggest a higher species richness and habitat heterogeneity in Zones A and E compared to Zones B and D.

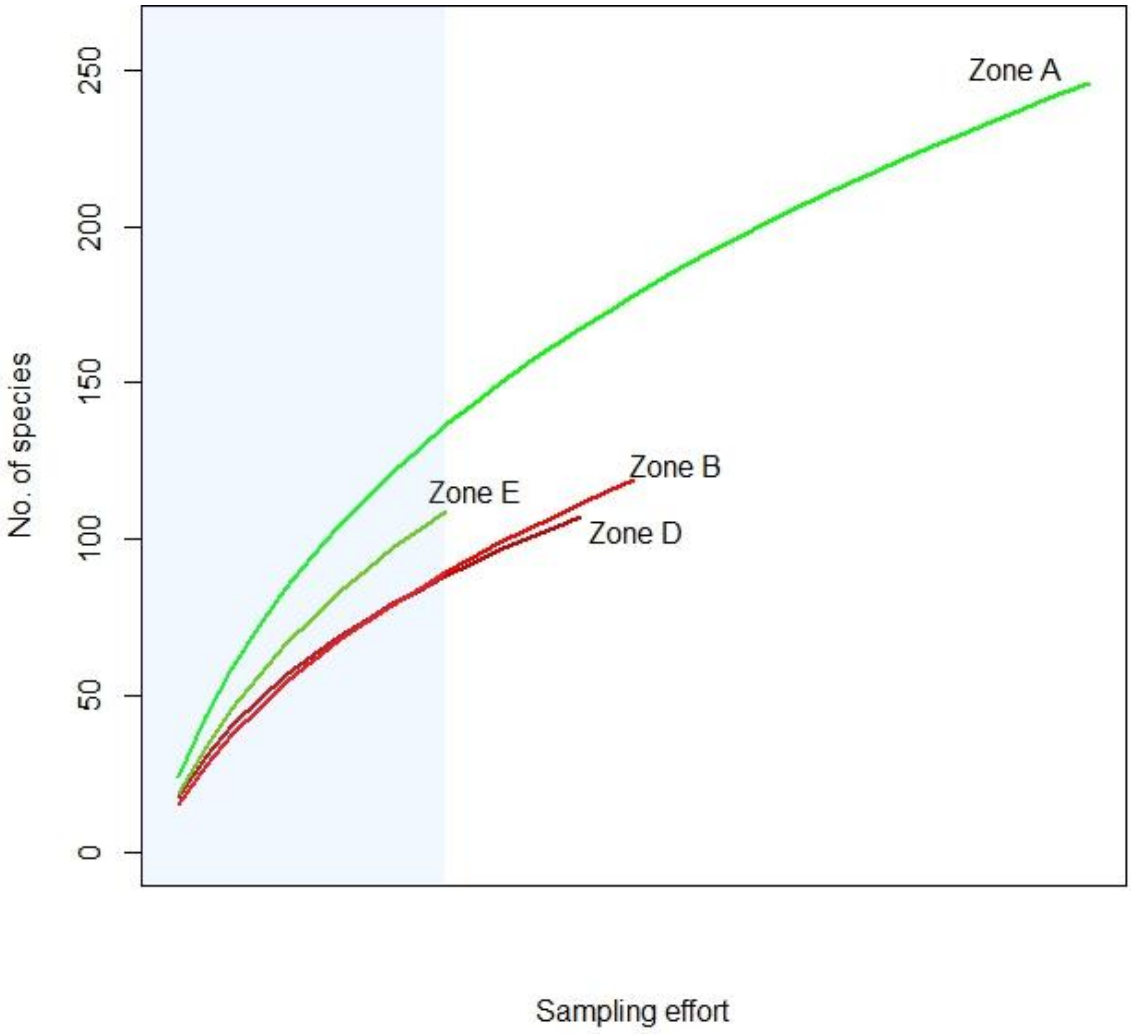


Figure 19. Species accumulation curves generated from sampling points in Zones A−E. The light blue shaded area highlights where the curves can be most fairly compared, and is limited by the zone with the smallest number of sampling points (Zone E).

A brief comparison of the proportion of native and non-native species across the surveyed zones is presented in the pie charts in Figure 20. It is clear that Zone B, Zone D, and the spontaneous vegetation within the Night Safari compound and Singapore Zoo back-of-house areas have a high proportion of non-native species (about a quarter of the species recorded per zone), while Zone A, Zone E, and Fragment 1 are native-species dominated, and have a high proportion of species that are of conservation significance.

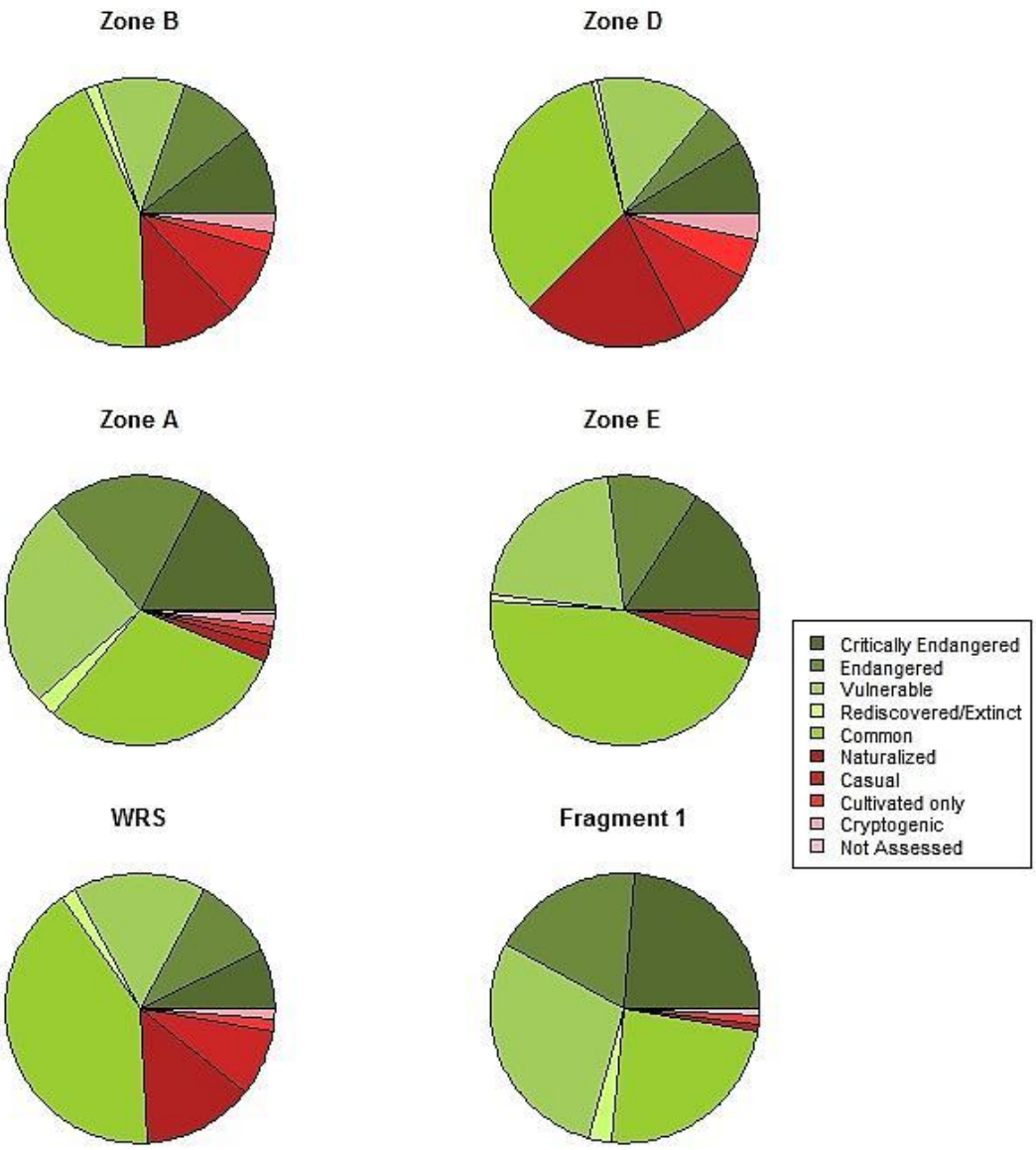


Figure 20. Relative proportions of native (in green) and non-native (in red) species recorded per zone.

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Appendix 1: List of all vascular plant species recorded in Zone B including point sampling and opportunistic encounters, and their families, and national conservation statuses.

Species	Family	National conservation status
Adiantum latifolium	Adiantaceae	Naturalized
Agelaea macrophylla	Connaraceae	Crit. End.
Aglaonema commutatum	Araceae	Casual
Alocasia longiloba	Araceae	Common
Alstonia scholaris	Apocynaceae	Cultivated only
Ampelocissus elegans	Vitaceae	Endangered
Ampelocissus gracilis	Vitaceae	Endangered
Aporosa frutescens	Phyllanthaceae	Common
Aporosa lucida var. lucida	Phyllanthaceae	Crit. End.
Aquilaria hirta	Thymelaeaceae	Rediscovered
Archidendron clypearia	Fabaceae	Common
Archidendron jiringa	Fabaceae	Vulnerable
Ardisia sanguinolenta	Primulaceae	Common
Artabotrys suaveolens	Annonaceae	Endangered
Artocarpus elasticus	Moraceae	Common
Asplenium longissimum	Aspleniaceae	Common
Asplenium nidus	Aspleniaceae	Common
Axonopus compressus	Poaceae	Naturalized
Baccaurea parviflora	Phyllanthaceae	Common
Baphia nitida	Fabaceae	Casual
Bauhinia semibifida var. semibifida	Fabaceae	Vulnerable
Beilschmiedia madang	Lauraceae	Endangered
Bhesa paniculata	Centroplacaceae	Common
Bridelia sp.	Phyllanthaceae	#N/A
Bridelia tomentosa	Phyllanthaceae	Common
Calathea ornata	Marantaceae	Cultivated only
Calophyllum ferrugineum	Calophyllaceae	Common
Campnosperma auriculatum	Anacardiaceae	Common
Canarium sp.	Burseraceae	#N/A
Caryota mitis	Arecaceae	Common
Cecropia pachystachya	Urticaceae	Naturalized
Cinnamomum iners	Lauraceae	Common
Claoxylon indicum	Euphorbiaceae	Common
Clausena excavata	Rutaceae	Common
Clerodendrum disparifolium	Lamiaceae	Common
Clerodendrum villosum	Lamiaceae	Vulnerable
Clidemia hirta	Melastomataceae	Naturalized
Cratoxylum formosum	Hypericaceae	Endangered
Cyclosorus dentatus	Thelypteridaceae	Cryptogenic Weed
Cyclosorus opulentus	Thelypteridaceae	Endangered
Cyperus javanicus	Cyperaceae	Common
Dicranopteris linearis	Gleicheniaceae	Common
Dillenia suffruticosa	Dilleniaceae	Common
Dimocarpus longan	Sapindaceae	Casual
Diospyros lanceifolia	Ebenaceae	Common
Dracaena fragrans	Asparagaceae	Casual
Dracaena surculosa	Asparagaceae	Cultivated only
Durio zibethinus	Malvaceae	Casual
Elaeis guineensis	Arecaceae	Casual
Elaeocarpus ferrugineus	Elaeocarpaceae	Common
Elaeocarpus obtusus ssp. apiculatus	Elaeocarpaceae	Crit. End.
Elaeocarpus salicifolius	Elaeocarpaceae	Vulnerable
Epipremnum aureum	Araceae	Casual
Epipremnum pinnatum	Araceae	Crit. End.
Erycibe tomentosa	Convolvulaceae	Common
Falcataria moluccana	Fabaceae	Naturalized
Fibraurea tinctoria	Menispermaceae	Common
Ficus benjamina	Moraceae	Cryptogenic Weed
Ficus cf. microcarpa	Moraceae	#N/A
Ficus fistulosa	Moraceae	Common
Ficus microcarpa	Moraceae	Common
Ficus stricta	Moraceae	Crit. End.
Ficus virens	Moraceae	Crit. End.
Friesodielsia latifolia	Annonaceae	Common
Garcinia parvifolia	Clusiaceae	Common
Gironniera nervosa	Cannabaceae	Common
Heliconia psittacorum	Heliconiaceae	Casual
Horsfieldia punctatifolia	Myristicaceae	Crit. End.
Hoya latifolia	Apocynaceae	Endangered
Indorouchera griffithiana	Linaceae	Common
Ixonanthes reticulata	Ixonanthaceae	Common
Ixora congesta	Rubiaceae	Common
Kyllinga polyphylla	Cyperaceae	Naturalized
Leea indica	Vitaceae	Common
Lepisanthes rubiginosa	Sapindaceae	Common
Lindera lucida	Lauraceae	Vulnerable
Litsea elliptica	Lauraceae	Common
Litsea firma	Lauraceae	Vulnerable
Litsea ridleyi	Lauraceae	Endangered
Lygodium longifolium	Schizaeaceae	Vulnerable
Lygodium microphyllum	Schizaeaceae	Common
Macaranga bancana	Euphorbiaceae	Common
Macaranga conifera	Euphorbiaceae	Common
Macaranga gigantea	Euphorbiaceae	Common
Macaranga heynei	Euphorbiaceae	Common
Manihot carthagenesis ssp. glaziovii	Euphorbiaceae	Naturalized
Melastoma malabathricum	Melastomataceae	Common
Memecylon lilacinum	Melastomataceae	Crit. End.
Mikania micrantha	Asteraceae	Naturalized
Mitrella kentii	Annonaceae	Common
Nephelium lappaceum	Sapindaceae	Crit. End. (but not of native provenance)
Nephelium ramboutan-ake	Sapindaceae	Rediscovered
Nephrolepis auriculata	Oleandraceae	Cryptogenic Weed
Oncosperma tigillarium	Arecaceae	Vulnerable
Ottochloa nodosa	Poaceae	Common
Palaquium obovatum	Sapotaceae	Vulnerable
Palaquium sp.	Sapotaceae	#N/A
Pandanus amaryllifolius	Pandanaceae	Casual

No. of species per conservation status category recorded from the sampling points only

Conservation status category	No. of species
Critically Endangered	13
Critically Endangered (but not of native provenance)	1
Endangered	11
Vulnerable	13
Rediscovered	2
Common	54
Naturalized	14
Casual	10
Cultivated only	3
Cryptogenic weed	3
Total	**124**

Native	93
Of conservation significance	39
Non-native	27
Critically Endangered (but not of native provenance)	1
Cryptogenic weed	3
Total	124

Pandanus atrocarpus	Pandanaceae	Endangered
Paraderris elliptica	Fabaceae	Endangered
Peperomia pellucida	Piperaceae	Naturalized
Piper aduncum	Piperaceae	Naturalized
Piper flavimarginatum	Piperaceae	Crit. End.
Piper pedicellosum	Piperaceae	Crit. End.
Piper sarmentosum	Piperaceae	Common
Pouteria obovata	Sapotaceae	Vulnerable
Prunus polystachya	Rosaceae	Common
Rhodamnia cinerea	Myrtaceae	Common
Rourea asplenifolia	Connaraceae	Crit. End.
Solanum torvum	Solanaceae	Naturalized
Spathodea campanulata	Bignoniaceae	Naturalized
Spatholobus ferrugineus	Fabaceae	Common
Stenochlaena palustris	Blechnaceae	Common
Symplocos fasciculata	Symplocaceae	Vulnerable
Synedrella nodiflora	Asteraceae	Naturalized
Syngonium podophyllum	Araceae	Naturalized
Syzygium borneense	Myrtaceae	Common
Syzygium grande	Myrtaceae	Common
Syzygium lineatum	Myrtaceae	Common
Syzygium polyanthum	Myrtaceae	Vulnerable
Syzygium pseudoformosum	Myrtaceae	Crit. End.
Syzygium sp.	Myrtaceae	#N/A
Syzygium zeylanicum	Myrtaceae	Common
Tabebuia rosea	Bignoniaceae	Casual
Tetracera fagifolia	Dilleniaceae	Vulnerable
Tetracera indica	Dilleniaceae	Common
Vitex pinnata	Lamiaceae	Common
Xanthophyllum ellipticum	Polygalaceae	Crit. End.
Xanthophyllum flavescens	Polygalaceae	Endangered

Appendix 2: List of all vascular plant species recorded in Zone D including point sampling and opportunistic encounters, and their families, and national conservation statuses.

Species	Family	National conservation status
Acacia auriculiformis	Fabaceae	Naturalized
Adenanthera pavonina	Fabaceae	Naturalized
Adiantum latifolium	Adiantaceae	Naturalized
Agelaea macrophylla	Connaraceae	Crit. End.
Aglaonema commutatum	Araceae	Casual
Alocasia longiloba	Araceae	Common
Alstonia scholaris	Apocynaceae	Cultivated only
Aporosa frutescens	Phyllanthaceae	Common
Aporosa lucida var. lucida	Phyllanthaceae	Crit. End.
Aporosa sp.	Phyllanthaceae	#N/A
Aquilaria malaccensis	Thymelaeaceae	Vulnerable
Archidendron clypearia	Fabaceae	Common
Artabotrys suaveolens	Annonaceae	Endangered
Artocarpus heterophyllus	Moraceae	Casual
Artocarpus integer	Moraceae	Casual
Asplenium nidus	Aspleniaceae	Common
Asystasia gangetica ssp. micrantha	Acanthaceae	Naturalized
Axonopus compressus	Poaceae	Naturalized
Bambusa sp.	Poaceae	#N/A
Bhesa paniculata	Centroplacaceae	Common
Bougainvillea glabra	Nyctaginaceae	Cultivated only
Calophyllum pulcherrimum	Calophyllaceae	Common
Calophyllum tetrapterum	Calophyllaceae	Vulnerable
Calophyllum wallichianum var. incrassatum	Calophyllaceae	Vulnerable
Calopogonium mucunoides	Fabaceae	Naturalized
Campnosperma auriculatum	Anacardiaceae	Common
Campnosperma squamatum	Anacardiaceae	Common
Canarium littorale	Burseraceae	Common
Caryota mitis	Arecaceae	Common
Cassytha filiformis	Lauraceae	Common
Castanopsis wallichii	Fagaceae	Crit. End.
Catharanthus roseus	Apocynaceae	Naturalized
Cecropia pachystachya	Urticaceae	Naturalized
Centotheca lappacea	Poaceae	Crit. End.
Centrosema sp.	Fabaceae	#N/A
Cheilocostus speciosus	Costaceae	Common
Cinnamomum iners	Lauraceae	Common
Claoxylon indicum	Euphorbiaceae	Common
Clausena excavata	Rutaceae	Common
Clerodendrum disparifolium	Lamiaceae	Common
Clerodendrum paniculatum	Lamiaceae	Casual
Clerodendrum villosum	Lamiaceae	Vulnerable
Clidemia hirta	Melastomataceae	Naturalized
Coffea canephora	Rubiaceae	Cultivated only
Costus lucanusianus	Costaceae	Casual
Cratoxylum arborescens	Hypericaceae	Vulnerable
Cyclosorus opulentus	Thelypteridaceae	Endangered
Cyclosorus sp.	Thelypteridaceae	#N/A
Cyclosorus subpubescens	Thelypteridaceae	Common
Dalbergia sp.	Fabaceae	#N/A
Dendrobium crumenatum	Orchidaceae	Common
Desmodium sp.	Fabaceae	Cryptogenic Weed
Dieffenbachia seguine var. seguine	Araceae	Casual
Dillenia suffruticosa	Dilleniaceae	Common
Dimocarpus longan	Sapindaceae	Casual
Dioscorea polyclados	Dioscoreaceae	Crit. End.
Diospyros lanceifolia	Ebenaceae	Common
Dracaena fragrans	Asparagaceae	Casual
Dracaena sanderiana	Asparagaceae	Cultivated only
Durio zibethinus	Malvaceae	Casual
Elaeis guineensis	Arecaceae	Casual
Elaeocarpus salicifolius	Elaeocarpaceae	Vulnerable
Elaeocarpus sp.	Elaeocarpaceae	#N/A
Elaeocarpus stipularis	Elaeocarpaceae	Vulnerable
Eleutheranthera ruderalis	Asteraceae	Naturalized
Epipremnum aureum	Araceae	Casual
Falcataria moluccana	Fabaceae	Naturalized
Fibraurea tinctoria	Menispermaceae	Common
Ficus apiocarpa	Moraceae	Endangered
Ficus cf. microcarpa	Moraceae	#N/A
Ficus fistulosa	Moraceae	Common
Ficus heteropleura	Moraceae	Common
Ficus microcarpa	Moraceae	Common
Ficus obscura var. borneensis	Moraceae	Crit. End.
Ficus pisocarpa	Moraceae	Crit. End.
Ficus variegata	Moraceae	Common
Ficus vasculosa	Moraceae	Endangered
Fimbristylis sp.	Cyperaceae	#N/A
Garcinia forbesii	Clusiaceae	Crit. End.
Gironniera nervosa	Cannabaceae	Common
Gynotroches axillaris	Rhizophoraceae	Common
Heliconia sp.	Heliconiaceae	Cultivated only
Hoya latifolia	Apocynaceae	Endangered
Hura crepitans	Euphorbiaceae	Cultivated only
Hyptis capitata	Lamiaceae	Naturalized
Imperata cylindrica	Poaceae	Cryptogenic Weed
Ipomoea cairica	Convolvulaceae	Naturalized
Ipomoea pes-caprae	Convolvulaceae	Common
Ipomoea sp.	Convolvulaceae	#N/A
Ischaemum ciliare	Poaceae	Cryptogenic Weed
Ischaemum muticum	Poaceae	Common
Ixonanthes icosandra	Ixonanthaceae	Vulnerable
Ixora congesta	Rubiaceae	Common
Koilodepas longifolium	Euphorbiaceae	Vulnerable
Kyllinga polyphylla	Cyperaceae	Naturalized
Kyllinga sp.	Cyperaceae	#N/A
Lantana camara	Verbenaceae	Naturalized
Leea indica	Vitaceae	Common
Litsea castanea	Lauraceae	Endangered

No. of species per conservation status category recorded from the sampling points only	
Conservation status category	**No. of species**
Critically Endangered	13
Critically Endangered (but not of native provenance)	1
Endangered	8
Vulnerable	21
Rediscovered	1
Common	50
Naturalized	30
Casual	14
Cultivated only	7
Cryptogenic weed	5
Total	**150**

Native	93
Of conservation significance	43
Non-native	51
Critically Endangered (but not of native provenance)	1
Cryptogenic weed	5
Total	150

Litsea elliptica	Lauraceae	Common
Lygodium sp.	Schizaeaceae	#N/A
Macaranga bancana	Euphorbiaceae	Common
Macaranga conifera	Euphorbiaceae	Common
Macaranga gigantea	Euphorbiaceae	Common
Mangifera foetida	Anacardiaceae	Vulnerable
Melastoma malabathricum	Melastomataceae	Common
Melicope lunu-ankenda	Rutaceae	Crit. End.
Melothria pendula	Cucurbitaceae	Naturalized
Mikania micrantha	Asteraceae	Naturalized
Mimosa diplotricha	Fabaceae	Naturalized
Mimosa pudica	Fabaceae	Naturalized
Mimosa sp.	Fabaceae	#N/A
Mukia maderaspatana	Cucurbitaceae	Naturalized
Muntingia calabura	Muntingiaceae	Naturalized
Musa sp.	Musaceae	Cultivated only
Nephelium lappaceum	Sapindaceae	Crit. End. (but not of native provenance)
Nephrolepis auriculata	Oleandraceae	Cryptogenic Weed
Oncosperma sp.	Arecaceae	#N/A
Oncosperma tigillarium	Arecaceae	Vulnerable
Ottochloa nodosa	Poaceae	Common
Pandanus amaryllifolius	Pandanaceae	Casual
Panicum sp.	Poaceae	#N/A
Paraderris elliptica	Fabaceae	Endangered
Pennisetum sp.	Fabaceae	#N/A
Phaeanthus ophthalmicus	Annonaceae	Vulnerable
Philodendron hederaceum	Araceae	Casual
Phytocrene bracteata	Icacinaceae	Vulnerable
Piper aduncum	Piperaceae	Naturalized
Piper betle	Piperaceae	Casual
Piper muricatum	Piperaceae	Crit. End.
Piper pedicellosum	Piperaceae	Crit. End.
Piper sarmentosum	Piperaceae	Common
Poikilospermum suaveolens	Urticaceae	Vulnerable
Porterandia anisophylla	Rubiaceae	Vulnerable
Pouteria obovata	Sapotaceae	Vulnerable
Pternandra coerulescens	Melastomataceae	Vulnerable
Ptychosperma macarthurii	Arecaceae	Naturalized
Pueraria phaseoloides	Fabaceae	Naturalized
Pyrrosia piloselloides	Polypodiaceae	Common
Rhodamnia cinerea	Myrtaceae	Common
Rhynchospora rubra	Cyperaceae	Cryptogenic Weed
Rourea acutipetala ssp. acutipetala	Connaraceae	Rediscovered
Saccharum sp.	Fabaceae	#N/A
Salacia grandiflora	Celastraceae	Crit. End.
Smilax setosa	Smilacaceae	Common
Solanum torvum	Solanaceae	Naturalized
Spathodea campanulata	Bignoniaceae	Naturalized
Spathoglottis plicata	Orchidaceae	Common
Spatholobus ferrugineus	Fabaceae	Common
Spermacoce remota	Rubiaceae	Naturalized
Sphagneticola trilobata	Asteraceae	Naturalized
Stenochlaena palustris	Blechnaceae	Common
Stephania capitata	Menispermaceae	Crit. End.
Sterculia sp.	Malvaceae	#N/A
Strychnos ignatii	Loganiaceae	Vulnerable
Symplocos fasciculata	Symplocaceae	Vulnerable
Syngonium podophyllum	Araceae	Naturalized
Syzygium borneense	Myrtaceae	Common
Syzygium lineatum	Myrtaceae	Common
Syzygium polyanthum	Myrtaceae	Vulnerable
Syzygium zeylanicum	Myrtaceae	Common
Terminalia catappa	Combretaceae	Common
Tetracera macrophylla	Dilleniaceae	Vulnerable
Timonius wallichianus	Rubiaceae	Common
Tridax procumbens	Asteraceae	Naturalized
Vitex pinnata	Lamiaceae	Common
Xanthophyllum flavescens	Polygalaceae	Endangered

Appendix 3: List of all vascular plant species recorded in Zone A including point sampling and opportunistic encounters, and their families, and national conservation statuses.

Species	Family	National conservation status
Adiantum latifolium	Adiantaceae	Naturalized
Agelaea borneensis	Connaraceae	Vulnerable
Agelaea macrophylla	Connaraceae	Crit. End.
Aglaia sp.	Meliaceae	#N/A
Aglaonema sp.	Araceae	#N/A
Agrostistachys borneensis	Euphorbiaceae	Common
Aidia densiflora	Rubiaceae	Vulnerable
Alchornea tiliifolia	Euphorbiaceae	Crit. End.
Alocasia longiloba	Araceae	Common
Alstonia angustifolia	Apocynaceae	Common
Alstonia scholaris	Apocynaceae	Cultivated only
Alyxia reinwardtii	Apocynaceae	Common
Ampelocissus gracilis	Vitaceae	Endangered
Anadendrum sp.	Araceae	#N/A
Anisophyllea disticha	Anisophyllaceae	Common
Anodendron candolleanum	Apocynaceae	Crit. End.
Antidesma cuspidatum	Phyllanthaceae	Common
Aporosa frutescens	Phyllanthaceae	Common
Aporosa lucida var. lucida	Phyllanthaceae	Crit. End.
Aquilaria malaccensis	Thymelaeaceae	Vulnerable
Aquilaria microcarpa	Thymelaeaceae	Crit. End.
Archidendron clypearia	Fabaceae	Common
Archidendron microcarpum	Fabaceae	Endangered
Ardisia sanguinolenta	Primulaceae	Common
Ardisia teysmanniana	Primulaceae	Endangered
Artabotrys suaveolens	Annonaceae	Endangered
Arthrophyllum diversifolium	Araliaceae	Common
Artocarpus elasticus	Moraceae	Common
Aspidopterys concava	Malpighiaceae	Endangered
Asplenium nidus	Aspleniaceae	Common
Asystasia gangetica ssp. Micrantha	Acanthaceae	Naturalized
Baccaurea parviflora	Phyllanthaceae	Common
Baccaurea polyneura	Phyllanthaceae	Endangered
Bauhinia semibifida var. semibifida	Fabaceae	Vulnerable
Beilschmiedia madang	Lauraceae	Endangered
Bhesa paniculata	Centroplacaceae	Common
Blechnum finlaysonianum	Blechnaceae	Vulnerable
Byttneria maingayi	Malvaceae	Crit. End.
Calophyllum pulcherrimum	Calophyllaceae	Common
Calophyllum rubiginosum	Calophyllaceae	Endangered
Calophyllum tetrapterum	Calophyllaceae	Vulnerable
Calophyllum teysmannii	Calophyllaceae	Vulnerable
Calophyllum wallichianum var. incrassatum	Calophyllaceae	Vulnerable
Campnosperma auriculatum	Anacardiaceae	Common
Campnosperma squamatum	Anacardiaceae	Common
Canarium pilosum	Burseraceae	Endangered
Caryota mitis	Arecaceae	Common
Castanopsis wallichii	Fagaceae	Crit. End.
Chassalia sp.	Rubiaceae	#N/A
Cinnamomum iners	Lauraceae	Common
Clerodendrum deflexum	Lamiaceae	Vulnerable
Clerodendrum disparifolium	Lamiaceae	Common
Clidemia hirta	Melastomataceae	Naturalized
Cnestis palala	Connaraceae	Common
Connarus semidecandrus	Connaraceae	Crit. End.
Connarus sp.	Connaraceae	#N/A
Coscinium fenestratum	Menispermaceae	Endangered
Cratoxylum formosum	Hypericaceae	Endangered
Cratoxylum maingayi	Hypericaceae	Crit. End.
Cyathea latebrosa	Cyatheaceae	Vulnerable
Cyathea squamulata	Cyatheaceae	Endangered
Cyclosorus dentatus	Thelypteridaceae	Cryptogenic Weed
Cyclosorus triphyllus	Thelypteridaceae	Common
Dacryodes longifolia	Burseraceae	Crit. End.
Dalbergia sp.	Fabaceae	#N/A
Dasymaschalon dasymaschalum	Annonaceae	Crit. End.
Derris amoena var. maingayana	Fabaceae	Vulnerable
Dichapetalum sordidum	Dichapetalaceae	Rediscovered
Dicranopteris curranii	Gleicheniaceae	Common
Dicranopteris linearis	Gleicheniaceae	Common
Dillenia suffruticosa	Dilleniaceae	Common
Dioscorea pyrifolia	Dioscoreaceae	Common
Diospyros lanceifolia	Ebenaceae	Common
Diospyros venosa	Ebenaceae	Crit. End.
Dissochaeta sp.	Melastomataceae	#N/A
Dracaena porteri	Asparagaceae	Common
Drepananthus ramuliflorus	Annonaceae	Common
Drypetes pendula	Putranjivaceae	Crit. End.
Durio zibethinus	Malvaceae	Casual
Dyera costulata	Apocynaceae	Common
Dysoxylum cauliflorum	Meliaceae	Vulnerable
Elaeis guineensis	Arecaceae	Casual
Elaeocarpus ferrugineus	Elaeocarpaceae	Common
Elaeocarpus mastersii	Elaeocarpaceae	Common
Elaeocarpus petiolatus	Elaeocarpaceae	Common
Elaeocarpus salicifolius	Elaeocarpaceae	Vulnerable
Elaeocarpus stipularis	Elaeocarpaceae	Vulnerable
Enkleia malaccensis	Thymelaeaceae	Crit. End.
Erycibe leucoxyloides	Convolvulaceae	Cryptogenic Weed
Erycibe tomentosa	Convolvulaceae	Common
Eurycoma longifolia	Simaroubaceae	Crit. End.
Fibraurea tinctoria	Menispermaceae	Common
Ficus globosa	Moraceae	Endangered
Ficus microsyce	Moraceae	Crit. End.
Ficus punctata	Moraceae	Common
Fissistigma fulgens	Annonaceae	Vulnerable
Fissistigma latifolium var. ovoideum	Annonaceae	Vulnerable
Friesodielsia glauca	Annonaceae	Rediscovered
Friesodielsia latifolia	Annonaceae	Common
Gaertnera grisea	Rubiaceae	Vulnerable
Gaertnera obesa	Rubiaceae	Endangered
Garcinia griffithii	Clusiaceae	Endangered
Garcinia parvifolia	Clusiaceae	Common

No. of species per conservation status category recorded from the sampling points only

Conservation status category	No. of species
Critically Endangered	37
Critically Endangered (but not of native provenance)	1
Endangered	40
Vulnerable	54
Rediscovered	5
Common	64
Naturalized	4
Casual	3
Cultivated only	2
Cryptogenic weed	3
Not Assessed	1
Total	**214**

Native	200
Of conservation significance	136
Non-native	9
Critically Endangered (but not of native provenance)	1
Cryptogenic weed	3
Not Assessed	1
Total	214

Garcinia rostrata	Clusiaceae	Crit. End.
Garcinia scortechinii	Clusiaceae	Crit. End.
Gironniera nervosa	Cannabaceae	Common
Gironniera subaequalis	Cannabaceae	Endangered
Glycosmis chlorosperma var. chlorosperma	Rutaceae	Vulnerable
Gnetum sp.	Gnetaceae	#N/A
Goniothalamus macrophyllus	Annonaceae	Vulnerable
Gonystylus confusus	Thymelaeaceae	Endangered
Gordonia multinervis	Theaceae	Endangered
Grenacheria amentacea	Primulaceae	Rediscovered
Grewia laevigata	Malvaceae	Vulnerable
Guioa pleuropteris	Sapindaceae	Vulnerable
Guioa pubescens	Sapindaceae	Vulnerable
Gymnacranthera bancana	Myristicaceae	Crit. End.
Gynochthodes coriacea	Rubiaceae	Vulnerable
Gynotroches axillaris	Rhizophoraceae	Common
Horsfieldia crassifolia	Myristicaceae	Crit. End.
Horsfieldia polyspherula var. sumatrana	Myristicaceae	Vulnerable
Horsfieldia sp.	Myristicaceae	#N/A
Ixonanthes icosandra	Ixonanthaceae	Vulnerable
Ixora congesta	Rubiaceae	Common
Ixora sp.	Rubiaceae	#N/A
Ixora sp. A	Rubiaceae	#N/A
Knema communis	Myristicaceae	Endangered
Knema curtisii var. curtisii	Myristicaceae	Endangered
Knema intermedia	Myristicaceae	Endangered
Knema latericia ssp. Ridleyi	Myristicaceae	Endangered
Knema sp.	Myristicaceae	#N/A
Koompassia malaccensis	Fabaceae	Endangered
Kunstleria ridleyi	Fabaceae	Endangered
Lansium domesticum	Meliaceae	Cultivated only
Licania splendens	Chrysobalanaceae	Common
Licuala sp.	Arecaceae	#N/A
Limacia scandens	Menispermaceae	Vulnerable
Lindera lucida	Lauraceae	Vulnerable
Lithocarpus ewyckii	Fagaceae	Endangered
Litsea castanea	Lauraceae	Endangered
Litsea cf. grandis	Lauraceae	#N/A
Litsea elliptica	Lauraceae	Common
Litsea firma	Lauraceae	Vulnerable
Litsea grandis	Lauraceae	Endangered
Litsea lancifolia	Lauraceae	Crit. End.
Luvunga crassifolia	Rutaceae	Crit. End.
Lygodium microphyllum	Schizaeaceae	Common
Macaranga bancana	Euphorbiaceae	Common
Macaranga conifera	Euphorbiaceae	Common
Macaranga gigantea	Euphorbiaceae	Common
Macaranga heynei	Euphorbiaceae	Common
Macaranga sp.	Euphorbiaceae	#N/A
Macaranga trichocarpa	Euphorbiaceae	Endangered
Maclurodendron porteri	Rutaceae	Vulnerable
Magnolia sp.	Magnoliaceae	#N/A
Magnolia villosa	Magnoliaceae	Crit. End.
Mallotus paniculatus	Euphorbiaceae	Common
Melastoma malabathricum	Melastomataceae	Common
Meliosma simplicifolia ssp. fruticosa	Sabiaceae	Crit. End.
Melothria pendula	Cucurbitaceae	Naturalized
Memecylon amplexicaule	Melastomataceae	Crit. End.
Memecylon lilacinum	Melastomataceae	Crit. End.
Memecylon paniculatum	Melastomataceae	Crit. End.
Mitrella kentii	Annonaceae	Common
Nephelium lappaceum	Sapindaceae	Crit. End. (but not of native provenance)
Nephrolepis auriculata	Oleandraceae	Cryptogenic Weed
Nothaphoebe umbelliflora	Lauraceae	Common
Nothocissus spicifera	Vitaceae	Crit. End.
Oncosperma horridum	Arecaceae	Vulnerable
Ottochloa nodosa	Poaceae	Common
Oxyceros bispinosus	Rubiaceae	Endangered
Oxyceros longiflorus	Rubiaceae	Vulnerable
Palaquium obovatum	Sapotaceae	Vulnerable
Pandanus atrocarpus	Pandanaceae	Endangered
Paraderris elliptica	Fabaceae	Endangered
Phaeanthus ophthalmicus	Annonaceae	Vulnerable
Piper pedicellosum	Piperaceae	Crit. End.
Polyalthia angustissima	Annonaceae	Vulnerable
Porterandia anisophylla	Rubiaceae	Vulnerable
Pouteria obovata	Sapotaceae	Vulnerable
Prunus grisea var. tomentosa	Rosaceae	Crit. End.
Prunus polystachya	Rosaceae	Common
Psychotria penangensis	Rubiaceae	Vulnerable
Psydrax sp. 10	Rubiaceae	Not Assessed
Pterocarpus indicus	Fabaceae	Casual
Ptychosperma macarthurii	Arecaceae	Naturalized
Rhodamnia cinerea	Myrtaceae	Common
Rothmannia macrophylla	Rubiaceae	Vulnerable
Rourea acutipetala ssp. acutipetala	Connaraceae	Rediscovered
Rourea asplenifolia	Connaraceae	Crit. End.
Rourea cf. minor	Connaraceae	#N/A
Rourea mimosoides	Connaraceae	Endangered
Salacia grandiflora	Celastraceae	Crit. End.
Salacia korthalsiana	Celastraceae	Crit. End.
Santiria laevigata	Burseraceae	Vulnerable
Santiria rubiginosa	Burseraceae	Vulnerable
Santiria tomentosa	Burseraceae	Endangered
Scaphium macropodum	Malvaceae	Endangered
Scindapsus sp.	Araceae	#N/A
Scleria sp.	Cyperaceae	#N/A
Smilax setosa	Smilacaceae	Common
Spatholobus ferrugineus	Fabaceae	Common
Spatholobus ridleyi	Fabaceae	Crit. End.
Stenochlaena palustris	Blechnaceae	Common
Sterculia coccinea	Malvaceae	Vulnerable
Sterculia parviflora	Malvaceae	Crit. End.
Sterculia rubiginosa	Malvaceae	Vulnerable
Streblus elongatus	Moraceae	Vulnerable

Strombosia ceylanica	Olacaceae	Vulnerable
Strychnos ignatii	Loganiaceae	Vulnerable
Strychnos maingayi	Loganiaceae	Crit. End.
Symplocos fasciculata	Symplocaceae	Vulnerable
Syzygium acuminatissimum	Myrtaceae	Endangered
Syzygium borneense	Myrtaceae	Common
Syzygium claviflorum var. maingayi	Myrtaceae	Crit. End.
Syzygium filiforme var. filiforme	Myrtaceae	Endangered
Syzygium grande	Myrtaceae	Common
Syzygium lineatum	Myrtaceae	Common
Syzygium polyanthum	Myrtaceae	Vulnerable
Syzygium sp.	Myrtaceae	#N/A
Tabernaemontana corymbosa	Apocynaceae	Endangered
Taenitis sp.	Pteridaceae	Common
Tetracera akara	Dilleniaceae	Vulnerable
Tetracera fagifolia	Dilleniaceae	Vulnerable
Tetracera macrophylla	Dilleniaceae	Vulnerable
Thottea grandiflora	Aristolochiaceae	Vulnerable
Timonius wallichianus	Rubiaceae	Common
Tinomiscium petiolare	Menispermaceae	Endangered
Uncaria cf. lanosa	Rubiaceae	#N/A
Uncaria sp.	Rubiaceae	#N/A
Uvaria curtsii	Annonaceae	#N/A
Uvaria sp.	Annonaceae	#N/A
Ventilago lanceata	Rhamnaceae	Crit. End.
Ventilago malaccensis	Rhamnaceae	Endangered
Willughbeia coriacea	Apocynaceae	Rediscovered
Xanthophyllum ellipticum	Polygalaceae	Crit. End.
Xanthophyllum eurhynchum	Polygalaceae	Vulnerable
Xanthophyllum flavescens	Polygalaceae	Endangered
Xylopia caudata	Annonaceae	Vulnerable
Xylopia malayana	Annonaceae	Common
Ziziphus calophylla	Rhamnaceae	Vulnerable

Appendix 4: List of all vascular plant species recorded in Zone E including point sampling and opportunistic encounters, and their families, and national conservation statuses.

Species	Family	National conservation status
Adiantum latifolium	Adiantaceae	Naturalized
Agelaea borneensis	Connaraceae	Vulnerable
Agelaea macrophylla	Connaraceae	Crit. End.
Alocasia longiloba	Araceae	Common
Alstonia angustifolia	Apocynaceae	Common
Alstonia angustiloba	Apocynaceae	Common
Ampelocissus elegans	Vitaceae	Endangered
Anisophyllea disticha	Anisophyllaceae	Common
Anodendron candolleanum	Apocynaceae	Crit. End.
Aporosa frutescens	Phyllanthaceae	Common
Aporosa lucida var. lucida	Phyllanthaceae	Crit. End.
Aporosa nervosa	Phyllanthaceae	Vulnerable
Aquilaria malaccensis	Thymelaeaceae	Vulnerable
Ardisia sanguinolenta	Primulaceae	Common
Artabotrys crassifolius	Annonaceae	Crit. End.
Artocarpus lacucha	Moraceae	Endangered
Aspidopterys concava	Malpighiaceae	Endangered
Asplenium longissimum	Aspleniaceae	Common
Baccaurea macrophylla	Phyllanthaceae	Extinct
Baccaurea parviflora	Phyllanthaceae	Common
Baccaurea polyneura	Phyllanthaceae	Endangered
Baphia nitida	Fabaceae	Casual
Bauhinia semibifida var. semibifida	Fabaceae	Vulnerable
Caesalpinia minax	Fabaceae	Casual
Calophyllum pulcherrimum	Calophyllaceae	Common
Calophyllum tetrapterum	Calophyllaceae	Vulnerable
Calophyllum wallichianum var. incrassatum	Calophyllaceae	Vulnerable
Campnosperma auriculatum	Anacardiaceae	Common
Caryota mitis	Arecaceae	Common
Champereia manillana	Opiliaceae	Common
Cinnamomum iners	Lauraceae	Common
Claoxylon indicum	Euphorbiaceae	Common
Clausena excavata	Rutaceae	Common
Clerodendrum disparifolium	Lamiaceae	Common
Clerodendrum villosum	Lamiaceae	Vulnerable
Clidemia hirta	Melastomataceae	Naturalized
Connarus semidecandrus	Connaraceae	Crit. End.
Cratoxylum maingayi	Hypericaceae	Crit. End.
Cyathea sp.	Cyatheaceae	#N/A
Cyclosorus triphyllus	Thelypteridaceae	Common
Davallia denticulata	Davalliaceae	Common
Dillenia suffruticosa	Dilleniaceae	Common
Diospyros lanceifolia	Ebenaceae	Common
Dracaena porteri	Asparagaceae	Common
Elaeocarpus obtusus ssp. apiculatus	Elaeocarpaceae	Crit. End.
Endospermum diadenum	Euphorbiaceae	Vulnerable
Enkleia malaccensis	Thymelaeaceae	Crit. End.
Erycibe tomentosa	Convolvulaceae	Common
Fibraurea tinctoria	Menispermaceae	Common
Ficus apiocarpa	Moraceae	Endangered
Ficus fistulosa	Moraceae	Common
Ficus microcarpa	Moraceae	Common
Ficus sagittata	Moraceae	Crit. End.
Fissistigma manubriatum	Annonaceae	Vulnerable
Garcinia griffithii	Clusiaceae	Endangered
Garcinia parvifolia	Clusiaceae	Common
Gironniera nervosa	Cannabaceae	Common
Glycosmis chlorosperma var. chlorosperma	Rutaceae	Vulnerable
Gynotroches axillaris	Rhizophoraceae	Common
Hevea brasiliensis	Euphorbiaceae	Naturalized
Ixora congesta	Rubiaceae	Common
Knema latericia ssp. ridleyi	Myristicaceae	Endangered
Knema sp.	Myristicaceae	#N/A
Leea indica	Vitaceae	Common
Licania splendens	Chrysobalanaceae	Common
Limacia scandens	Menispermaceae	Vulnerable
Lindera lucida	Lauraceae	Vulnerable
Lithocarpus ewyckii	Fagaceae	Endangered
Lygodium longifolium	Schizaeaceae	Vulnerable
Madhuca sp.	Sapotaceae	#N/A
Mallotus paniculatus	Euphorbiaceae	Common
Memecylon lilacinum	Melastomataceae	Crit. End.
Memecylon paniculatum	Melastomataceae	Crit. End.
Memecylon sp.	Melastomataceae	#N/A
Myristica lowiana	Myristicaceae	Crit. End.
Neolitsea cassia	Lauraceae	Vulnerable
Nephelium lappaceum	Sapindaceae	Crit. End. (but not of native provenance)
Oncosperma horridum	Arecaceae	Vulnerable
Oncosperma sp.	Araceae	#N/A
Oncosperma tigillarium	Arecaceae	Vulnerable
Ottochloa nodosa	Poaceae	Common
Palaquium hexandrum	Sapotaceae	Crit. End.
Pandanus sp.	Pandanaceae	#N/A
Phaeanthus ophthalmicus	Annonaceae	Vulnerable
Piper flavimarginatum	Piperaceae	Crit. End.
Piper pedicellosum	Piperaceae	Crit. End.
Pternandra coerulescens	Melastomataceae	Vulnerable
Pternandra echinata	Melastomataceae	Vulnerable
Ptychosperma macarthurii	Arecaceae	Naturalized
Rhodamnia cinerea	Myrtaceae	Common
Rourea asplenifolia	Connaraceae	Crit. End.
Rourea minor	Connaraceae	Crit. End.
Salacia sp.	Celastraceae	#N/A
Sandoricum koetjape	Meliaceae	Endangered
Scindapsus hederaceus	Araceae	Common
Spatholobus ferrugineus	Fabaceae	Common
Stenochlaena palustris	Blechnaceae	Common
Symplocos fasciculata	Symplocaceae	Vulnerable
Syngonium podophyllum	Araceae	Naturalized
Syzygium borneense	Myrtaceae	Common
Syzygium grande	Myrtaceae	Common
Syzygium inophyllum	Myrtaceae	Crit. End.
Syzygium lineatum	Myrtaceae	Common

No. of species per conservation status category recorded from the sampling points only

Conservation status category	No. of species
Critically Endangered	16
Critically Endangered (but not of native provenance)	1
Endangered	11
Vulnerable	21
Extinct	1
Common	45
Naturalized	5
Casual	1
Cultivated only	0
Cryptogenic weed	0
Total	**101**

Native	94
Of conservation significance	49
Non-native	6
Critically Endangered (but not of native provenance)	1
Total	101

Syzygium pseudoformosum	Myrtaceae	Crit. End.
Syzygium sp.	Myrtaceae	#N/A
Syzygium zeylanicum	Myrtaceae	Common
Tabernaemontana corymbosa	Apocynaceae	Endangered
Taenitis blechnoides	Pteridaceae	Common
Taenitis sp.	Pteridaceae	Common
Tetracera fagifolia	Dilleniaceae	Vulnerable
Timonius wallichianus	Rubiaceae	Common
Xanthophyllum flavescens	Polygalaceae	Endangered
Xylopia malayana	Annonaceae	Common

Appendix 5: List of all vascular plant species recorded in the Night Safari and Singapore Zoo back-of-house areas, their families, and national conservation statuses.

Location	Species	Family	National conservation status
Others	Syngonium podophyllum	Araceae	Naturalized
Others	Cinnamomum iners	Lauraceae	Common
Others	Spathodea campanulata	Bignoniaceae	Naturalized
Others	Nephelium lappaceum	Sapindaceae	Crit. End. (but not of native provenance)
Others	Caryota mitis	Arecaceae	Common
Others	Syzygium polyanthum	Myrtaceae	Vulnerable
Others	Syzygium grande	Myrtaceae	Common
Others	Ptychosperma macarthurii	Arecaceae	Naturalized
Others	Archidendron sp.	Fabaceae	#N/A
Others	Nephrolepis auriculata	Oleandraceae	Cryptogenic Weed
Others	Oncosperma sp.	Arecaceae	#N/A
Others	Dracaena fragrans	Asparagaceae	Casual
Others	Dioscorea sansibarensis	Dioscoreaceae	Naturalized
Others	Claoxylon indicum	Euphorbiaceae	Common
Others	Syzygium zeylanicum	Myrtaceae	Common
Others	Ficus aurata var. aurata	Moraceae	Vulnerable
Others	Ficus fistulosa	Moraceae	Common
Others	Dillenia suffruticosa	Dilleniaceae	Common
Others	Alocasia macrorrhizos	Araceae	Naturalized
Others	Elaeis guineensis	Arecaceae	Casual
Others	Pometia pinnata	Sapindaceae	Endangered
Others	Dimocarpus longan	Sapindaceae	Casual
Others	Adiantum latifolium	Adiantaceae	Naturalized
Others	Ottochloa nodosa	Poaceae	Common
Others	Asplenium nidus	Aspleniaceae	Common
Others	Thunbergia fragrans	Acanthaceae	Naturalized
Others	Asystasia gangetica ssp. micrantha	Acanthaceae	Naturalized
Others	Clidemia hirta	Melastomataceae	Naturalized
Others	Macaranga gigantea	Euphorbiaceae	Common
Others	Mikania micrantha	Asteraceae	Naturalized
Others	Pyrrosia piloselloides	Polypodiaceae	Common
Others	Colocasia esculenta	Araceae	Casual
Others	Poikilospermum suaveolens	Urticaceae	Vulnerable
Others	Microsorum punctatum	Polypodiaceae	Common
Others	Cissus repens	Vitaceae	Endangered
Others	Cecropia pachystachya	Urticaceae	Naturalized
Others	Neolitsea cassia	Lauraceae	Vulnerable
Others	Cratoxylum formosum	Hypericaceae	Endangered
Others	Epipremnum aureum	Araceae	Casual
Others	Terminalia catappa	Combretaceae	Common
Others	Elaeocarpus obtusus ssp. apiculatus	Elaeocarpaceae	Crit. End.
Others	Davallia denticulata	Davalliaceae	Common
Others	Ficus microcarpa	Moraceae	Common
Others	Plectranthus sp.	Lamiaceae	#N/A
Others	Peperomia pellucida	Piperaceae	Naturalized
Others	Melothria pendula	Cucurbitaceae	Naturalized
Others	Passiflora suberosa	Passifloraceae	Naturalized
Others	Clausena excavata	Rutaceae	Common
Others	Centotheca lappacea	Poaceae	Crit. End.
Others	Adenanthera pavonina	Fabaceae	Naturalized
Others	Bauhinia kochiana	Fabaceae	Cultivated only
Others	Aspidopterys concava	Malpighiaceae	Endangered
Others	Fibraurea tinctoria	Menispermaceae	Common
Others	Hoya latifolia	Apocynaceae	Endangered
Others	Ficus globosa	Moraceae	Endangered
Others	Archidendron clypearia	Fabaceae	Common
Others	Calophyllum pulcherrimum	Calophyllaceae	Common
Others	Palaquium obovatum	Sapotaceae	Vulnerable
Others	Bauhinia semibifida var. semibifida	Fabaceae	Vulnerable
Others	Smilax setosa	Smilacaceae	Common
Others	Syzygium borneense	Myrtaceae	Common
Others	Dioscorea pyrifolia	Dioscoreaceae	Common
Others	Clerodendrum disparifolium	Lamiaceae	Common
Others	Xanthophyllum flavescens	Polygalaceae	Endangered
Others	Ardisia elliptica	Primulaceae	Endangered
Others	Acalypha indica	Euphorbiaceae	Cryptogenic Weed
Others	Hevea brasiliensis	Euphorbiaceae	Naturalized
Others	Anisophyllea disticha	Anisophyllaceae	Common
Others	Passiflora laurifolia	Passifloraceae	Naturalized
Others	Indorouchera griffithiana	Linaceae	Common
Others	Stenochlaena palustris	Blechnaceae	Common
Others	Campnosperma auriculatum	Anacardiaceae	Common
Others	Acacia auriculiformis	Fabaceae	Naturalized
Others	Philodendron hederaceum	Araceae	Casual
Others	Alstonia scholaris	Apocynaceae	Cultivated only
Others	Rhodamnia cinerea	Myrtaceae	Common
Others	Falcataria moluccana	Fabaceae	Naturalized
Others	Ficus variegata	Moraceae	Common
Others	Dieffenbachia seguine var. seguine	Araceae	Casual
Others	Bridelia stipularis	Phyllanthaceae	Vulnerable
Others	Dioscorea orbiculata var. tenuifolia	Dioscoreaceae	Rediscovered
Others	Pongamia pinnata	Fabaceae	Endangered
Others	Gynochthodes coriacea	Rubiaceae	Vulnerable
Others	Litsea elliptica	Lauraceae	Common
Others	Taenitis sp.	Pteridaceae	Common
Others	Combretum indicum	Combretaceae	Casual
Others	Ficus grossularioides var. grossularioides	Moraceae	Common
Others	Xylopia malayana	Annonaceae	Common
Others	Agelaea macrophylla	Connaraceae	Crit. End.
Others	Piper pedicellosum	Piperaceae	Crit. End.
Others	Syzygium lineatum	Myrtaceae	Common
Others	Poikilospermum suaveolens	Urticaceae	Vulnerable
Others	Macaranga bancana	Euphorbiaceae	Common
Others	Uncaria sp. 1	Rubiaceae	#N/A
Others	Ficus heteropleura	Moraceae	Common
Others	Tetracera macrophylla	Dilleniaceae	Vulnerable
Others	Phytocrene bracteata	Icacinaceae	Vulnerable
Others	Friesodielsia latifolia	Annonaceae	Common
Others	Asplenium longissimum	Aspleniaceae	Common

No. of species per conservation status category recorded overall from the area	
Conservation status category	**No. of species**
Critically Endangered	16
Critically Endangered (but not of native provenance)	1
Endangered	22
Vulnerable	36
Rediscovered	2
Extinct	2
Common	92
Naturalized	30
Casual	18
Cultivated only	3
Cryptogenic weed	3
Total	**225**

Native	170
Of conservation significance	78
Non-native	51
Critically Endangered (but not of native provenance)	1
Cryptogenic weed	3
Total	225

Others	Flagellaria indica	Flagellariaceae	Common
Others	Melastoma malabathricum	Melastomataceae	Common
Others	Ampelocissus elegans	Vitaceae	Endangered
Others	Derris amoena var. maingayana	Fabaceae	Vulnerable
Others	Cyathea sp.	Cyatheaceae	#N/A
Others	Gironniera nervosa	Cannabaceae	Common
Others	Gynotroches axillaris	Rhizophoraceae	Common
Others	Phytocrene bracteata	Icacinaceae	Vulnerable
Others	Elaeis guineensis	Arecaceae	Casual
Others	Taliparitiliaceum	Malvaceae	Common
Others	Lygodium microphyllum	Schizaeaceae	Common
Others	Vitex pinnata	Lamiaceae	Common
Others	Paederia foetida	Rubiaceae	Common
Others	Tamarindus indica	Fabaceae	Casual
Others	Artocarpus heterophyllus	Moraceae	Casual
Others	Tetracera fagifolia	Dilleniaceae	Vulnerable
Others	Calophyllum teysmannii	Calophyllaceae	Vulnerable
Others	Antidesma coriaceum	Phyllanthaceae	Vulnerable
Others	Agelaea borneensis	Connaraceae	Vulnerable
Others	Horsfieldia punctatifolia	Myristicaceae	Crit. End.
Others	Epipremnum giganteum	Araceae	Common
Others	Piper aduncum	Piperaceae	Naturalized
Others	Diospyros lanceifolia	Ebenaceae	Common
Others	Aphanamixis polystachya	Meliaceae	Endangered
Others	Ipomoea sp.	Convolvulaceae	#N/A
Others	Breynia discigera	Phyllanthaceae	Crit. End.
Others	Gynotroches axillaris	Rhizophoraceae	Common
Others	Leea rubra	Vitaceae	Extinct
Others	Diospyros lanceifolia	Ebenaceae	Common
Others	Pipturus argenteus	Urticaceae	Naturalized
Others	Artabotrys cf. costatus	Annonaceae	#N/A
A	Andira inermis	Fabaceae	Casual
A	Ipomoea cairica	Convolvulaceae	Naturalized
A	Erycibe tomentosa	Convolvulaceae	Common
A	Cyrtophyllum fragrans	Gentianaceae	Common
A	Bridelia tomentosa	Phyllanthaceae	Common
B	Dioscorea orbiculata var. tenuifolia	Dioscoreaceae	Rediscovered
B	Ficus globosa	Moraceae	Endangered
B	Dillenia indica	Dilleniaceae	Extinct
B	Palaquium obovatum	Sapotaceae	Vulnerable
B	Erycibe tomentosa	Convolvulaceae	Common
B	Syzygium borneense	Myrtaceae	Common
B	Caryota mitis	Arecaceae	Common
B	Anisophyllea disticha	Anisophyllaceae	Common
B	Ficus fistulosa	Moraceae	Common
B	Clerodendrum disparifolium	Lamiaceae	Common
B	Stenochlaena palustris	Blechnaceae	Common
B	Streblus elongatus	Moraceae	Vulnerable
B	Calophyllum pulcherrimum	Calophyllaceae	Common
B	Cinnamomum iners	Lauraceae	Common
B	Timonius wallichianus	Rubiaceae	Common
B	Macaranga gigantea	Euphorbiaceae	Common
B	Calophyllum wallichianum var. incrassatum	Calophyllaceae	Vulnerable
B	Dillenia suffruticosa	Dilleniaceae	Common
B	Campnosperma auriculatum	Anacardiaceae	Common
B	Artocarpus elasticus	Moraceae	Common
B	Ficus punctata	Moraceae	Common
B	Aquilaria malaccensis	Thymelaeaceae	Vulnerable
B	Porterandia anisophylla	Rubiaceae	Vulnerable
B	Garcinia cf. forbesii	Clusiaceae	#N/A
B	Calophyllum wallichianum var. incrassatum	Calophyllaceae	Vulnerable
C	Leea indica	Vitaceae	Common
C	Cyclosorus triphyllus	Thelypteridaceae	Common
C	Prunus polystachya	Rosaceae	Common
C	Piper flavimarginatum	Piperaceae	Crit. End.
D	Ardisia sanguinolenta	Primulaceae	Common
D	Macaranga gigantea	Euphorbiaceae	Common
D	Timonius wallichianus	Rubiaceae	Common
D	Artocarpus elasticus	Moraceae	Common
D	Sterculia rubiginosa	Malvaceae	Vulnerable
D	Archidendron sp.	Fabaceae	#N/A
D	Freycinetia sp.	Pandanaceae	#N/A
D	Xanthophyllum flavescens	Polygalaceae	Endangered
D	Palaquium obovatum	Sapotaceae	Vulnerable
D	Piper flavimarginatum	Piperaceae	Crit. End.
D	Bauhinia semibifida var. semibifida	Fabaceae	Vulnerable
D	Alocasia longiloba	Araceae	Common
D	Dioscorea sansibarensis	Dioscoreaceae	Naturalized
D	Uncaria sp. 2	Rubiaceae	#N/A
D	Aglaonema commutatum	Araceae	Casual
D	Leea indica	Vitaceae	Common
D	Cinnamomum iners	Lauraceae	Common
D	Elaeis guineensis	Arecaceae	Casual
D	Syzygium borneense	Myrtaceae	Common
D	Colocasia esculenta	Araceae	Casual
D	Asplenium nidus	Aspleniaceae	Common
D	Clerodendrum disparifolium	Lamiaceae	Common
D	Syzygium sp.	Myrtaceae	#N/A
D	Lindera lucida	Lauraceae	Vulnerable
D	Ptychosperma macarthurii	Arecaceae	Naturalized
D	Alstonia angustiloba	Apocynaceae	Common
D	Pyrrosia longifolia	Polypodiaceae	Common
D	Pipturus argenteus	Urticaceae	Naturalized
D	Grewia laevigata	Malvaceae	Vulnerable
D	Macaranga heynei	Euphorbiaceae	Common
D	Mallotus paniculatus	Euphorbiaceae	Common
D	Ficus fistulosa	Moraceae	Common
D	Grewia laevigata	Malvaceae	Vulnerable
E	Asplenium nidus	Aspleniaceae	Common
E	Leea indica	Vitaceae	Common
E	Asystasia gangetica ssp. micrantha	Acanthaceae	Naturalized

E	Cyathea sp.	Cyatheaceae	#N/A
E	Dieffenbachia seguine var. seguine	Araceae	Casual
E	Adiantum latifolium	Adiantaceae	Naturalized
E	Pipturus argenteus	Urticaceae	Naturalized
E	Selaginella sp.	Selaginellaceae	#N/A
E	Ficus elastica	Moraceae	Casual
E	Ficus sp.	Moraceae	#N/A
E	Phymatosorus scolopendria	Polypodiaceae	Common
E	Drynaria quercifolia	Polypodiaceae	Common
E	Glycosmis chlorosperma var. chlorosperma	Rutaceae	Vulnerable
E	Hoya verticillata var. verticillata	Apocynaceae	Common
F	Artabotrys sp.	Annonaceae	#N/A
F	Dendrobium crumenatum	Orchidaceae	Common
F	Gluta wallichii	Anacardiaceae	Common
G	Dioscorea sp.	Dioscoreaceae	#N/A
G	Porterandia anisophylla	Rubiaceae	Vulnerable
G	Mangifera sp.	Anacardiaceae	#N/A
G	Saccharum sp.	Poaceae	#N/A
G	Parkia speciosa	Fabaceae	Vulnerable
G	Dicranopteris linearis	Gleicheniaceae	Common
G	Trema sp.	Cannabaceae	#N/A
G	Commersonia bartramia	Malvaceae	Common
G	Horsfieldia cf. polyspherula	Myristicaceae	#N/A
G	Spatholobus ferrugineus	Fabaceae	Common
G	Sterculia rubiginosa	Malvaceae	Vulnerable
G	Cyclosorus sp.	Thelypteridaceae	#N/A
H	Oncosperma horridum	Arecaceae	Vulnerable
H	Macaranga conifera	Euphorbiaceae	Common
H	Clidemia hirta	Melastomataceae	Naturalized
H	Anisophyllea disticha	Anisophyllaceae	Common
H	Ficus fistulosa	Moraceae	Common
H	Ficus heteropleura	Moraceae	Common
H	Calophyllum wallichianum var. incrassatum	Calophyllaceae	Vulnerable
I	Timonius wallichianus	Rubiaceae	Common
I	Bambusa sp.	Poaceae	#N/A
I	Macaranga bancana	Euphorbiaceae	Common
I	Leea indica	Vitaceae	Common
I	Fibraurea tinctoria	Menispermaceae	Common
I	Cinnamomum iners	Lauraceae	Common
I	Bauhinia semibifida var. semibifida	Fabaceae	Vulnerable
I	Asystasia gangetica ssp. micrantha	Acanthaceae	Naturalized
I	Clausena excavata	Rutaceae	Common
I	Erycibe tomentosa	Convolvulaceae	Common
I	Bridelia tomentosa	Phyllanthaceae	Common
I	Ptychosperma macarthurii	Arecaceae	Naturalized
I	Diospyros lanceifolia	Ebenaceae	Common
I	Passiflora suberosa	Passifloraceae	Naturalized
I	Palaquium obovatum	Sapotaceae	Vulnerable
I	Pternandra echinata	Melastomataceae	Vulnerable
I	Spatholobus ferrugineus	Fabaceae	Common
I	Gynotroches axillaris	Rhizophoraceae	Common
I	Lygodium longifolium	Schizaeaceae	Vulnerable
I	Ampelocissus gracilis	Vitaceae	Endangered
I	Gironniera nervosa	Cannabaceae	Common
I	Taenitis sp.	Pteridaceae	Common
I	Syzygium borneense	Myrtaceae	Common
I	Garcinia parvifolia	Clusiaceae	Common
I	Artabotrys sp.	Annonaceae	#N/A
I	Sterculia rubiginosa	Malvaceae	Vulnerable
I	Aspidopterys concava	Malpighiaceae	Endangered
I	Porterandia anisophylla	Rubiaceae	Vulnerable
I	Cyathea sp.	Cyatheaceae	#N/A
I	Caryota mitis	Arecaceae	Common
I	Calophyllum pulcherrimum	Calophyllaceae	Common
I	Grewia laevigata	Malvaceae	Vulnerable
I	Epipremnum giganteum	Araceae	Common
I	Blechnum sp.	Blechnaceae	#N/A
I	Dioscorea pyrifolia	Dioscoreaceae	Common
I	Rourea mimosoides	Connaraceae	Endangered
I	Andira inermis	Fabaceae	Casual
I	Artocarpus sp.	Moraceae	#N/A
I	Xanthophyllum flavescens	Polygalaceae	Endangered
I	Dillenia suffruticosa	Dilleniaceae	Common
I	Melastoma malabathricum	Melastomataceae	Common
I	Macaranga gigantea	Euphorbiaceae	Common
I	Cratoxylum formosum	Hypericaceae	Endangered
I	Claoxylon indicum	Euphorbiaceae	Common
I	Aporosa frutescens	Phyllanthaceae	Common
I	Ficus aurata var. aurata	Moraceae	Vulnerable
I	Alocasia longiloba	Araceae	Common
I	Gonystylus confusus	Thymelaeaceae	Endangered
I	Baccaurea parviflora	Phyllanthaceae	Common
I	Baphia nitida	Fabaceae	Casual
I	Symplocos fasciculata	Symplocaceae	Vulnerable
I	Archidendron clypearia	Fabaceae	Common
I	Guioa sp.	Sapindaceae	#N/A
I	Hoya latifolia	Apocynaceae	Endangered
I	Alstonia angustiloba	Apocynaceae	Common
I	Friesodielsia latifolia	Annonaceae	Common
I	Tetracera fagifolia	Dilleniaceae	Vulnerable
I	Prunus polystachya	Rosaceae	Common
I	Arthrophyllum diversifolium	Araliaceae	Common
I	Alstonia angustifolia	Apocynaceae	Common
I	Adinandra dumosa	Pentaphylacaceae	Common
I	Syzygium zeylanicum	Myrtaceae	Common
I	Gynochthodes coriacea	Rubiaceae	Vulnerable
I	Litsea firma	Lauraceae	Vulnerable
I	Smilax setosa	Smilacaceae	Common
I	Canarium littorale	Burseraceae	Common
I	Baccaurea polyneura	Phyllanthaceae	Endangered
I	Limacia scandens	Menispermaceae	Vulnerable

I	Trema sp.	Cannabaceae	#N/A
I	Litsea elliptica	Lauraceae	Common
I	Ficus globosa	Moraceae	Endangered
I	Rhodamnia cinerea	Myrtaceae	Common
I	Clerodendrum disparifolium	Lamiaceae	Common
I	Syngonium podophyllum	Araceae	Naturalized
I	Scindapsus hederaceus	Araceae	Common
I	Ixora congesta	Rubiaceae	Common
I	Uvaria sp.	Annonaceae	#N/A
I	Agelaea macrophylla	Connaraceae	Crit. End.
I	Clerodendrum villosum	Lamiaceae	Vulnerable
I	Artocarpus elasticus	Moraceae	Common
I	Shorea macroptera ssp. Macroptera	Dipterocarpaceae	Vulnerable
I	Bhesa robusta	Centroplacaceae	Vulnerable
I	Psychotria sarmentosa	Rubiaceae	Crit. End.
I	Phytocrene bracteata	Icacinaceae	Vulnerable
I	Ficus apiocarpa	Moraceae	Endangered
I	Morinda rigida	Rubiaceae	Rediscovered
I	Elaeocarpus mastersii	Elaeocarpaceae	Common
I	Stenochlaena palustris	Blechnaceae	Common
I	Ficus variegata	Moraceae	Common
I	Licania splendens	Chrysobalanaceae	Common
I	Connarus semidecandrus	Connaraceae	Crit. End.
I	Horsfieldia polyspherula var. polyspherula	Myristicaceae	Vulnerable
I	Dalbergia velutina	Fabaceae	Crit. End.
I	Pandanus sp.	Pandanaceae	#N/A
I	Litsea sp.	Lauraceae	#N/A
I	Horsfieldia punctatifolia	Myristicaceae	Crit. End.
I	Aporosa lucida var. lucida	Phyllanthaceae	Crit. End.
I	Artabotrys suaveolens	Annonaceae	Endangered
I	Bhesa paniculata	Centroplacaceae	Common
I	Eurycoma longifolia	Simaroubaceae	Crit. End.
I	Canarium littorale	Burseraceae	Common
I	Gordonia multinervis	Theaceae	Endangered
I	Memecylon sp.	Melastomataceae	#N/A
I	Calophyllum teysmannii	Calophyllaceae	Vulnerable
I	Schefflera actinophylla	Araliaceae	Casual
I	Dioscorea glabra	Dioscoreaceae	Crit. End.
I	Dioscorea orbiculata var. tenuifolia	Dioscoreaceae	Rediscovered
I	Uncaria sp. 3	Rubiaceae	#N/A
I	Campnosperma auriculatum	Anacardiaceae	Common
I	Calophyllum sp.	Calophyllaceae	#N/A
I	Lindera lucida	Lauraceae	Vulnerable
I	Ficus grossularioides var. grossularioides	Moraceae	Common
I	Dalbergia sp.	Fabaceae	#N/A
I	Elaeocarpus salicifolius	Elaeocarpaceae	Vulnerable
I	Litsea castanea	Lauraceae	Endangered
I	Senna sp.	Fabaceae	#N/A
I	Argyreia nervosa	Convolvulaceae	Cultivated only
I	Tetracera sp.	Dilleniaceae	#N/A
I	Bidens alba	Asteraceae	Cultivated only
J	Dyera costulata	Apocynaceae	Common
J	Entada spiralis	Fabaceae	Common
J	Mikania micrantha	Asteraceae	Naturalized
J	Asystasia gangetica ssp. micrantha	Acanthaceae	Naturalized
J	Cecropia pachystachya	Urticaceae	Naturalized
J	Saccharum sp.	Poaceae	#N/A
J	Spathodea campanulata	Bignoniaceae	Naturalized
J	Paederia foetida	Rubiaceae	Common
K	Syngonium podophyllum	Araceae	Naturalized
K	Claoxylon indicum	Euphorbiaceae	Common
K	Falcataria moluccana	Fabaceae	Naturalized
K	Centrosema sp.	Fabaceae	#N/A
K	Poikilospermum suaveolens	Urticaceae	Vulnerable
K	Bauhinia semibifida var. semibifida	Fabaceae	Vulnerable
K	Epipremnum aureum	Araceae	Casual
K	Ficus fistulosa	Moraceae	Common
K	Phytocrene bracteata	Icacinaceae	Vulnerable
K	Macaranga gigantea	Euphorbiaceae	Common
K	Caryota mitis	Arecaceae	Common
K	Acacia auriculiformis	Fabaceae	Naturalized
K	Centella asiatica	Apiaceae	Common
K	Ampelocissus sp.	Vitaceae	#N/A
K	Ipomoea sp.	Convolvulaceae	#N/A
K	Dracaena fragrans	Asparagaceae	Casual
K	Axonopus compressus	Poaceae	Naturalized
K	Clidemia hirta	Melastomataceae	Naturalized
K	Ficus sagittata	Moraceae	Crit. End.
K	Andira inermis	Fabaceae	Casual
K	Thunbergia grandiflora	Acanthaceae	Casual
K	Clerodendrum villosum	Lamiaceae	Vulnerable
K	Cinnamomum iners	Lauraceae	Common
K	Elaeis guineensis	Arecaceae	Casual
K	Ficus heteropleura	Moraceae	Common
K	Dillenia suffruticosa	Dilleniaceae	Common
K	Cissus hastata	Vitaceae	Common
K	Luvunga crassifolia	Rutaceae	Crit. End.
K	Xanthophyllum flavescens	Polygalaceae	Endangered
K	Ptychosperma macarthurii	Arecaceae	Naturalized
K	Asplenium nidus	Aspleniaceae	Common
K	Hoya latifolia	Apocynaceae	Endangered
K	Dendrobium crumenatum	Orchidaceae	Common
K	Davallia denticulata	Davalliaceae	Common
K	Adenanthera pavonina	Fabaceae	Naturalized
K	Spathodea campanulata	Bignoniaceae	Naturalized
K	Asystasia gangetica ssp. micrantha	Acanthaceae	Naturalized
K	Axonopus compressus	Poaceae	Naturalized
K	Elaeis guineensis	Arecaceae	Casual
K	Dracaena fragrans	Asparagaceae	Casual
L	Claoxylon indicum	Euphorbiaceae	Common
L	Areca catechu	Arecaceae	Casual

L	Vernonia cinerea	Asteraceae	Cryptogenic Weed
L	Syngonium podophyllum	Araceae	Naturalized
L	Ficus apiocarpa	Moraceae	Endangered
L	Piper betle	Piperaceae	Casual
L	Dioscorea sansibarensis	Dioscoreaceae	Naturalized
L	Caryota mitis	Arecaceae	Common
L	Alocasia macrorrhizos	Araceae	Naturalized
L	Sterculia rubiginosa	Malvaceae	Vulnerable
L	Aspidopterys concava	Malpighiaceae	Endangered
L	Fibraurea tinctoria	Menispermaceae	Common
L	Tetracera indica	Dilleniaceae	Common
L	Plectranthus monostachyus	Lamiaceae	Naturalized
L	Pilea microphylla	Urticaceae	Naturalized
L	Cinnamomum iners	Lauraceae	Common
L	Nephrolepis auriculata	Oleandraceae	Cryptogenic Weed
L	Arthrophyllum diversifolium	Araliaceae	Common
L	Syzygium grande	Myrtaceae	Common
L	Ficus heteropleura	Moraceae	Common
L	Ficus fistulosa	Moraceae	Common
L	Lygodium microphyllum	Schizaeaceae	Common
L	Clidemia hirta	Melastomataceae	Naturalized
L	Melastoma malabathricum	Melastomataceae	Common
L	Erycibe tomentosa	Convolvulaceae	Common
L	Dillenia suffruticosa	Dilleniaceae	Common
L	Piper sarmentosum	Piperaceae	Common
L	Poikilospermum suaveolens	Urticaceae	Vulnerable
L	Epipremnum aureum	Araceae	Casual
L	Archidendron clypearia	Fabaceae	Common
L	Artocarpus heterophyllus	Moraceae	Casual
L	Palaquium obovatum	Sapotaceae	Vulnerable
L	Timonius wallichianus	Rubiaceae	Common
L	Terminalia catappa	Combretaceae	Common
L	Hoya latifolia	Apocynaceae	Endangered
L	Mikania micrantha	Asteraceae	Naturalized
L	Phytocrene bracteata	Icacinaceae	Vulnerable
L	Clerodendrum inerme	Lamiaceae	Common
L	Andira inermis	Fabaceae	Casual
L	Cyclosorus sp.	Thelypteridaceae	#N/A
L	Dioscorea orbiculata var. tenuifolia	Dioscoreaceae	Rediscovered
L	Spatholobus ferrugineus	Fabaceae	Common
L	Ficus fistulosa	Moraceae	Common
L	Ventilago malaccensis	Rhamnaceae	Endangered
L	Dalbergia sp.	Fabaceae	#N/A
L	Willughbeia sp.	Apocynaceae	#N/A
L	Artocarpus elasticus	Moraceae	Common
L	Leea indica	Vitaceae	Common
L	Bauhinia kochiana	Fabaceae	Cultivated only
L	Centotheca lappacea	Poaceae	Crit. End.
L	Selaginella sp.	Selaginellaceae	#N/A
L	Cissus repens	Vitaceae	Endangered
L	Agelaea borneensis	Connaraceae	Vulnerable
L	Ficus globosa	Moraceae	Endangered
L	Muntingia calabura	Muntingiaceae	Naturalized
L	Melothria pendula	Cucurbitaceae	Naturalized
L	Cecropia pachystachya	Urticaceae	Naturalized
L	Syzygium borneense	Myrtaceae	Common
L	Horsfieldia sucosa	Myristicaceae	Endangered
L	Cratoxylum formosum	Hypericaceae	Endangered
L	Epipremnum pinnatum	Araceae	Crit. End.
L	Bridelia tomentosa	Phyllanthaceae	Common
L	Aporosa sp.	Phyllanthaceae	#N/A
L	Palaquium obovatum	Sapotaceae	Vulnerable
L	Ficus aurata var. aurata	Moraceae	Vulnerable
L	Lygodium sp.	Schizaeaceae	#N/A
L	Derris amoena var. maingayana	Fabaceae	Vulnerable
L	Bauhinia semibifida var. semibifida	Fabaceae	Vulnerable
L	Clerodendrum disparifolium	Lamiaceae	Common
L	Mallotus paniculatus	Euphorbiaceae	Common
L	Garcinia parvifolia	Clusiaceae	Common
L	Ardisia elliptica	Primulaceae	Endangered
L	Agelaea macrophylla	Connaraceae	Crit. End.
L	Kunstleria ridleyi	Fabaceae	Endangered
L	Anisophyllea disticha	Anisophyllaceae	Common
L	Asplenium nidus	Aspleniaceae	Common
L	Nephelium lappaceum	Sapindaceae	Crit. End. (but not of native provenance)
L	Ficus punctata	Moraceae	Common
L	Microsorum punctatum	Polypodiaceae	Common
L	Gironniera nervosa	Cannabaceae	Common
L	Ixonanthes icosandra	Ixonanthaceae	Vulnerable
L	Dieffenbachia seguine var. seguine	Araceae	Casual
L	Gynochthodes coriacea	Rubiaceae	Vulnerable
L	Aquilaria sp.	Thymelaeaceae	#N/A
L	Elaeocarpus petiolatus	Elaeocarpaceae	Common
L	Acalypha indica	Euphorbiaceae	Cryptogenic Weed
L	Philodendron hederaceum	Araceae	Casual
L	Manihot esculenta	Euphorbiaceae	Naturalized
L	Leucaena leucocephala	Fabaceae	Naturalized
L	Hevea brasiliensis	Euphorbiaceae	Naturalized
L	Oncosperma sp.	Arecaceae	#N/A
L	Syzygium polyanthum	Myrtaceae	Vulnerable
L	Coccinia grandis	Cucurbitaceae	Naturalized
L	Barringtonia racemosa	Lecythidaceae	Crit. End.

Appendix 6: List of all vascular plant species recorded in "Fragment 1" within the WRS zone.

Species	Family	National conservation status
Adenanthera malayana	Fabaceae	Vulnerable
Agelaea borneensis	Connaraceae	Vulnerable
Agelaea macrophylla	Connaraceae	Crit. End.
Agrostistachys borneensis	Euphorbiaceae	Common
Alocasia longiloba	Araceae	Common
Alseodaphne bancana	Lauraceae	Crit. End.
Ampelocissus gracilis	Vitaceae	Endangered
Anisophyllea disticha	Anisophyllaceae	Common
Anodendron candolleanum	Apocynaceae	Crit. End.
Antidesma cuspidatum	Phyllanthaceae	Common
Aporosa frutescens	Phyllanthaceae	Common
Aporosa lucida var. lucida	Phyllanthaceae	Crit. End.
Aporosa lunata	Phyllanthaceae	Crit. End.
Aporosa nervosa	Phyllanthaceae	Vulnerable
Aporosa symplocoides	Phyllanthaceae	Common
Archidendron clypearia	Fabaceae	Common
Ardisia sanguinolenta	Primulaceae	Common
Ardisia teysmanniana	Primulaceae	Endangered
Artabotrys maingayi	Annonaceae	Crit. End.
Arthrophyllum diversifolium	Araliaceae	Common
Artocarpus elasticus	Moraceae	Common
Aspidopterys concava	Malpighiaceae	Endangered
Baccaurea parviflora	Phyllanthaceae	Common
Bauhinia semibifida var. semibifida	Fabaceae	Vulnerable
Beilschmiedia kunstleri	Lauraceae	Crit. End.
Calophyllum tetrapterum	Calophyllaceae	Vulnerable
Calophyllum teysmannii	Calophyllaceae	Vulnerable
Calophyllum wallichianum var. incrassatum	Calophyllaceae	Vulnerable
Canarium pilosum	Burseraceae	Endangered
Chassalia sp.	Rubiaceae	#N/A
Cinnamomum iners	Lauraceae	Common
Clerodendrum disparifolium	Lamiaceae	Common
Clidemia hirta	Melastomataceae	Naturalized
Connarus semidecandrus	Connaraceae	Crit. End.
Coscinium fenestratum	Menispermaceae	Endangered
Croton oblongus	Euphorbiaceae	Endangered
Cryptocarya griffithiana	Lauraceae	Crit. End.
Dacryodes longifolia	Burseraceae	Crit. End.
Daemonorops sp.	Arecaceae	#N/A
Dasymaschalon dasymaschalum	Annonaceae	Crit. End.
Dialium platysepalum	Fabaceae	Crit. End.
Diospyros lanceifolia	Ebenaceae	Common
Dracaena cantleyi	Asparagaceae	Vulnerable
Durio singaporensis	Malvaceae	Vulnerable
Dysoxylum cauliflorum	Meliaceae	Vulnerable
Erycibe tomentosa	Convolvulaceae	Common
Fibraurea tinctoria	Menispermaceae	Common
Ficus globosa	Moraceae	Endangered
Ficus vasculosa	Moraceae	Endangered
Fissistigma latifolium var. ovoideum	Annonaceae	Vulnerable
Freycinetia javanica	Pandanaceae	Rediscovered
Friesodielsia latifolia	Annonaceae	Common
Galearia fulva	Pandaceae	Vulnerable
Garcinia parvifolia	Clusiaceae	Common
Gironniera nervosa	Cannabaceae	Common
Glycosmis chlorosperma var. chlorosperma	Rutaceae	Vulnerable
Gordonia multinervis	Theaceae	Endangered
Gynochthodes coriacea	Rubiaceae	Vulnerable
Gynotroches axillaris	Rhizophoraceae	Common
Horsfieldia polyspherula var. polyspherula	Myristicaceae	Vulnerable
Ixora congesta	Rubiaceae	Common
Knema communis	Myristicaceae	Endangered
Knema latericia ssp. Ridleyi	Myristicaceae	Endangered
Knema malayana	Myristicaceae	Endangered
Koilodepas longifolium	Euphorbiaceae	Vulnerable
Korthalsia sp.	Arecaceae	#N/A
Limacia scandens	Menispermaceae	Vulnerable
Litsea elliptica	Lauraceae	Common
Luvunga crassifolia	Rutaceae	Crit. End.
Macaranga gigantea	Euphorbiaceae	Common
Memecylon amplexicaule	Melastomataceae	Crit. End.
Memecylon lilacinum	Melastomataceae	Crit. End.
Monocarpia marginalis	Annonaceae	Vulnerable
Nauclea officinalis	Rubiaceae	Crit. End.
Osmelia philippina	Salicaceae	Endangered
Oxyceros bispinosus	Rubiaceae	Endangered
Palaquium obovatum	Sapotaceae	Vulnerable
Phaeanthus ophthalmicus	Annonaceae	Vulnerable
Phytocrene bracteata	Icacinaceae	Vulnerable
Pinanga malaiana	Arecaceae	Endangered
Piper flavimarginatum	Piperaceae	Crit. End.
Piper pedicellosum	Piperaceae	Crit. End.
Polyalthia rumphii	Annonaceae	Crit. End.
Popowia fusca	Annonaceae	Vulnerable
Porterandia anisophylla	Rubiaceae	Vulnerable
Psydrax sp. 10	Rubiaceae	Not Assessed
Pternandra coerulescens	Melastomataceae	Vulnerable
Rhodamnia cinerea	Myrtaceae	Common
Rothmannia macrophylla	Rubiaceae	Vulnerable
Rourea acutipetala ssp. acutipetala	Connaraceae	Rediscovered
Rourea asplenifolia	Connaraceae	Crit. End.
Salacia grandiflora	Celastraceae	Crit. End.
Santiria griffithii	Burseraceae	Common
Scorodocarpus borneensis	Olacaceae	Endangered
Shorea ovalis ssp. ovalis	Dipterocarpaceae	Crit. End.
Sterculia lanceolata var. coccinea	Malvaceae	Cultivated only

No. of species per conservation status category recorded overall from the area

Conservation status category	No. of species
Critically Endangered	26
Endangered	20
Vulnerable	31
Rediscovered	2
Extinct	1
Common	26
Naturalized	1
Casual	0
Cultivated only	1
Not Assessed	1
Total	**109**

Native	106
Of conservation significance	80
Non-native	2
Not Assessed	1

Sterculia rubiginosa	Malvaceae	Vulnerable
Strombosia ceylanica	Olacaceae	Vulnerable
Syzygium borneense	Myrtaceae	Common
Syzygium chloranthum	Myrtaceae	Crit. End.
Syzygium filiforme var. filiforme	Myrtaceae	Endangered
Syzygium glabratum	Myrtaceae	Extinct
Syzygium pseudoformosum	Myrtaceae	Crit. End.
Syzygium ridleyi	Myrtaceae	Endangered
Tabernaemontana corymbosa	Apocynaceae	Endangered
Tetracera fagifolia	Dilleniaceae	Vulnerable
Tetracera macrophylla	Dilleniaceae	Vulnerable
Tinospora macrocarpa	Menispermaceae	Crit. End.
Uncaria longiflora var. pteropoda	Rubiaceae	Crit. End.
Uncaria sp.	Rubiaceae	#N/A
Ventilago malaccensis	Rhamnaceae	Endangered
Xanthophyllum eurhynchum	Polygalaceae	Vulnerable
Ziziphus calophylla	Rhamnaceae	Vulnerable

Annex 14.2

Terrestrial

MANDAI TERRESTRIAL FAUNA REPORT 2015

Subaraj Rajathurai

INTRODUCTION

For the purpose of an Environmental Impact Assessment (EIA) of the Mandai Project site and its surroundings, a Biodiversity Study was commissioned by the Environmental Consultant, Environmental Resource Management (ERM) for Temasek Holdings. My small team took on the study of most of the terrestrial fauna groups, including the vertebrates (birds, mammals, reptiles, amphibians) and selected indicator invertebrates (butterflies, odonates). These groups are considered indicators of habitats. Additionally, I led the rest of the biodiversity study team, which comprised of individuals and small teams conducting studies on other invertebrates, flora, fresh-water fauna.

A brief baseline biodiversity study in 2014 had only covered the 2 project parcels (development site north and south of Mandai Lake Road) and the immediate surroundings. The baseline checklist of species reflected only the area of coverage.

The current study area has been expanded to include the rest of the Seletar North Peninsula and Wildlife Reserves Singapore areas of the zoo and night safari grounds and adjacent parcels. These are part of the main study but a limited coverage of the Ulu Sembawang Forest (CCNR) was also undertaken by my team.

There are additional past studies of the study area and surroundings, including past project studies carried out in 2007/08.

SCOPE OF STUDY

i To carry out monthly diurnal field surveys at all 6 sites to determine current faunal diversity, density and their distribution. Vertebrates (mammals, birds and herptiles) butterflies and odonates will be covered. This will be a year-long study that will continue beyond this report.

ii To carry out extra research of the 6 sites and fringe areas such as Ulu Sembawang, to obtain additional information about the species diversity and distribution. This will include nocturnal studies that may include mist-netting and harping, as well as afternoon herptiles surveys.

iii To conduct desktop research of past data for the area, to boost our current knowledge of the fauna at Mandai.

iv To study probable wildlife movement and foraging areas, so as to determine how we can minimise any impact from proposed development and suggest possible mitigations.

STUDY EFFORT

- A transect across each of the 6 main parcels (A, B, D, E, F, G) were surveyed on one morning each month.
- Additional parcel H was covered more sporadically with one transect and one point count.
- Additional diurnal point counts were carried out adjacent to Area A and Area B.
- A nocturnal study was carried out once at each of the 7 zones and involved nocturnal transects, spot sampling and mist-netting. Additionally, harp trapping was carried out twice.
- Afternoon herp studies were carried out at all zones, at least once at each zone.
- Desk-top research, though limited for these areas, was carried out but limited to fairly recent records.

STUDY METHODOLOGY

For the field work, observation surveys were carried out, using transects, point counts, spot sampling and casual sightings, while nocturnal studies included mist-netting and occasional harp-trapping. The nocturnal studies commenced in daylight to facilitate the setting up of mist-nets, with actual bat observations commencing at dusk. As a result diurnal species were also seen and/or heard. Most data listed is from 1900 hrs. All vertebrates, butterflies and dragonflies encountered, by sight or sound, were documented and counted. Where possible, photos were also taken.

Research work was also carried out to derive data obtained for the area during the NParks Nature Reserve Survey (1993 – 1997) and baseline & specific studies conducted in 2007 and 2014. This would provide comparative data but, more importantly, a more complete picture.

FINDINGS OF STUDY

Much interesting and important data has been obtained and this is reflected here to update our existing knowledge of this area. Additionally, this current study also includes population counts, which was not done during previous surveys.

I have collated the data obtained in a series of tables below, along with an up-dated checklist of species from the various groups studied. This checklist is carefully designed to also show-case as much information as possible; in particular, the status and habitat dependence of many important animals.

Thus far, **447**species of animals, from the fauna groups studied, have been documented within the area of coverage including species only recorded in 2014). This total includes **130** birds, **28** mammals, **57** reptiles, **17** amphibians, **170** butterflies and **45** odonates. This is quite an impressive variety but more are expected to be added during the coming months.

During the current study, **29** species were added to the original interim baseline checklist, including **4** birds, **1** mammal, **21** reptiles and **3** butterflies. The inclusion of the WRS attractions grounds and the Ulu Sembawang forest did continue to contribute some of these new records but the original area also produced few surprises missed previously.

Of the 447 species on record, **168** may be considered **National Threatened/Near-Threatened**. This includes **32** birds, **12** mammals, **26** reptiles, **3** amphibians, **82** butterflies and **13** odonates. The Singapore Red Data book (2nd Edition, 2008) lists **28** of these animals as **Critically Endangered (CR)** with **20** others listed as **Endangered (EN)** and **18** more listed as **Vulnerable (VU)**. For the butterflies, **5** more are listed as being **Data Deficient**

(DD), while there are **3** species that were listed as Nationally Extinct but were subsequently rediscovered here.

There are **9** animals recorded here that are considered **Globally Threatened/Near-Threatened**. They are ***Grey-headed Fish-Eagle, Masked Finfoot, Blue-rumped Parrot, Red-crowned Barbet, Mangrove Pitta, Straw-headed Bulbul, Sunda Pangolin, Sunda Slow Loris*** and ***Banded Leaf Monkey***. Most are residents though the pitta and parrot are believed to be mere visitors to Mandai. The only migrant is the finfoot. Additionally, although mere free-ranging species from the zoo, both stork species are considered Globally Threatened too.

In terms of habitat specialisation and dependence, **122** species (**19** birds, **8** mammals, **14** reptiles, **6** amphibians, **68** butterflies and **7** odonates) may be considered Forest Specialists while **80** more (**38** birds, **5** mammals, **13** reptiles, **1** amphibian, **22** butterflies and **1** odonate can be regarded as Woodland Dependent. **65** species (**15** birds, **1** mammal, **8** reptiles, **8** amphibians and **33** odonates) are Aquatic Dependent and **42** species (**11** birds, **1** mammal, **2** reptiles, **2** amphibians, **1** odonate and **33** butterflies) are Grassland Dependent.

As the vertebrates and selected invertebrate groups like the butterflies and odonates are all good indicator groups of habitat quality, additional studies were carried out and a few like the monthly diurnal transects will only end in February 2016 to cover a full one year. Nocturnal studies, including temporarily capturing bats through mist-netting and harping, as well as afternoon herping were also carried out along with additional transect and observations.

Yeo Suay Hwee has written brief reports of the odonate and butterfly studies, while Serin Subaraj has done the same for the herptile study. These are attached separately. I am left with the task of focusing on the mammals and birds, both highly sensitive higher animal groups that are easily impacted upon.

Mammals

28 mammal species have been recorded within the study area so far and of these, **12** are actually **Locally Threatened/Near-Threatened.** Half of these threatened/near-threatened are listed as **Critically Endangered** in the Singapore Red Data Book and are highly vulnerable to any form of impact within their territories, which can lead to local extinction.

Except for some bats, all mammals are highly vulnerable to fragmentation of habitat due to development and many end up as roadkill while trying to bridge the gaps or seeking better foraging grounds. In and around the Mandai area, several such tragedies have occurred, involving species such as the **Globally Threatened** Sunda Pangolin, the Sambar Deer and many smaller animals, including rodents and snakes.

Most animals, including the mammals have been dependent on the various existing corridors that run through Zones B and D, as well as Zone C, to connect between the nature reserve areas east and west of Mandai Lake Road. As developments and road widening comes to this

area, it is vital that complete solutions for all species must be resolved if we are to avoid a complete loss of biodiversity in the area, and maybe Singapore.

BIRDS

The Mandai area is rather rich in birdlife and **130** species have been recorded so far. More should be added with surveys continuing through this migratory period, and with future studies. Presently **32** are considered **Locally Threatened/Near Threatened. 6** birds of the area are considered **Globally Threatened**.

While many birds are able to cross gaps like roads, development and clearings through flight, there are some species of the lower story that are also prone to genetic isolation due to their weak flight resistricting lengthy movements. This includes species such as the Short-tailed and Abbott's Babblers. Like many mammals and reptiles, these species may only be saved by very specific wildlife corridors and crossings.

DISCUSSION

The discussion about the development of Zone B and D in Mandai has been going on for some time and I have been involved since 2007. While it is fully understood that both parcels are just outside the Central Catchment Nature Reserve, their proximity to the reserve complicates matters quite a bit as any kind of development has to be highly sensitive toward the neighbours.

The former Mandai Orchid Garden allowed squatter farming outside her boundaries and this virtually degraded or removed any forested nature reserve connection for fauna attempting to move through the very narrow corridor that links the reserve east and west of Mandai Lake Road. How such a narrow corridor is all that is left as a nature reserve linkage is a worthy debate for another day!

The abandonment of old farming areas, use for military training, presence of pockets of mature forest within the reserve peninsulas and night safari grounds has allowed wildlife to determine their own series of wild corridors. These include a secondary growth/old agriculture belt through Zone D and another through the military training area at Zone C. These terrestrial wooded corridors are important for both diurnal and nocturnal species.

Additional wildlife movement follows the main stream along the Project western boundary and connects under the Mandai Lake Road.The planned widening of the Mandai Lake Road will result in a major obstacle for many animals to connect and the planning of the right wildlife crossings, to connect to wildlife corridors on either side, is vital. A 2nd precaution is to ensure the substantial slow-down of traffic speed along the Mandai Lake Road as this runs through what is to be known as the Nature Cluster. At the end of the day, it does not matter whether we are saving native or exotic species....we are also saving ourselves.

It is also important to note that the survival of such a varied biodiversity here has been due to the mix of habitats (mature & secondary rainforest, woodland, old agriculture, grassland, scrub, parkland....etc). Most animals here have survived by using all available habitats and food resources, rather than just the good habitat. Some of the animals have good movement ranges, for their size, but are dependent on good connectivity rather than just quality of habitat.

MANDAI PROJECT AREA - Survey Data Sheets (Vertebrates, Odonates & Butterflies)

Subaraj Rajathurai

Appendix 1 : Diurnal Transects

Zone A – Upper Seletar Peninsula (Central Catchment Nature Reserve) Transect

	Bold Print – Locally Threatened	Bold Print & Capital Lettering – Internationally Threatened								
			Mar	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
No	**Common Names**	**Latin Names**	**31st**	**27th**	**20th**	**29th**	**22nd**	**26th**	**23rd**	**15th**
	Birds									
1	Grey Heron	*Ardea cinerea*	1							
2	**Purple Heron**	*Ardea purpurea*			2					
3	Brahminy Kite	*Haliastur indus*					1		1	
4	White-bellied Sea-Eagle	*Haliaeetus leucogaster*				2		2	2	
5	**GREY-HEADED FISH-EAGLE**	*Ichthyophaga ichthyaetus*	1	1			2	2	2	2
6	**Changeable Hawk-Eagle**	*Nisaetus limnaeetus*	1	1	2			1	1	1
7	**"Red Junglefowl"**	*Gallus gallus*							1	1
8	**Thick-billed Green-Pigeon**	*Treron curvirostra*				1				
9	Pink-necked Green-Pigeon	*Treron vernans*		4	6	2	4	2	1	2
10	Spotted Dove	*Streptopelia chinensis*				1				1
11	**Emerald Dove**	*Chalcophaps indica*	1	1		1	3			1
12	Rose-ringed Parakeet	*Psittacula krameri*						10	6	16
13	Long-tailed Parakeet	*Psittacula longicauda*			6	4	5			
14	**Banded Bay Cuckoo**	*Cacomantis sonneratii*	1							
15	**Plaintive Cuckoo**	*Cacomantis merulinus*				1				
16	**Violet Cuckoo**	*Chrysococcyx xanthorhynchus*	1		1	2	1			

17	**Drongo Cuckoo**	*Surniculus lugubris*	1		1	2				
18	Asian Koel	*Eudynamys scolopacea*								1
19	**Buffy Fish Owl**	*Ketupa ketupu*				2				
20	Germain's Swiftlet	*Aerodramus germani*			4	6	5			
21	**Blue-eared Kingfisher**	*Alcedo meninting*	1		3			1	3	
22	Stork-billed Kingfisher	*Halcyon capensis*	2	1	2	2	1	1	1	1
23	White-throated Kingfisher	*Halcyon smyrnensis*				1		1	2	1
24	Blue-tailed Bee-eater	*Merops philippinus*								6
25	Blue-throated Bee-eater	*Merops viridis*				2		2	4	
26	**Dollarbird**	*Eurystomus orientalis*		1						
27	**RED-CROWNED BARBET**	*Megalaima rafflesii*	1					1		
28	**Rufous Woodpecker**	*Micropternus brachyurus*	1							
29	Banded Woodpecker	*Chrysophelgma miniaceus*		2	2	2				
30	Common Flameback	*Dinopium javanense*	1	1		2				
31	**MANGROVE PITTA**	*Pitta megarhyncha*							1	
32	House Swallow	*Hirundo tahitica*			2		2		2	2
33	**Blue-winged Leafbird**	*Chloropsis cochinchinensis*	1	1	1	1		1		1
34	**STRAW-HEADED BULBUL**	*Pycnonotus zeylanicus*	1		1	1		1	1	2
35	Yellow-vented Bulbul	*Pycnonotus goiavier*						1		
36	Olive-winged Bulbul	*Pycnonotus plumosus*	4		9	4	6	10	9	8
37	Cream-vented Bulbul	*Pycnonotus simplex*		1	1			4	6	
38	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	2		1	3	4	4	6	4
39	Asian Fairy-Bluebird	*Irena puella*						2	3	1
40	Southern Jungle Crow	*Corvus macrorhynchos*					1			1
41	Short-tailed Babbler	*Malacocincla malaccensis*	1	1	1	1	2	2	2	
42	Pin-striped Tit-Babbler	*Macronous gularis*		1	10	7	8	12	14	5
43	Arctic Warbler	*Phylloscopus borealis*						1		
44	Dark-necked Tailorbird	*Orthotomus atrogularis*	2	1	1	4	4	10	12	7
45	Rufous-tailed Tailorbird	*Orthotomus sericeus*		1	1	2	1	1		
46	Forest Wagtail	*Dendronanthus indicus*								2
47	Asian Glossy Starling	*Aplonis panayensis*	6		5	1	9	3	4	1

48	Javan Myna	*Acridotheres javanicus*		5		1		4	2	1
49	**Common Hill Myna**	*Gracula religiosa*		1	1	1	2		5	3
50	Brown-throated Sunbird	*Anthrepetes malacensis*			2					
51	Van Hasselt's Sunbird	*Leptocoma brasiliana*				2	2	7	8	3
52	Crimson Sunbird	*Aethopyga siparaja*	1	1		3			2	
53	Little Spiderhunter	*Arachnothera longirostra*	1	2						
54	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	1	1	1	2	5	7	4	8
	Mammals									
1	Common Treeshrew	*Tupaia glis*	3	2	4	4	2	4		4
2	**Banded Leaf Monkey**	*Presbytis femoralis*		1	1	2			2	
3	Long-tailed Macaque	*Macaca fascicularis*	3							
4	Plantain Squirrel	*Callosciurus notatus*	3	4	5	3	2	4	5	2
5	Slender Squirrel	*Sundasciurus tenuis*	3	1	2	1	2	5	3	3
6	Wild Boar	*Sus scrofa*		1			1			3
7	**Lesser Mousedeer**	*Tragulus kanchil*		1?						
8	**Sambar Deer**	*Rasa unicolor*	1							
	Reptiles									
1	Malayan Water Monior	*Varanus salvator*	2	3	3	1	3	1		2
2	Common Sun Skink	*Eutropis multifasciatus*	4	2	3	3	2			2
3	Black Bearded Flying Dragon	*Draco melanopogon*								1
4	Red-eared Slider	*Trachemys scripta*		4	3	1				
	Amphibians									
1	Copper-cheeked Frog	*Hylarana labialis*				4				
2	**Lim's Black-spotted Sticky Frog**	*Kalophrynus limbooliati*				1				
	Dragonflies									

1	Ornate Coraltail	*Ceriagrion cerinorubellum*							1	
2	Common Blue Sprite	*Pseudagrion microcephalum*							2	
3	**Telephone Sylvan**	*Coeliccia octogesima*	1	1		1	4		2	
4	**Orange-striped Threadtail**	*Prodasineura humeralis*	15	20	25	20	13	15	27	13
5	Common Flangetail	*Ictinogomphus decoratus*	3	4	4	3	2		3	2
6	Dark-tipped Forest-skimmer	*Cratilla metallica*				1				
7	Scarlet Grenadier	*Lathrecista asiatica*	2							
8	Common Parasol	*Neurothemis fluctuans*						1		
9	Spine-tufted Skimmer	*Orthetrum chrysis*			2					
10	Scarlet Skimmer	*Orthetrum testaceum*	2							
11	**Banded Skimmer**	*Pseudothemis jorina*		5	10			1	3	2
12	Common Redbolt	*Rhodothemis rufa*	1							
13	**Sapphire Flutterer**	*Rhyothemis triangularis*								1
14	Dawn Dropwing	*Trithemis aurora*		3	6			2	1	1
15	Scarlet Basker	*Urothemis signata*		2			2			

Butterflies

1	Lime Butterfly	*Papilio demoleus malayanus*					1			
2	Common Mormon	*Papilio polytes romulus*	2		1					
3	Tailed Jay	*Graphium agamemnon agamemnon*	1							
4	Painted Jezebel	*Delias hyparete metarete*	1						1	
5	Lemon Emigrant	*Catopsilia pomona pomona*	2							
6	**Perseoides Bush Brown**	*Mycalese perseoides perseoides*			1					
7	Knight	*Lebadea martha parkeri*					1		1	
8	**Dot-Dash Sergeant**	*Athyma nefte subrata*					1			
9	Malay Viscount	*Tanaecia pelea pelea*	1							1

10	Archduke	*Lexias pardalis dirteana*	2							
11	Purple Duke	*Eulaceura osteria kumana*	1			3				
12	**Spotted Judy**	*Abisara geza niya*			1	1				
13	**Quaker**	*Neopithercops zalmora zalmora*	1							
14	**Sky Blue**	*Jamides caeruleus caeruleus*	1				5	2	2	
15	**Tailed Disc Oakblue**	*Arhopala atosia malayana*						1		
16	Branded Imperial	*Eooxylides tharis distanti*								1
17	**Pygmy Posy**	*Drupadia rufotaenia rufotaenia*					1			
18	**Spotted Flitter**	*Zographetus doxus*	1							
19	**Yellow Chequered Lancer**	*Plastingia pellonia*				1				

Zone B – Stephen Lee Woods Transect

	Bold Print – Locally Threatened	Bold Print & Capital Lettering – Internationally Threatened									
			Mar	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	
No	**Common Names**	**Latin Names**	**30th**	**28th**	**18th**	**30th**	**30th**	**24th**	**18th**	**17th**	
	Birds										
1	**Purple Heron**	*Ardea purpurea*	1	1							
2	Japanese Sparrowhawk	*Accipiter gularis*								1	
3	**Changeable Hawk-Eagle**	*Nisaetus limnaeetus*	2		1	2	1			2	
4	"Red Junglefowl"	*Gallus gallus*							1	1	
5	Pink-necked Green-Pigeon	*Treron vernans*	10	7	6	4	4	2	9	5	
6	Spotted Dove	*Streptopelia chinensis*	1	2	1	1			2	1	
7	**Emerald Dove**	*Chalcophaps indica*	4		6						
8	Long-tailed Parakeet	*Psittacula longicauda*	6			3	8	3	12	6	
9	**Banded Bay Cuckoo**	*Cacomantis sonneratii*	1		1						
10	Asian Koel	*Eudynamys scolopacea*		1		1					

11	**Chestnut-bellied Malkoha**	*Phaenicophaeus sumatranus*			3					3	
12	Lesser Coucal	*Centropus bengalensis*				1			1		
13	Collared Scops Owl	*Otus bakkamoena*								2	
14	Germain's Swiftlet	*Aerodramus germane*			10	14	10		10	3	
15	White-throated Kingfisher	*Halcyon smyrnensis*	2	1		2					
16	Blue-throated Bee-eater	*Merops viridis*							6		
17	**Dollarbird**	*Eurystomus orientalis*	1				1				
18	**RED-CROWNED BARBET**	*Megalaima rafflesii*								2	
19	Laced Woodpecker	*Picus vittatus*	1				1		1		
20	Banded Woodpecker	*Chrysophelgma miniaceus*		1	1	1	1	3		4	
21	Common Flameback	*Dinopium javanense*		1	1	4	2		2	1	
22	House Swallow	*Hirundo tahitica*				3			2		
23	Common Iora	*Aegithina tiphia*	2		1		2				
24	**Blue-winged Leafbird**	*Chloropsis cochinchinensis*						1			
25	**STRAW-HEADED BULBUL**	*Pycnonotus zeylanicus*	2	1	1	1	2	2	4	2	
26	Yellow-vented Bulbul	*Pycnonotus goiavier*	3	1	1			1			
27	Olive-winged Bulbul	*Pycnonotus plumosus*	6	1	1	1	10	10	7	3	
28	Cream-vented Bulbul	*Pycnonotus simplex*						1			
29	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	3		3		9	8	7	6	
30	Black-naped Oriole	*Oriolus chinensis*	1		2	2	7	5	5	2	
31	Asian Fairy-Bluebird	*Irena puella*								1	
32	Southern Jungle Crow	*Corvus macrorhynchos*					1				
33	**Abbott's Babbler**	*Malacocincla abbotti*	1	1	1	1	2	2	3	2	
34	Pin-striped Tit-Babbler	*Macronous gularis*	5	1	1	1	4	6	6	1	
35	White-crested Laughingthrush	*Garrulax leucolophus*	5				2	6	10	4	
36	Siberian Blue Robin	*Luscinia cyane*								1	
27	Common Tailorbird	*Orthotomus sutorius*					2			1	
38	Dark-necked Tailorbird	*Orthotomus atrogularis*	1		1	1	2	4	4	2	
39	Rufous-tailed Tailorbird	*Orthotomus sericeus*	1		1	1	4	2	3	2	
40	Forest Wagtail	*Dendronanthus indicus*								1	

41	Tiger Shrike	*Lanius tigrinus*						1		2	
42	Asian Glossy Starling	*Aplonis panayensis*	20	15	4	5	30	3	12	23	
43	Javan Myna	*Acridotheres javanicus*	20	6		1	8	2	5	9	
44	**Common Hill Myna**	*Gracula religiosa*	1	1				2			
45	Brown-throated Sunbird	*Anthrepetes malacensis*			2						
46	Crimson Sunbird	*Aethopyga siparaja*	2	1	1	2	3	5	4	4	
47	Little Spiderhunter	*Arachnothera longirostra*	1	1	1	1		4	5	1	
48	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	3	1	1		1		2	4	
	Mammals										
1	Common Treeshrew	*Tupaia glis*	2	1		1	2	7	1	3	
2	Malayan Colugo	*Galeopterus variegatus*			1						
3	Long-tailed Macaque	*Macaca fascicularis*			1	5	1		12	2	
4	Plantain Squirrel	*Callosciurus notatus*	2	5	4	3	8	7	5	12	
5	Slender Squirrel	*Sundasciurus tenuis*	2	2	2	5	6	4	1	7	
6	Wild Boar	*Sus scrofa*	1							3	
7	**Sambar Deer**	*Rasa unicolor*	(1)					1			
	Reptiles										
1	Common Flying Dragon	*Draco sumatranus*								1	
2	Malayan Box Terrapin	*Cuora amboinensis*				2					
	Amphibians										
1	Common Tree Frog	*Polypedates leucomystax*	10T								
	Dragonflies										
1	**Spoon-tailed Duskhawker**	*Gynacantha basiguttata*						1			
2	**Grenadier**	*Agrionoptera insignis*			1						
3	**Handsome Grenadier**	*Agrionoptera sexlineata*		1			1	1	1		

4	Dark-tipped Forest-skimmer	*Cratilla metallica*	1		1	4		5	2	3	
5	Scarlet Grenadier	*Lathrecista asiatica*	2				1				
6	Common Parasol	*Neurothemis fluctuans*	4	2	1	2	1		1		
7	Spine-tufted Skimmer	*Orthetrum chrysis*					1				
8	Common Blue Skimmer	*Orthetrum glaucum*				2	1				
9	Scarlet Skimmer	*Orthetrum testaceum*	2			1	1		1		
10	Wandering Glider	*Pantala flavescens*								25	
11	**Banded Skimmer**	*Pseudothemis jorina*	3		4		2				
12	Yellow-barred Flutterer	*Rhyothemis phyllis*	4	3			3				
13	White-barred Duskhawk	*Tholymis tillarga*						2	1	12	
14	Dawn Dropwing	*Trithemis aurora*	2								
15	Scarlet Basker	*Urothemis signata*				1					

Butterflies

1	Common Mormon	*Papilio polytes romulus*	4	4	3		4		3	3	
2	Great Mormon	*Papilio memnon agenor*				2					
3	Common Bluebottle	*Graphium sarpedon luctatius*					1				
4	Painted Jezebel	*Delias hyparete metarete*	2	2	1						
5	Lemon Emigrant	*Catopsilia pomona pomona*	1	1		1					
6	**Anderson's Grass Yellow**	*Eurema andersonii andersonii*				1					
7	Chocolate Grass Yellow	*Eurema sari sodalis*			1	2	15		3	2	
8	**Common Evening Brown**	*Melanitis leda leda*				1					
9	Common Palmfly	*Elymnias hypermnestra agina*					1				
10	Dingy Bush Brown	*Mycalesis perseus cepheus*	2			1		4	2	2	
11	**Perseoides Bush Brown**	*Mycalese perseoides perseoides*				4	5	2			
12	Dark Brand Bush Brown	*Mycalesis mineus*		3		2	2		2		

		macromalayana									
13	**Long Brand Bush Brown**	*Mycalesis visala phamis*		2	3		5				
14	Dark Grass Brown	*Orsotriaena medus cinerea*		1	2	6					
15	Common Faun	*Faunis canens arcesilas*		2			1		1	1	
16	Malayan Eggfly	*Hypolimnas anomala anomala*	1		1	1					
17	Chocolate Pansy	*Junonia hedonia ida*	5	2	2		1			1	
18	Leopard	*Phalanta phalantha phalantha*	3								
19	**Dot-Dash Sergeant**	*Athyma nefte subrata*					1				
20	Malay Viscount	*Tanaecia pelea pelea*					1				
21	Horsfield's Baron	*Tanaecia iapis puseda*				3				1	
22	Baron	*Euthalia aconthea gurda*				1					
23	Archduke	*Lexias pardalis dirteana*			3	1			2		
24	Purple Duke	*Eulaceura osteria kumana*			1		1				
25	Bigg's Brownwing	*Miletus biggsii biggsii*				1					
26	**Plain PlushBlue**	*Flos apidanus saturatus*		1							
27	Chestnut Bob	*Iambrix salsala salsala*		1		1					
28	Palm Bob	*Suastus gremius*		1			6				
29	Banded Demon	*Notocrypta paralysos*						2	1		
30	Lesser Dart	*Potanthus omaha omaha*						2			
31	Contiguous Swift	*Polytremis lubricans lubricans*			1	3					
32	**Full Stop Swift**	*Caltoris cormasa*		1		1					

Zone D –Unnamed Road Along Project Western Boundary Open Country Transect

	Bold Print – Locally Threatened	Bold Print & Capital Lettering – Internationally Threatened								

	Blue – Addition to site	? – Spoor only								
			Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
No	**Common Names**	**Latin Names**	**28th**	**26th**	**16th**	**23rd**	**16th**	**29th**	**16th**	**17th**
	Birds									
1	**Purple Heron**	*Ardea purpurea*	3	3	1	2				
2	Oriental Honey Buzzard	*Pernis ptilorhynchus*								1
3	Brahminy Kite	*Haliastur indus*				3	1			
4	White-bellied Sea-Eagle	*Haliaeetus leucogaster*		2		1				1
5	**GREY-HEADED FISH-EAGLE**	*Ichthyophaga ichthyaetus*						1		
6	Japanese Sparrowhawk	*Accipiter gularis*	2							
7	**Changeable Hawk-Eagle**	*Nisaetus limnaeetus*	1	2	2	1	1	2	1	1
8	**"Red Junglefowl"**	*Gallus gallus*						2		1
9	Slaty-breasted Rail	*Gallirallus striatus*	1						1	
10	Red-legged Crake	*Rallina fasciata*								1
11	White-breasted Waterhen	*Amaurornis phoenicurus*	1				1		1	
12	Pintail Snipe	*Gallinago stenura*	1							
13	**Thick-billed Green-Pigeon**	*Treron curvirostra*	1	2	2					
14	Pink-necked Green-Pigeon	*Treron vernans*	15	57	26	28	29	41	24	7
15	Spotted Dove	*Streptopelia chinensis*	13	8	4	7	5	6	7	7
16	Zebra Dove	*Geopelia striata*	3	8	3	1	5	1	3	
17	**Emerald Dove**	*Chalcophaps indica*	1	1	2	1	1			1
18	Red-breasted Parakeet	*Psittacula alexandri*	8	7						
19	Long-tailed Parakeet	*Psittacula longicauda*	9	9	5	4	57	5	10	12
20	**Blue-crowned Hanging Parrot**	*Loriculus galgulus*		1		2	1	2		
21	**Banded Bay Cuckoo**	*Cacomantis sonneratii*	2	2	2					
22	**Violet Cuckoo**	*Chrysococcyx xanthorhynchus*		1		1	1			
23	**Drongo Cuckoo**	*Surniculus lugubris*		1						
24	Asian Koel	*Eudynamys scolopacea*	1	2					1	
25	**Chestnut-bellied Malkoha**	*Phaenicophaeus sumatranus*				1	1	1		
26	**Greater Coucal**	*Centropus sinensis*			1		1			

27	Lesser Coucal	*Centropus bengalensis*		1	2	2	2	4	1	1
28	Germain's Swiftlet	*Aerodramus germani*	22	8	21	32	30	88	34	62
29	Black-Nest Swiftlet	*Aerodramus maximus*					1			
30	Himalayan Swiftlet	*Aerodramus brevirostris*	16						5	
31	Stork-billed Kingfisher	*Halcyon capensis*		1						
32	White-throated Kingfisher	*Halcyon smyrnensis*	1	1	2	1	1	2		3
33	Collared Kingfisher	*Todiramphus chloris*	3	4	2	2	3			
34	Blue-throated Bee-eater	*Merops viridis*	5		4		2	1	2	1
35	**Dollarbird**	*Eurystomus orientalis*	2			1	2			
36	**RED-CROWNED BARBET**	*Megalaima rafflesii*		2			1			
37	Lineated Barbet	*Megalaima lineata*	1							
38	Laced Woodpecker	*Picus vittatus*	1	1	1	2	1	1		2
39	Banded Woodpecker	*Chrysophelgma miniaceus*	3	1	1		3	2	3	1
40	Common Flameback	*Dinopium javanense*	3	2	4	3	2	1	3	3
41	Sunda Pygmy Woodpecker	*Dendrocopus moluccensis*						1		
42	**MANGROVE PITTA**	*Pitta megarhyncha*			1					
43	Barn Swallow	*Hirundo rustica*	3						4	
44	House Swallow	*Hirundo tahitica*	2		2	4	2	3	3	2
45	Pied Triller	*Lalage nigra*	2							
46	Ashy Minivet	*Pericrocotus divaricatus*	2							
47	Common Iora	*Aegithina tiphia*	10	16	12	8	18	24	13	5
48	**STRAW-HEADED BULBUL**	*Pycnonotus zeylanicus*	9	4	4	2	5	8	3	4
49	Red-whiskered Bulbul	*Pycnonotus jocosus*	2							
50	Yellow-vented Bulbul	*Pycnonotus goiavier*	5	17	14	10	14	4	24	10
51	Olive-winged Bulbul	*Pycnonotus plumosus*	13	16	6	10	12	4	12	3
52	Cream-vented Bulbul	*Pycnonotus simplex*					2	1	2	
53	**Red-eyed Bulbul**	*Pycnonotus brunneus*							2	
54	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	12	7	8	3	4	6	3	5
55	Black-naped Oriole	*Oriolus chinensis*	7	11	6	9	9	8	10	9
56	House Crow	*Corvus splendens*			1		2	10		
57	Southern Jungte Crow	*Corvus macrorhynchos*						1		

58	**Abbott's Babbler**	*Malacocincla abbotti*	1		3	1		2		
59	Pin-striped Tit-Babbler	*Macronous gularis*	4	12	9	2	10	5	2	3
60	**Oriental Magpie-Robin**	*Copsychus saularis*	1	4	2	1	3		2	
61	Arctic Warbler	*Phylloscopus borealis*	2							1
62	Common Tailorbird	*Orthotomus sutorius*	1	1	1	2	1	3	2	1
63	Dark-necked Tailorbird	*Orthotomus atrogularis*	2	4	3	7	9	7	6	6
64	Rufous-tailed Tailorbird	*Orthotomus sericeus*	2	3	2	2	7	4	3	1
65	Yellow-bellied Prinia	*Prinia flaviventris*				1	3		1	1
66	Asian Brown Flycatcher	*Muscicapa dauurica*	3							1
67	Forest Wagtail	*Dendronanthus indicus*	1							
68	Paddyfield Pipit	*Anthus rufulus*						1		
69	Brown Shrike	*Lanius cristatus*	1	1						3
70	Tiger Shrike	*Lanius tigrinus*							1	
71	Asian Glossy Starling	*Aplonis panayensis*	155	126	16	100	46	89	40	121
72	Javan Myna	*Acridotheres javanicus*	24	10	8	14	16	11	11	68
73	**Common Hill Myna**	*Gracula religiosa*	1	1		2	3	5	2	
74	Brown-throated Sunbird	*Anthrepetes malacensis*	1	3	5	3	5	2	2	2
75	Van Hasselt's Sunbird	*Leptocoma brasiliana*	2		1	1	2			
76	Olive-backed Sunbird	*Cinnyris jugularis*	2	1		3	3	2	6	1
77	Crimson Sunbird	*Aethopyga siparaja*	6	3	4	3	2	3	3	5
78	Little Spiderhunter	*Arachnothera longirostra*	2	1	3	1	4	3	4	2
79	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*		2		1	3	2	3	2
80	Scarlet-backed Flowerpecker	*Dicaeum cruentatum*	1	1	3		4	2	1	1
81	Oriental White-eye	*Zosterops palpebrosus*							2	
82	Baya Weaver	*Ploceus philippinus*	9	8	9	6	8	7	4	2
83	Scaly-breasted Munia	*Lonchura punctulata*					1		4	2
84	**Chestnut Munia**	*Lonchura atricapilla*	2	16	1	2	2			
E	**MILKY STORK**	*Mycteria cinerea*	1			3				
	Mammals									

1	Long-tailed Macaque	*Macaca fascicularis*				1	2			1
2	Plantain Squirrel	*Callosciurus notatus*	5	8	3	5	4	3	3	3
3	Slender Squirrel	*Sundasciurus tenuis*	1			3	2	3	4	1
4	**Common Palm Civet**	*Paradoxurus hermaphroditus*	?		?		?			
5	Wild Boar	*Sus scrofa*		1					6	
	Reptiles									
1	Painted Bronzeback	*Dendrelaphis pictus*			1	1				
2	Changeable Lizard	*Calotes versicolor*	1				1			2
	Amphibians									
1	Asian Toad	*Duttaphrynus melanostictus*			1					
2	Common Greenback	*Hylarana erythraea*	1							
3	Dark-sided Chorus Frog	*Microhyla heymonsi*		4						
	Dragonflies									
1	Common Flashwing	*Vestalis amethystina*			1	1				
2	Ornate Coraltail	*Ceriagrion cerinorubellum*	2		1					
3	Common Blue Sprite	*Pseudagrion microcephalum*		2			2	1	2	
4	**Grey Sprite**	*Pseudagrion pruinosum*			4	1	1		2	
5	Yellow Featherlegs	*Copera marginipes*		1	2		1			4
6	**Orange-striped Threadtail**	*Prodasineura humeralis*	3		14	1			3	2
7	Common Flangetail	*Ictinogomphus decoratus*	1		1	1				
8	Trumpet Tail	*Acisoma panorpoides*			1					
9	**Grenadier**	*Agrioptera insignis*						1		
10	Blue Dasher	*Brachydiplax chalybea*			1	2				
11	Common Scarlet	*Crocothemis servilia*	1							1
12	Scarlet Grenadier	*Lathrecista asiatica*	6		2					
13	Coastal Glider	*Macrodiplax cora*				3				
14	Common Parasol	*Neurothemis fluctuans*	5	2	14	12	8	3	2	1
15	Spine-tufted Skimmer	*Orthetrum chrysis*	2	2	4	2	2	6	3	1
16	Common Blue Skimmer	*Orthetrum glaucum*			1					

17	Slender Blue Skimmer	*Orthetrum luzonicum*	1	3	7	4	3	2	8	3
18	Scarlet Skimmer	*Orthetrum testaceum*	3		1	1	2	2		
19	Wandering Glider	*Pantala flavescens*	5		3		6		3	
20	**Banded Skimmer**	*Pseudothemis jorina*			1		1			
21	Yellow-barred Flutterer	*Rhyothemis phyllis*			1	4				
22	Saddlebag Glider	*Tramea transmarina*				1				
23	Dawn Dropwing	*Trithemis aurora*	6	2	5	8	2	4	3	10
24	Indigo Dropwing	*Trithemis festiva*	1	2	1	2	1		1	1

Butterflies

1	Common Mormon	*Papilio polytes romulus*	3	2	7	4	4	2	5	1
2	Painted Jezebel	*Delias hyparete metarete*	3	2	3	1			4	
3	Psyche	*Leptosia nina malayana*	1		4	2	1			
4	Striped Albatross	*Appias libythea olferna*			1	2			1	1
5	Lemon Emigrant	*Catopsilia pomona pomona*	1		7	5	6			2
6	Grass Yellow	*Eurema sp.*	4	4	2	10	8	4	9	5
7	Blue Glassy Tiger	*Ideopsis vulgaris macrina*			1	1	1			
8	Striped Blue Crow	*Euploea mulciber mulciber*			1		1			1
9	**Common Evening Brown**	*Melanitis leda leda*	1							
10	**Tawny Palmfly**	*Elymnias panthera panthera*		1	3					
11	Common Palmfly	*Elymnias hypermnestra agina*			3		3			
12	Dingy Bush Brown	*Mycalesis perseus*	1							
13	Bush Brown	*Mycalesis sp.*	4	8	12	3	13	16	7	2
14	Dark Grass Brown	*Orsotriaena medus cinerea*	5	4	1	8	24	45	15	23
15	Ring	*Ypthima sp.*		1						
16	**Palm King**	*Amathusia phidippus phidippus*						1		
17	Malayan Eggfly	*Hypolimnas anomala anomala*			1					1
18	Chocolate Pansy	*Junonia hedonia ida*	2	1	1	7	4		1	2

19	**Grey Pansy**	*Junonia atlites atlites*			6	2				
20	Peacock Pansy	*Junonia almana javana*			1	1				
21	Tawny Coster	*Acraea violae*					1			
22	Leopard	*Phalanta phalantha phalantha*			1					
23	Sailor sp.	*?*	1		2	2	4	2	3	1
24	Horfield's Baron	*Tanaecia iapis puseda*					1			
25	Pale Mottle	*Logania marmorata*		1						
26	Lesser Grass Blue	*Zizina otis lampa*		2						
27	Pygmy Grass Blue	*Zizula hylax pygmaea*			1					
28	Gram Blue	*Euchrysops cnejus cnejus*	2							
29	Common Caerulean	*Jamides celeno aelianus*	1	1	1		1			
	Blue sp.	*?*		1						
30	Chestnut Bob	*Iambrix salsala salsala*		4	2	1		2	2	1
31	Chocolate Demon	*Ancistroides nigrita maura*						1		1
32	Banded Demon	*Notocrypta paralysos*	1	2	3	1	1	3	1	3
33	**Grass Demon**	*Udaspes folus*		2		1		1	1	1
34	Lesser Dart	*Potanthus omaha omaha*	2	1	1	1	1		2	
35	Formosan Swift	*Borbo cinnara*	1					1		
36	Small Branded Swift	*Pelopidas mathias mathias*						1		
	Skipper sp.	?				1		1		

Zone E – Mandai Range Forest (Central Catchment Nature Reserve) Transect

	Bold Print – Locally Threatened	Bold Print & Capital Lettering – Internationally Threatened								
			Mar	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
No	**Common Names**	**Latin Names**	**31st**	**25th**	**16th**	**29th**	**17th**	**8th**	**2nd**	**17th**
	Birds									
1	**Purple Heron**	*Ardea purpurea*	3	1	6	3		3	2	4
2	Eastern Cattle Egret	*Bubulcus coromandus*								1
3	Oriental Honey Buzzard	*Pernis ptilorhyncus*								1

4	Brahminy Kite	*Haliastur indus*					1		1	2
5	White-bellied Sea-Eagle	*Haliaeetus leucogaster*		1		2		1	2	1
6	**GREY-HEADED FISH-EAGLE**	*Ichthyophaga ichthyaetus*		1		1	1	2	1	1
7	**Crested Serpent Eagle**	*Splornis cheela*				1	2	2	2	3
8	**Changeable Hawk-Eagle**	*Nisaetus limnaeetus*	2	2	1	3				
9	Slaty-breasted Rail	*Gallirallus striatus*	1					1		
10	Red-legged Crake	*Rallina fasciata*	1							
11	White-breasted Waterhen	*Amaurornis phoenicurus*		1				2	1	1
12	**Thick-billed Green-Pigeon**	*Treron curvirostra*	2	4	2	3	4	2	4	7
13	Pink-necked Green-Pigeon	*Treron vernans*	6	4	5	6	9	6	11	16
14	Spotted Dove	*Streptopelia chinensis*	2	2		3	5	8	6	3
15	Zebra Dove	*Geopelia striata*	2	1		3	6	3	2	9
16	**Emerald Dove**	*Chalcophaps indica*	1	1			2	1	2	2
17	Long-tailed Parakeet	*Psittacula longicauda*	4	2	2	3	13	35	14	7
18	**BLUE-RUMPED PARROT**	*Psittinus cyanurus*								1
19	**Blue-crowned Hanging Parrot**	*Loriculus galgulus*	1	1		1	1	1	2	1
20	**Banded Bay Cuckoo**	*Cacomantis sonneratii*	1	2	1		1	1		1
21	**Plaintive Cuckoo**	*Cacomantis merulinus*	1	1					1	
22	**Violet Cuckoo**	*Chrysococcyx xanthorhynchus*			1		1	1	1	
23	Little Bronze Cuckoo	*Chrysococcyx minutillus*			1					
24	**Drongo Cuckoo**	*Surniculus lugubris*	1	1	1		1	2		1
25	Asian Koel	*Eudynamys scolopacea*	1	2	2		1	1	1	2
26	**Chestnut-bellied Malkoha**	*Phaenicophaeus sumatranus*	1	1			2	2	2	2
27	**Greater Coucal**	*Centropus sinensis*			2		1		1	1
28	Germain's Swiftlet	*Aerodramus germane*	5	1		13	16	13	25	15

29	Himalayan Swiftlet	*Aerodramus brevirostris*	3							7
30	**Grey-rumped Treeswift**	*Hemiprocne longipennis*								1
31	**Black-backed Kingfisher**	*Ceyx erithaca*								1
32	Stork-billed Kingfisher	*Halcyon capensis*	1	1				1		
33	White-throated Kingfisher	*Halcyon smyrnensis*		1	2		1	1	1	3
34	Collared Kingfisher	*Todiramphus chloris*	1	1				2		1
35	Blue-tailed Bee-eater	*Merops philippinus*	3						2	5
36	Blue-throated Bee-eater	*Merops viridis*	6			3				
37	**Dollarbird**	*Eurystomus orientalis*	5	2		2	2	5	2	1
38	**RED-CROWNED BARBET**	*Megalaima rafflesii*			1		2	2	1	2
39	Coppersmith Barbet	*Megalaima haemacephala*						1		
40	**Rufous Woodpecker**	*Micropternus brachyurus*							1	1
41	Laced Woodpecker	*Picus vittatus*	1	1	1	1	1	2	3	1
42	Banded Woodpecker	*Chrysophelgma miniaceus*	1	2	1	3	3	1	2	2
43	Common Flameback	*Dinopium javanense*	1		3	2	1	1	1	7
44	**MANGROVE PITTA**	*Pitta megarhyncha*						1	1	
45	House Swallow	*Hirundo tahitica*			2	1	4	2	2	3
46	Pied Triller	*Lalage nigra*				1	3	2	1	2
47	Ashy Minivet	*Pericrocotus divaricatus*								19
48	Common Iora	*Aegithina tiphia*	3	4	5	3	3	5	3	5
49	**Blue-winged Leafbird**	*Chloropsis cochinchinensis*						1		
50	**STRAW-HEADED BULBUL**	*Pycnonotus zeylanicus*	4	3	4	3	6	4	5	3
51	Red-whiskered Bulbul	*Pycnonotus jocosus*	2			1	2	2	1	2
52	Yellow-vented Bulbul	*Pycnonotus goiavier*	2	4	2	3	4	6	3	4
53	Olive-winged Bulbul	*Pycnonotus plumosus*	7	5	5	7	12	8	16	12
54	Cream-vented Bulbul	*Pycnonotus simplex*	2				1			1
55	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	5	3	2	2	5	6	4	2
56	Black-naped Oriole	*Oriolus chinensis*	3	2	3	4	3	4	3	4
57	Asian Fairy-Bluebird	*Irena puella*	2				1		1	
58	House Crow	*Corvus splendens*					2	1		6

59	Southern Jungle Crow	*Corvus macrorhynchos*		2			6	4	6	3
60	**Abbott's Babbler**	*Malacocincla abbotti*	2	1	1	1	1	1	1	1
61	Short-tailed Babbler	*Malacocincla malaccensis*			1		1			1
62	Pin-striped Tit-Babbler	*Macronous gularis*	4	6	3	10	23	11	14	16
63	White-crested Laughingthrush	*Garrulax leucolophus*		3						
64	**Oriental Magpie-Robin**	*Copsychus saularis*	1		2		1	2	1	1
65	**White-rumped Shama**	*Copsychus malabaricus*						1		
66	Arctic Warbler	*Phylloscopus borealis*					1		4	1
67	Common Tailorbird	*Orthotomus sutorius*	2	2	1	2	2	5	2	3
68	Dark-necked Tailorbird	*Orthotomus atrogularis*	4	4	3	5	8	2	5	5
69	Rufous-tailed Tailorbird	*Orthotomus sericeus*	1	1	1	1	1	1	2	
70	Yellow-bellied Prinia	*Prinia flaviventris*					2	1	2	1
71	Asian Brown Flycatcher	*Muscicapa dauurica*	1						1	3
72	Pied Fantail	*Rhipidura javanica*			1		1	2		1
73	Pied Fantail	*Rhipidura javanica*					1	2		1
74	Paddyfield Pipit	*Anthus rufulus*						1	2	1
75	Brown Shrike	*Lanius cristatus*	1	1					1	
76	Tiger Shrike	*Lanius tigrinus*	1							
77	Asian Glossy Starling	*Aplonis panayensis*	11	30	7	15	11	32	16	8
78	Purple-backed Starling	*Sturnus sturninus*								3
79	Common Myna	*Acridotheres tristis*				2				
80	Javan Myna	*Acridotheres javanicus*	5	5	2	10	14	6	4	8
81	**Common Hill Myna**	*Gracula religiosa*	2	1		2	3	1	2	1
82	Brown-throated Sunbird	*Anthrepetes malacensis*	5	4	2	5	3	2	2	4
83	Van Hasselt's Sunbird	*Leptocoma brasiliana*								1
84	Olive-backed Sunbird	*Cinnyris jugularis*	2	2	2	3	5	4	2	2
85	Crimson Sunbird	*Aethopyga siparaja*	3	1	3	4	7	3	4	5
86	Little Spiderhunter	*Arachnothera longirostra*	2	1	1	1	1	2	2	3
87	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	2	2	1	2	1	1	2	
88	Scarlet-backed	*Dicaeum cruentatum*		2	2	3	1	3	1	5

	Flowerpecker									
89	Oriental White-eye	*Zosterops palpebrosus*		5						1
90	Baya Weaver	*Ploceus philippinus*				3	15	12	6	19
91	Scaly-breasted Munia	*Lonchura punctulata*	7	10	5	2	32	26	11	49
92	**Chestnut Munia**	*Lonchura atricapilla*		1	6	4	6	6	2	11
E	**MILKY STORK**	*Mycteria cinerea*			1	4				
E	**PAINTED STORK**	*Mycteria leucocephala*			11	2				
	Mammals									
1	Common Treeshrew	*Tupaia glis*			1	3	1	1	1	3
2	Malayan Colugo	*Galeopterus variegatus*			1		1	1	2	1
3	Long-tailed Macaque	*Macaca fascicularis*				13	12		9	2
4	Plantain Squirrel	*Callosciurus notatus*	1	3	3	2	5	3	4	3
5	Slender Squirrel	*Sundasciurus tenuis*	2	2	1	7	7	2	6	3
6	Wild Boar	*Sus scrofa*					1		2	5
7	**Sambar Deer**	*Rasa unicolor*				(1)			1	
	Reptiles									
1	Paradise Tree Snake	*Chrysopelea paradisi*				1			1	
2	Red-necked Bronzeback	*Dendrelaphis kopsteini*						1		
3	Malayan Water Monior	*Varanus salvator*							1	
4	Clouded Monitor	*Varanus nebulosus*					1	1	1	
5	Common Sun Skink	*Eutropis multifasciatus*				2	1	1	1	1
6	Spotted House Gecko	*Gekko monarchus*					1			
7	Spiny-tailed House Gecko	*Hemidactylus frenatus*					4	2		3
8	Common Flying Dragon	*Draco sumatranus*					1			1
9	Green-crested Lizard	*Bronchocela cristella*							1	
10	Changeable Lizard	*Calotes versicolor*		1			1		2	
	Dragonflies									
1	Common Blue Sprite	*Pseudagrion microcephalum*					1	2		3
2	**Orange-striped**	*Prodasineura humeralis*					3	2	5	2

	Threadtail									
3	**Grenadier**	*Agrionoptera insignis*		1		1		1		1
4	**Handsome Grenadier**	*Agrionoptera sexlineata*		3			3	1	2	1
5	Dark-tipped Forest-skimmer	*Cratilla metallica*		2	3	1	2	3	1	3
6	Common Parasol	*Neurothemis fluctuans*			5	5	12	16	24	13
7	Spine-tufted Skimmer	*Orthetrum chrysis*					5	2		2
8	Common Blue Skimmer	*Orthetrum glaucum*					1	3		2
9	Variegated Green Skimmer	*Orthetrum sabina*				3	1	1	4	1
10	Scarlet Skimmer	*Orthetrum testaceum*				3		2		3
11	Wandering Glider	*Pantala flavescens*					4	6	11	2
12	**Banded Skimmer**	*Pseudothemis jorina*							1	
13	**Bronze Flutterer**	*Rhyohemis obsolescens*				1		1		
14	Yellow-barred Flutterer	*Rhyothemis phyllis*		7		2	4	2	45	3
15	Saddlebag Glider	*Tramea transmarina*					1		1	
16	Dawn Dropwing	*Trithemis aurora*				2		2		4

Butterflies

1	**Common Rose**	*Pachliopta aristolochiae asteris*		1						
2	Common Mime	*Chilasa clytia clytia*								1
3	Lime Butterfly	*Papilio demoleus malayanus*					1	2		1
4	Common Mormon	*Papilio polytes romulus*		2	3	3	3	2	5	4
5	Common Bluebottle	*Graphium sarpedon luctatius*			3		1		1	
6	Tailed Jay	*Graphium agamemnon*	1							

		agamemnon								
7	Painted Jezebel	*Delias hyparete metarete*	6	3	3		5	2	1	1
8	Psyche	*Leptosia nina malayana*					3	2		1
9	Striped Albatross	*Appias libythea olferna*			2		4	2	4	3
10	Lemon Emigrant	*Catopsilia pomona pomona*	1		2	8	2	5	4	2
11	Orange Emigrant	*Catopsilia scylla cornelia*						1		1
	Grass Yellow	*Eurema sp.*	10		10	3	6	2	4	6
12	Chocolate Grass Yellow	*Eurema sari sodalis*					1			
13	Tree Yellow	*Gandaca harina distanti*							1	
14	Blue Glassy Tiger	*Ideopsis vulgaris macrina*					2	5	2	1
15	Striped Blue Crow	*Euploea mulciber mulciber*						2		2
16	**Common Evening Brown**	*Melanitis leda leda*					1			
17	Common Palmfly	*Elymnias hypermnestra agina*	3				5	6	3	2
18	Dark Brand Bush Brown	*Mycalesis mineus macromalayana*			7	4	3	4	2	6
19	Dark Grass Brown	*Orsotriaena medus cinerea*			2	2				
20	Common Faun	*Faunis canens arcesilas*	2							
21	Chocolate Pansy	*Junonia hedonia ida*	4			2	1	3	2	4
22	**Grey Pansy**	*Junonia atlites atlites*	1				1			1
23	Peacock Pansy	*Junonia almana javana*					1	2	4	
24	Blue Pansy	*Junonia orithya wallacei*	2					1	3	4
25	Leopard	*Phalanta phalantha phalantha*	2							
26	Rustic	*Cupha erymanthis lotis*	3					1		1
27	Cruiser	*Vindula dejone erotella*				1			1	
28	Knight	*Lebadea martha parkeri*			3		5	2	3	5
29	Common Sailor	*Neptis hylas papaja*						2	2	2
	Sailor sp.	*?*				2	1		1	
30	Lascar sp.	*?*		1					1	
31	Malay Viscount	*Tanaecia pelea pelea*						1	1	
32	Horsfield's Baron	*Tanaecia iapis puseda*			1		2	4	2	4
33	Archduke	*Lexias pardalis dirteana*	2		1			1	1	
34	Purple Duke	*Eulaceura osteria kumana*							1	

35	**Lesser Harlequin**	*Laxita thuisto thuisto*						1		
36	Malayan Sunbeam	*Curetis santana malayica*								1
37	Lesser Grass Blue	*Zizina otis lampa*	10		4		6	2	2	4
38	Cycad Blue	*Chilades pandava pandava*		1						
39	Common Caerulean	*Jamides celeno aelianus*	2			4				
40	Branded Imperial	*Eooxylides tharis distanti*				1		1	1	1
41	**Common Awl**	*Hasora badra badra*						1		
42	**Plain Banded Awl**	*Hasora vitta vitta*				2				
43	Chestnut Bob	*Iambrix salsala salsala*					2		2	
44	Chocolate Demon	*Ancistroides nigrita maura*						3		
45	**Pugnacious Lancer**	*Pemara pugnans*		1						
46	Lesser Dart	*Potanthus omaha omaha*				2	1	1	3	2
47	Formosan Swift	*Borbo cinnara*						1		
48*	Banana Skipper	*Erionota thrax thrax*								1
	Skipper sp.	*?*		1						

Zone F – Zoo Grounds (Wildlife Reserves Singapore) Transect

	Bold Print – Locally Threatened	Bold Print & Capital Lettering – Internationally Threatened								
			Apr	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
No	**Common Names**	**Latin Names**	**1st**	**27th**	**13th**	**12th**	**27th**	**30th**	**21st**	**16th**
	Birds									
1	**Purple Heron**	*Ardea purpurea*	26	51	13	11		4	1	
2	Little Heron	*Butorides striatus*	1						1	1
3	Chinese Pond Heron	*Ardeola bacchus*	1							
4	Eastern Cattle Egret	*Bubulcus coromandus*	1	1						
5	Oriental Honey-Buzzard	*Pernis ptilorhyncus*								1
6	Brahminy Kite	*Haliastur indus*								
7	White-bellied Sea-Eagle	*Haliaeetus leucogaster*						1	2	1

8	**Changeable Hawk-Eagle**	*Nisaetus limnaeetus*						2	1	2
9	White-breasted Waterhen	*Amaurornis phoenicurus*	1	2	1		1	1	1	2
10	Common Sandpiper	*Actitis hypoleucos*	1					1	2	2
11	**Thick-billed Green-Pigeon**	*Treron curvirostra*							1	
12	Pink-necked Green-Pigeon	*Treron vernans*	3	37	2	8	12	6	4	12
13	Spotted Dove	*Streptopelia chinensis*	4	3	6	3	9	4	2	5
14	Zebra Dove	*Geopelia striata*				3		1	3	4
15	**Emerald Dove**	*Chalcophaps indica*	2					2	1	2
16	Long-tailed Parakeet	*Psittacula longicauda*	1	1	5	7	2	5	3	8
17	**BLUE-RUMPED PARROT**	*Psittinus cyanurus*								1
18	**Blue-crowned Hanging Parrot**	*Loriculus galgulus*				1		1	2	1
19	Little Bronze Cuckoo	*Chrysococcyx minutilus*	1							
20	**Banded Bay Cuckoo**	*Cacomantis sonneratii*						1	1	1
21	**Plaintive Cuckoo**	*Cacomantis merulinus*								1
22	Asian Koel	*Eudynamys scolopacea*	2		1	1		2	1	3
23	Germain's Swiftlet	*Aerodramus germane*	10	6	23	8	16	16	13	34
24	Black-Nest Swiftlet	*Aerodramus maxima*							3	
25	Himalayan Swiftlet	*Aerodramus brevirostris*	1						9	12
26	House Swift	*Apus affinis*			1					
27	**Blue-eared Kingfisher**	*Alcedo meninting*		1						
28	Stork-billed Kingfisher	*Halcyon capensis*	1	2	3	1	1	2	1	3
29	White-throated Kingfisher	*Halcyon smyrnensis*	1	1	1		2	1	1	3
30	Collared Kingfisher	*Todiramphus chloris*	2	2		1		1	1	2
31	Blue-tailed Bee-eater	*Merops philippinus*							5	9
32	Blue-throated Bee-eater	*Merops viridis*			1					
33	**Dollarbird**	*Eurystomus orientalis*						2	1	2
34	**RED-CROWNED BARBET**	*Megalaima rafflesii*							1	

35	Lineated Barbet	*Megalaima lineata*							1	
36	Coppersmith Barbet	*Megalaima haemacephala*						1		1
37	**Rufous Woodpecker**	*Micropternus brachyurus*						1	1	3
38	Laced Woodpecker	*Picus vittatus*						2	3	1
39	Banded Woodpecker	*Chrysophelgma miniaceus*							2	1
40	Common Flameback	*Dinopium javanense*						1	4	1
41	Barn Swallow	*Hirundo rustica*							2	
42	House Swallow	*Hirundo tahitica*	5		2		6	5	6	5
43	Pied Triller	*Lalage nigra*	1			1		2	2	2
44	Ashy Minivet	*Pericrocotus divaricatus*							5	4
45	Common Iora	*Aegithina tiphia*	3	1	2	4		5	4	
46	**Blue-winged Leafbird**	*Chloropsis cochinchinensis*								1
47	**STRAW-HEADED BULBUL**	*Pycnonotus zeylanicus*	4	4	4	6	5	4	5	6
48	Yellow-vented Bulbul	*Pycnonotus goiavier*			6	2		8	4	3
49	Olive-winged Bulbul	*Pycnonotus plumosus*	1	14	33	3	21	12	9	9
50	Cream-vented Bulbul	*Pycnonotus simplex*	2		1		1	2		1
51	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	3				1	2	4	6
52	Black-naped Oriole	*Oriolus chinensis*	3	4	3	2	3	5	2	3
53	House Crow	*Corvus splendens*	1	2		1		3	3	1
54	Southern Jungle Crow	*Corvus macrorhynchos*	4	4	2		7	1	2	1
55	**Abbott's Babbler**	*Malacocincla abbotti*				1			1	
56	Short-tailed Babbler	*Malacocincla malaccensis*								1
57	Pin-striped Tit-Babbler	*Macronous gularis*	2		9	2	20	6	7	6
58	Siberian Blue Robin	*Luscinia cyane*							1	
59	**Oriental Magpie-Robin**	*Copsychus saularis*	2	10	6	2	6	3	3	1
60	Golden-bellied Gerygone	*Gerygone sulphurea*	3			1				
61	Arctic Warbler	*Phylloscopus borealis*	2	7				2	1	2
62	Common Tailorbird	*Orthotomus sutorius*	3			1	2	5	4	4
63	Dark-necked Tailorbird	*Orthotomus atrogularis*	1		1	2	14	3	7	6
64	Rufous-tailed Tailorbird	*Orthotomus sericeus*		3	11	1	7		1	1
65	Asian Brown Flycatcher	*Muscicapa dauurica*	1					1	3	1

66	Pied Fantail	*Rhipidura javanica*	1			1			2	4
67	Brown Shrike	*Lanius cristatus*						2	1	1
68	Tiger Shrike	*Lanius tigrinus*	1							
69	Asian Glossy Starling	*Aplonis panayensis*		8	10	14	25	5	15	16
70	Common Myna	*Acridotheres tristis*	2							
71	Javan Myna	*Acridotheres javanicus*	3	8	13	1	11	7	6	2
72	**Common Hill Myna**	*Gracula religiosa*	1	1		2		1	2	1
73	Brown-throated Sunbird	*Anthrepetes malacensis*	5	6	9	2	6	4	5	3
74	Van Hasselt's Sunbird	*Leptocoma brasiliana*	1							
75	Olive-backed Sunbird	*Cinnyris jugularis*	3	3	10	3	4	2	3	5
76	Crimson Sunbird	*Aethopyga siparaja*	2	7	3	3	5	2	2	4
77	Little Spiderhunter	*Arachnothera longirostra*			1	1		1	1	1
78	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*		2	1	2	9		1	1
79	Scarlet-backed Flowerpecker	*Dicaeum cruentatum*	1	2	10	3	3	3	3	4
80	Oriental White-eye	*Zosterops palpebrosus*			6		1			2
E	Common Peafowl	*Pavo cristatus*			6		2			
E	**MILKY STORK**	*Mycteria cinerea*	1		20		3			
E	**PAINTED STORK**	*Mycteria cinerea*	20			13				
	STORKS (Painted/Milky)	*Mycteria spp*		50	60					
	Mammals									
1	Malayan Colugo	*Galeopterus variegatus*				3	3	1	1	2
2	Common Fruit Bat	*Cynopterus brachyotis*					6	2	2	9
3	Plantain Squirrel	*Callosciurus notatus*	4	4	9	6	15	2	2	7
4	Slender Squirrel	*Sundasciurus tenuis*	6	5	2	3	5	1	3	3
	Reptiles									
1	Malayan Water Monior	*Varanus salvator*	2		2		3	2	2	
2	Clouded Monitor	*Varanus nebulosus*		1	1	2	2	1	3	
3	Common Sun Skink	*Eutropis multifasciatus*	2	2		2				

4	Tokay Gecko	*Gekko gecko*			2					
5	Spotted House Gecko	*Gekko monarchus*	1							
6	Four-clawed Gecko	*Gehyra mutilata*	2				1			
7	Spiny-tailed House Gecko	*Hemidactylus frenatus*	3		1		3	1		4
8	Gecko sp.	*?*		1						
9	Common Flying Dragon	*Draco sumatranus*			1				2	2
10	**Green Crested Lizard**	*Bronchocela cristatellus*			1			1		
11	Changeable Lizard	*Calotes versicolor*		1		1			1	
12	Red-eared Terrapin	*Trachemys scripta*					5			
	Amphibians									
1	Common Greenback	*Hylarana erythraea*						6	2	1
2	Dark-sided Chorus Frog	*Microhyla heymonsi*		2						
	Dragonflies									
1	Ornate Coraltail	*Ceriagrion cerinorubellum*						1		
2	Common Blue Sprite	*Pseudagrion microcephalum*				6		5	2	5
3	**Orange-striped Threadtail**	*Prodasineura humeralis*			2			5	2	7
4	Common Flangetail	*Ictinogomphus decoratus*					1			1
5	**Grenadier**	*Agrionoptera insignis*				1		1		1
6	**Handsome Grenadier**	*Agrionoptera sexlineata*				3				
7	Blue Dasher	*Brachydiplax chalybea*			1			4	1	2
8	**Sultan**	*Camacinia gigantea*							1	
9	Dark-tipped Forest-skimmer	*Cratilla metallica*				2			1	
10	Coastal Glider	*Macrodiplax cora*		3						
11	Common Parasol	*Neurothemis fluctuans*	5	3	16	3	7	12	6	19
12	Spine-tufted Skimmer	*Orthetrum chrysis*			1			3	1	1
13	Common Blue Skimmer	*Orthetrum glaucum*						1	5	2
14	Variegated Green Skimmer	*Orthetrum sabina*			1		5	4	1	7

15	Scarlet Skimmer	*Orthetrum testaceum*		2	8		5	4	1	1
16	**Banded Skimmer**	*Pseudothemis jorina*							1	
17	Yellow-barred Flutterer	*Rhyothemis phyllis*	3	2	2	17		2	5	15
18	Saddlebag Glider	*Tramea transmarina*			1		1			
19	Dawn Dropwing	*Trithemis aurora*		1			5		5	
20	Indigo Dropwing	*Trithemis festiva*						2		

Butterflies

1	**Common Birdwing**	*Troides helena cerberus*			1					
2	**Common Rose**	*Pachliopta aristolochiae asteris*	1					1		
3	Lime Butterfly	*Papilio demoleus malayanus*				2				
4	Common Mormon	*Papilio polytes romulus*	3	2	3	1	1	4	1	3
5	Common Bluebottle	*Graphium sarpedon luctatius*						1		
6	Blue Jay	*Grasphium evemon eventus*					1			1
7	Painted Jezebel	*Delias hyparete metarete*	4	8	6		1	5	2	3
8	Psyche	*Leptosia nina malayana*							2	
9	Striped Albatross	*Appias libythea olferna*						2	6	1
10	Mottled Emigrant	*Catopsilia pyranthe pyranthe*						1		
11	Lemon Emigrant	*Catopsilia pomona pomona*	4	18	3	3	24	5	1	3
12	Orange Emigrant	*Catopsilia scylla cornelia*		2	2					
13	Grass Yellow	*Eurema sp.*		4	1	5	2	2	4	1
14	Dark Glassy Tiger	*Parantica agleoides agleoides*	1					1	1	1
15	Blue Glassy Tiger	*Ideopsis vulgaris macrina*		2						
16	**Common Tree Nymph**	*Idea stolli logani*			1					
17	Striped Blue Crow	*Euploea mulciber mulciber*	1	1				5	2	1
18	Common Palmfly	*Elymnias hypermnestra agina*	1	2	2	4	7	2	4	1

19	Bush Brown	*Mycalesis sp.*					2			
20	Common Faun	*Faunis canens arcesilas*						2		1
21	Malayan Eggfly	*Hypolimnas anomala anomala*		5			2			
22	Great Eggfly	*Hypolimnas bolina bolina*							1	
23	Chocolate Pansy	*Junonia hedonia ida*	2	4	6	6	2	2	1	1
24	Peacock Pansy	*Junonia almana javana*			1		3			
25	Blue Pansy	*Junonia orithya wallacei*								1
26	Leopard Lacewing	*Cethosia cyane*	1							
27	Leopard	*Phalanta phalantha phalantha*					1	2		
28	Rustic	*Cupha erymanthis lotis*	1	5	1		1		1	
29	Knight	*Lebadea martha parkeri*						2	4	1
30	Sailor sp.	*?*				2	2		2	1
31	Lascar sp.	*?*						1		1
32	Malay Viscount	*Tanaecia pelea pelea*					1			
33	Horsfield's Baron	*Tanaecia iapis puseda*	2					5	1	1
34	Lesser Grass Blue	*Zizina otis lampa*	3					2	5	9
35	Gram Blue	*Euchrysops cnejus cnejus*			1					
36	Tailless Line Blue	*Prosotas dubiosa lumpura*		22	1					
	Blue sp.	*?*		1						
37	Common Caerulean	*Jamides celeno aelianus*						1		
38	Branded Imperial	*Eooxylides tharis distanti*								1
39	Chestnut Bob	*Iambrix salsala salsala*						2	1	1
40	Chocolate Demon	*Ancistroides nigrita maura*	3						1	
41	Banded Demon	*Notocrypta paralysos varians*					1			
	Skipper	*?*					1			

Zone G – Night Safari Grounds (Wildlife Reserves Singapore) Transect

	Bold Print – Locally Threatened	Bold Print & Capital Lettering – Internationally Threatened								
			Mar	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
No	**Common Names**	**Latin Names**	**31st**	**25th**	**18th**	**10th**	**17th**	**27th**	**21st**	**25th**
	Birds									
1	**Purple Heron**	*Ardea purpurea*	2							
2	White-bellied Sea-Eagle	*Haliaetus leucogaster*						1		
3	**GREY-HEADED FISH-EAGLE**	*Ichthyophaga ichthyaetus*		2						
4	**Changeable Hawk-Eagle**	*Nisaetus limnaeetus*					1			
5	Red-legged Crake	*Rallina fasciata*			1			1		
6	White-breasted Waterhen	*Amaurornis phoenicurus*	2	3	2	1	1	4	2	2
7	**Thick-billed Green-Pigeon**	*Treron curvirostra*	5		1					4
8	Pink-necked Green-Pigeon	*Treron vernans*	5	15	22	8	8	8	7	5
9	Spotted Dove	*Streptopelia chinensis*	24	17	16	22	12	16	12	16
10	**Emerald Dove**	*Chalcophaps indica*	4	1	6	8	6	1	1	3
11	Long-tailed Parakeet	*Psittacula longicauda*	2	7	3	2	8	12	6	10
12	**BLUE-RUMPED PARROT**	*Psittinus cyanurus*	1							
13	Indian Cuckoo	*Cuculus micropterus*		1						
14	**Banded Bay Cuckoo**	*Cacomantis sonneratii*		1						
15	**Plaintive Cuckoo**	*Cacomantis merulinus*	1				1			
16	**Violet Cuckoo**	*Chrysococcyx xanthorhynchus*	1	1	1					
17	**Drongo Cuckoo**	*Surniculus lugubris*		2	1		1			
18	Asian Koel	*Eudynamys scolopacea*	3	1	2			1	2	3
19	**Chestnut-bellied Malkoha**	*Phaenicophaeus sumatranus*	2					2	1	

20	**Greater Coucal**	*Centropus sinensis*								1
21	Germain's Swiftlet	*Aerodramus germane*	33	8	22	29	19	21	34	26
22	**Blue-eared Kingfisher**	*Alcedo meninting*			1		1			
23	Stork-billed Kingfisher	*Halcyon capensis*	2	1	2		1	1	1	1
24	White-throated Kingfisher	*Halcyon smyrnensis*	4	1	3	2	1	3	2	1
25	Blue-throated Bee-eater	*Merops viridis*	2				6			1
26	**Dollarbird**	*Eurystomus orientalis*	1	1		1				1
27	**RED-CROWNED BARBET**	*Megalaima rafflesii*	3		1		2			
28	**Rufous Woodpecker**	*Micropternus brachyurus*	2					1		1
29	Banded Woodpecker	*Chrysophelgma miniaceus*	1	3	4	6	1	3	4	2
30	Common Flameback	*Dinopium javanense*		1		2	1	1	1	6
31	Barn Swallow	*Hirundo rustica*	1							1
32	House Swallow	*Hirundo tahitica*		2	2			2	3	3
33	Common Iora	*Aegithina tiphia*	1		2	1		2	1	
34	**STRAW-HEADED BULBUL**	*Pycnonotus zeylanicus*	4	6	1	3	3	1	1	6
35	Yellow-vented Bulbul	*Pycnonotus goiavier*		1	3	1	5	1		1
36	Olive-winged Bulbul	*Pycnonotus plumosus*	31	27	41	26	31	23	14	9
37	Cream-vented Bulbul	*Pycnonotus simplex*			1			4	2	
38	**Red-eyed Bulbul**	*Pycnonotus brunneus*	1		1	1	1			
39	Ashy Bulbul	*Hemixos flavala*							1	
40	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	5	4	5	3	5	4	3	5
41	Black-naped Oriole	*Oriolus chinensis*	5	14	2	5	5	6	5	1
42	Asian Fairy Bluebird	*Irena puella*							2	3
43	House Crow	*Corvus splendens*						1		
44	Southern Jungle	*Corvus macrorhynchos*	4	3	1	3	3			1

	Crow									
45	Pin-striped Tit-Babbler	*Macronous gularis*	11	18	18	24	15	16	12	9
46	Siberian Blue Robin	*Luscinia cyane*								1
47	**Oriental Magpie-Robin**	*Copsychus saularis*	8	8	4	6	8		9	5
48	Arctic Warbler	*Phylloscopus borealis*	4	6					3	6
49	Common Tailorbird	*Orthotomus sutorius*	4	3	5	5	1	1		1
50	Dark-necked Tailorbird	*Orthotomus atrogularis*	12	19	12	13	18	16	12	7
51	Rufous-tailed Tailorbird	*Orthotomus sericeus*	3	3	2	5	2	3	1	
52	Asian Brown Flycatcher	*Muscicapa dauurica*	3						2	3
53	Yellow-rumped Flycatcher	*Ficedula zanthopygia*								1
54	Tiger Shrike	*Lanius tigrinus*	1							1
55	Asian Glossy Starling	*Aplonis panayensis*	42	17	13	21	25	88	43	49
56	Javan Myna	*Acridotheres javanicus*	24	24	28	16	11	8	14	15
57	**Common Hill Myna**	*Gracula religiosa*		1	4	3	10	9	6	18
58	Brown-throated Sunbird	*Anthrepetes malacensis*	3	10	7	5	3			1
59	Van Hasselt's Sunbird	*Leptocoma brasiliana*	7		1	1	2			
60	Olive-backed Sunbird	*Cinnyris jugularis*		1	1					
61	Crimson Sunbird	*Aethopyga siparaja*	4	4	9	9	8	6	8	4
62	Little Spiderhunter	*Arachnothera longirostra*	1	2	5	3	3	4	3	
63	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	11	9	5	7	6	7	7	8
64	Scarlet-backed Flowerpecker	*Dicaeum cruentatum*	6	4	2	6	5	4	2	1
65	Oriental White-eye	*Zosterops palpebrosus*				3				

E	Common Peafowl	*Pavo cristatus*	1			1				1
E	Red Junglefowl (hybrid)	*Gallus gallus*	3	1						
E	**MILKY STORK**	*Mycteria cinerea*	1	1	1					
	Mammals									
1	Common Treeshrew	*Tupaia glis*			1				1	
2	Malayan Colugo	*Galeopterus variegatus*	1				2	2		1
3	Common Fruit Bat	*Cynopterus brachyotis*								2
4	Long-tailed Macaque	*Macaca fascicularis*	10	2	10	15	1		10	6
5	Plantain Squirrel	*Callosciurus notatus*	11	6	9	3	6	5	3	5
6	Slender Squirrel	*Sundasciurus tenuis*	4	5	10	6	13	11	6	3
7	Oriental House Rat	*Rattus tanezumi*							1	
	Reptiles									
1	Sunbeam Snake	*Xenopeltis unicolor*				1				
2	**King Cobra**	*Ophiophagus hannah*				1				
3	Black Spitting Cobra	*Naja sumatrana*							1	
4	Malayan Water Monior	*Varanus salvator*				1	1	1		1
5	Clouded Monitor	*Varanus nebulosus*				1			1	
6	Common Sun Skink	*Eutropis multifasciatus*				2	1		1	
7	Tokay Gecko	*Gekko gecko*	1			2				
8	Common House Gecko	*Hemidactylus frenatus*					2	1		1
9	Common Flying Dragon	*Draco sumatranus*				2		1		
10	**Green-crested Lizard**	*Bronchocela cristatella*	1	1						1
11	Malayan Box Terrapin	*Cuora amboinensis*								1
	Amphibians									

1	Asian Toad	*Duttaphrynus melanostictus*						2		
2	Dark-sided Chorus Frog	*Microhyla heymonsi*		1				2		
	Dragonflies									
1	Common Blue Sprite	*Pseudagrion microcephalum*	1		2					
2	**Orange-striped Threadtail**	*Prodasineura humeralis*				1				1
3	Common Flangetail	*Ictinogomphus decoratus*			1					
4	Pond Cruiser	*Epophthalmia vittigera*		1						
5	**Grenadier**	*Agrionoptera insignis*	1	1		1				1
6	Blue Dasher	*Brachydiplax chalybea*		3	1	1				
7	**Sultan**	*Camacinia gigantea*				3				
8	Dark-tipped Forest-skimmer	*Cratilla metallica*		1			1		1	
9	Common Scarlet	*Crocothemis servilia*								1
10	Chalky Percher	*Diplacodes trivialis*		1						
11	Water Monarch	*Hydrobasileus croceus*				3				
12	Scarlet Grenadier	*Lathrecista asiatica*						1		
13	Coastal Glider	*Macrodiplax cora*	2							1
14	Common Parasol	*Neurothemis fluctuans*	3	5	1	4	3	2	9	2
15	Spine-tufted Skimmer	*Orthetrum chrysis*		3	2	2	1			2
16	Variegated Green Skimmer	*Orthetrum sabina*	4	6	10	8	7	6	3	3
17	Scarlet Skimmer	*Orthetrum testaceum*	4	1	1	2	4	4	4	1
18	Wandering Glider	*Pantala flavescens*		1		2	2		2	1
19	Common Chaser	*Potamarcha congener*	1					1		
20	**Banded Skimmer**	*Pseudothemis jorina*					1			
21	Yellow-barred Flutterer	*Rhyothemis phyllis*	1	1			2	2	1	
22	Saddlebag Glider	*Tramea transmarina*	3	3	4	4	1	2	4	

23	Dawn Dropwing	*Trithemis aurora*	10	5	11	7	2	5	2	4

Butterflies

1	Common Mormon	*Papilio polytes romulus*			1			2		
2	Common Bluebottle	*Graphium sarpedon luctatius*	4	1						
3	Blue Jay	*Graphium evemon eventus*	2			1				
4	Painted Jezebel	*Delias hyparete metarete*	1	7	6	3	3	4	1	
5	Psyche	*Leptosia nina malayana*				1				
6	Mottled Emigrant	*Catopsilia pyranthe pyranthe*							1	
7	Lemon Emigrant	*Catopsilia pomona pomona*	4	8	1	3	8			
8	Chocolate Grass Yellow	*Eurema sari sodalis*						1		
	Grass Yellow	*Eurema sp.*	3	2	5	3	1	2	2	3
9	Blue Glassy Tiger	*Ideopsis vulgaris macrina*				1				
10	**Spotted Black Crow**	*Euploea crameri bremeri*					1			
11	**Common Evening Brown**	*Melanitis leda leda*				1				
12	**Tawny Palmfly**	*Elymnias panthera panthera*				1	1	2		
13	Common Palmfly	*Elymnias hypermnestra agina*	1	1	1	3	1		1	
14	Bush Brown	*Mycalesis sp.*					3	5		1
15	Ring	*Ypthima sp.*						1		
16	Common Faun	*Faunis canens arcesilas*					1			
17	**Palm King**	*Amathusia phidippus phidippus*	1							
18	Malayan Eggfly	*Hypolimnas anomala anomala*		5	4	5		1	1	1
19	Great Eggfly	*Hypolimnas bolina bolina*		2						
20	Jacintha Eggfly	*Hypolimnas bolina jacintha*				1				
21	Autumn Leaf	*Doleschallia bisaltide bisaltide*				1				
22	Chocolate Pansy	*Junonia hedonia ida*	5	4		6	5	4	5	
23	Tawny Coster	*Acraea violae*				1				
24	Leopard	*Phalanta phalantha phalantha*		3				4		
25	Rustic	*Cupha erymanthis lotis*	1	8	1	5	3	5		2

26	Cruiser	*Vindula dejone erotella*				2				
27	**Commander**	*Moduza procris milonia*				1			1	
28	Knight	*Labadea martha parkeri*						1		
29	Sailor sp.	*?*	1		2	1		1		
30	Lascar sp.	*?*				1				
31	Malay Viscount	*Tanaecia pelea pelea*	4	1	3	2		2	3	
32	Archduke	*Lexias pardalis dirteana*	1			1				
33	Purple Duke	*Eulaceura osteria kumana*	1							
34	**Malay Tailed Judy**	*Abisara savitri savitri*			1					
35	Common Hedge Blue	*Acytolepis puspa lambi*		1						
36	Common Caerulean	*Jamides celeno aelianus*	4					3	1	1
37	Tailless Line Blue	*Prosotas dubiosa lumpura*				?				
38	**Scarce Silverstreak**	*Iraota rochana boswelliana*					1			
	Blue sp.	*?*			1					
39	Oakblue sp.	*Arhopala sp.*						2		
40	Yamfly	*Loxura atymnus fuconius*		1						
41	**Large Snow Flat**	*Tagiades gana gana*				2				
42	Banded Demon	*Notocrypta paralysos*	1			1				
43	Lesser Dart	*Potanthus omaha omaha*		1						
	Skipper	*?*					1			

Appendix 2 : Diurnal Point Counts

Zone A : 2nd Peninsula Point Count – March to June 2015

	Bold Print – Locally Threatened	Bold Print & Capital Lettering – Internationally Threatened				
			Mar	**Apr**	**May**	**Jun**
No	**Common Names**	**Latin Names**	**30th**	**27th**	**20th**	**30th**
	Birds					

1	Grey Heron	*Ardea cinerea*		1		
2	White-bellied Sea-Eagle	*Haliaeetus leucogaster*				2
3	**GREY-HEADED FISH-EAGLE**	*Ichthyophaga ichthyaetus*		1		
4	**Changeable Hawk-Eagle**	*Nisaetus limnaeetus*			1	
5	Pink-necked Green-Pigeon	*Treron vernans*		6	3	4
6	Spotted Dove	*Streptopelia chinensis*		3	5	
7	Long-tailed Parakeet	*Psittacula longicauda*	1		8	10
8	**Violet Cuckoo**	*Chrysococcyx xanthorhynchus*	1			
9	Asian Koel	*Eudynamys scolopacea*		1		
10	Germain's Swiftlet	*Aerodramus germane*		3		3
11	Stork-billed Kingfisher	*Halcyon capensis*		1		
12	Banded Woodpecker	*Chrysophelgma miniaceus*	2	1		1
13	Common Flameback	*Dinopium javanense*	1	2	1	
14	House Swallow	*Hirundo tahitica*		1	2	
15	**STRAW-HEADED BULBUL**	*Pycnonotus zeylanicus*		1	1	
16	Yellow-vented Bulbul	*Pycnonotus goiavier*			1	
17	Olive-winged Bulbul	*Pycnonotus plumosus*	1	3	4	1
18	Cream-vented Bulbul	*Pycnonotus simplex*				1
19	Greater Racket-tailed Drongo	*Dicrurus paradiseus*			1	
20	Black-naped Oriole	*Oriolus chinensis*			1	
21	**Abbott's Babbler**	*Malacocincla abbotti*	1			1
22	Short-tailed Babbler	*Malacocincla malaccensis*		1		
23	Pin-striped Tit-Babbler	*Macronous gularis*	3	1		1
24	Dark-necked Tailorbird	*Orthotomus atrogularis*		1	1	1
25	Rufous-tailed Tailorbird	*Orthotomus sericeus*		1		
26	Asian Glossy Starling	*Aplonis panayensis*		14	15	
27	Javan Myna	*Acridotheres javanicus*		6	14	
28	**Common Hill Myna**	*Gracula religiosa*			1	
29	Van Hasselt's Sunbird	*Leptocoma brasiliana*				2
30	Crimson Sunbird	*Aethopyga siparaja*	1			
31	Orange-bellied	*Dicaeum trigonostigma*	1	1	1	1

	Flowerpecker					
	Mammals					
1	Slender Squirrel	*Sundasciurus tenuis*				1
	Reptiles					
1	Malayan Water Monior	*Varanus salvator*			1	
2	Red-eared Slider	*Trachemys scripta*			3	

July to October 2015

	Bold Print –	Locally Threatened					
	Bold Print & Capital Lettering –	Internationally Threatened					
		GPS - All bolded species	**Date**	30Jul	18Aug	24Sep	17Oct
			Site	Area A	Area A	Area A	Area A
	Birds						
1	**GREY-HEADED FISH-EAGLE**	*Ichthyophaga ichthyaetus*	sr				**1**
2	**Changeable Hawk-Eagle**	*Nisaetus limnaeetus*	ur		1		
3	Pink-necked Green-Pigeon	*Treron vernans*	cr	4	4	4	1
4	Spotted Dove	*Streptopelia chinensis*	cr	1	1		
5	Long-tailed Parakeet	*Psittacula longicauda*	cr	6	87	2	18
6	Germain's Swiftlet	*Aerodramus germane*	cr				6
7	Banded Woodpecker	*Chrysophelgma miniaceus*	cr				1
8	Common Flameback	*Dinopium javanense*	cr		2	1	1
9	**STRAW-HEADED BULBUL**	*Pycnonotus zeylanicus*	ur		1	1	
10	Olive-winged Bulbul	*Pycnonotus plumosus*	cr	4	2	2	2
11	Cream-vented Bulbul	*Pycnonotus simplex*	cr				
12	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	cr			2	2
13	Black-naped Oriole	*Oriolus chinensis*	cr		2		
14	**Abbott's Babbler**	*Malacocincla abbotti*	ur	1	1	1	1

15	Pin-striped Tit-Babbler	*Macronous gularis*	cr		2	2	3
16	Dark-necked Tailorbird	*Orthotomus atrogularis*	cr	1	1	1	1
17	Rufous-tailed Tailorbird	*Orthotomus sericeus*	cr				1
18	Asian Glossy Starling	*Aplonis panayensis*	cr		8		1
19	Purple-backed Starling	*Sturnus sturninus*	cm				
20	Javan Myna	*Acridotheres javanicus*	ci		3		2
21	**Common Hill Myna**	*Gracula religiosa*	ur				1
22	Crimson Sunbird	*Aethopyga siparaja*	cr	1			
23	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	cr			1	2
24	Scarlet-backed Flowerpecker	*Dicaeum cruentatum*	cr		1		
	Mammals						
1	Plantain Squirrel	*Callosciurus notatus*	cr		1		1
2	Slender Squirrel	*Sundasciurus tenuis*	cr	4			

Zone G : Mandai Lake Road Peninsula Point Count – March to June 2015

	Bold Print – Locally Threatened	Bold Print & Capital Lettering – Internationally Threatened				
			Mar	**Apr**	**May**	**Jun**
No	**Common Names**	**Latin Names**	**31st**	**28th**	**18th**	**29th**
	Birds					
1	Grey Heron	*Ardea cinerea*				1
2	White-bellied Sea-Eagle	*Haliaeetus leucogaster*				1
3	**Changeable Hawk-Eagle**	*Nisaetus limnaeetus*		1		
4	**Thick-billed Green-Pigeon**	*Treron curvirostra*				1
5	Pink-necked Green-Pigeon	*Treron vernans*		5		4
6	Spotted Dove	*Streptopelia chinensis*				6
7	**Emerald Dove**	*Chalcophaps indica*				1

8	Long-tailed Parakeet	*Psittacula longicauda*		6		13
9	**Drongo Cuckoo**	*Surniculus lugubris*	1			1
10	Lesser Coucal	*Centropus bengalensis*				1
11	Collared Scops Owl	*Otus bakkamoena*		1		
12	Germain's Swiftlet	*Aerodramus germane*				10
13	White-throated Kingfisher	*Halcyon smyrnensis*				1
14	Laced Woodpecker	*Picus vittatus*				1
15	Common Flameback	*Dinopium javanense*				2
16	House Swallow	*Hirundo tahitica*				1
17	Common Iora	*Aegithina tiphia*				1
18	**STRAW-HEADED BULBUL**	*Pycnonotus zeylanicus*				1
19	Olive-winged Bulbul	*Pycnonotus plumosus*	1	3		5
20	Cream-vented Bulbul	*Pycnonotus simplex*		2		
21	Greater Racket-tailed Drongo	*Dicrurus paradiseus*				2
22	**Abbott's Babbler**	*Malacocincla abbotti*		1		
23	Pin-striped Tit-Babbler	*Macronous gularis*		1		1
24	White-crested Laughingthrush	*Garrulax leucolophus*				1
25	Dark-necked Tailorbird	*Orthotomus atrogularis*	1	1		1
26	Rufous-tailed Tailorbird	*Orthotomus sericeus*				1
27	Asian Glossy Starling	*Aplonis panayensis*				7
28	Javan Myna	*Acridotheres javanicus*				8
29	**Common Hill Myna**	*Gracula religiosa*				1
30	Crimson Sunbird	*Aethopyga siparaja*	1	1		
31	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	1	1		1
	Mammals					
1	Plantain Squirrel	*Callosciurus notatus*				3
	Reptiles					

1	Malayan Water Monior	*Varanus salvator*				2
2	Red-eared Slider	*Trachemys scripta*				6

July to October 2015

	Bold Print –	Locally Threatened					
	Bold Print & Capital Lettering –	Internationally Threatened					
		GPS - All bolded species	**Date**	22 Jul	26 Aug	23Sep	15Oct
			Site	PC B	PC B	PC B	PC B
	Birds						
1	White-bellied Sea-Eagle	*Haliaeetus leucogaster*	cr				2
2	**Changeable Hawk-Eagle**	*Nisaetus limnaeetus*	ur		1		
3	Pink-necked Green-Pigeon	*Treron vernans*	cr	3	3	7	1
4	Spotted Dove	*Streptopelia chinensis*	cr	7	1	1	4
5	Zebra Dove	*Geopelia striata*	cr		1		
6	**Emerald Dove**	*Chalcophaps indica*	ur		1		
7	Long-tailed Parakeet	*Psittacula longicauda*	cr	4	1	4	11
8	Asian Koel	*Eudynamys scolopacea*	cr		1		
9	Lesser Coucal	*Centropus bengalensis*	cr	1			
10	Germain's Swiftlet	*Aerodramus germane*	cr	12	3	15	3
11	Blue-tailed Bee-eater	*Merops philippinus*	cm				1
12	Laced Woodpecker	*Picus vittatus*	cr	1			
13	House Swallow	*Hirundo tahitica*	cr		4	2	
14	**STRAW-HEADED BULBUL**	*Pycnonotus zeylanicus*	ur	1	1		1
15	Olive-winged Bulbul	*Pycnonotus plumosus*	cr	6	3	4	
16	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	cr		4		1
17	Short-tailed Babbler	*Malacocincla malaccensis*	cr	1			
18	Pin-striped Tit-Babbler	*Macronous gularis*	cr	2			
19	Common Tailorbird	*Orthotomus sutorius*	cr	1			
20	Dark-necked Tailorbird	*Orthotomus atrogularis*	cr		1		1
21	Asian Glossy Starling	*Aplonis panayensis*	cr	11	10	20	57

22	Javan Myna	*Acridotheres javanicus*	ci	12	4	4	5
23	**Common Hill Myna**	*Gracula religiosa*	ur				2
24	Brown-throated Sunbird	*Anthrepetes malacensis*	cr	1			1
25	Crimson Sunbird	*Aethopyga siparaja*	cr	1			1
26	Little Spiderhunter	*Arachnothera longirostra*	cr				1
27	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	cr		1		2
28	Red Jungle Fowl				1		
29	Tiger Shrike					1	
	Mammals						
1	Plantain Squirrel	*Callosciurus notatus*	cr				1
2	Slender Squirrel	*Sundasciurus tenuis*	cr				1
	Reptiles						
1	Malayan Water Monior	*Varanus salvator*	cr	1	1	1	
2	Red-eared Slider	*Trachemys scripta*	ci	6	3	3	5
3	Tokay Gecko				1		

Appendix 3 : Additional Rapid Fauna Survey

Zone H – Ulu Sembawang Forest (Central Catchment N.R) Transect & Pt Count

	Bold Print – Locally Threatened	Bold Print & Capital Lettering – Internationally Threatened	**T**	**PC**		
			Jun	**Jun**		
No	**Common Names**	**Latin Names**	**2nd**	**4th**		
	Birds					
1	White-bellied Sea-Eagle	*Haliaeetus leucogaster*		2		
2	**Changeable Hawk-Eagle**	*Nisaetus limnaeetus*	1			
3	Pink-necked Green-Pigeon	*Treron vernans*	1	8		
4	Spotted Dove	*Streptopelia chinensis*	1	2		
5	Long-tailed Parakeet	*Psittacula longicauda*	1	5		
6	**Chestnut-bellied Malkoha**	*Phaenicophaeus sumatranus*		2		

7	**Greater Coucal**	*Centropus sinensis*		1		
8	Black-Nest Swiftlet	*Aerodramus maxima*		5		
9	Collared Kingfisher	*Todiramphus chloris*	1			
10	Blue-throated Bee-eater	*Merops viridis*	1			
11	Common Flameback	*Dinopium javanense*	1			
12	House Swallow	*Hirundo tahitica*		2		
13	Common Iora	*Aegithina tiphia*	1			
14	**Blue-winged Leafbird**	*Chloropsis cochinchinensis*		1		
15	**STRAW-HEADED BULBUL**	*Pycnonotus zeylanicus*	1			
16	Yellow-vented Bulbul	*Pycnonotus goiavier*	1	1		
17	Olive-winged Bulbul	*Pycnonotus plumosus*	1	4		
18	Cream-vented Bulbul	*Pycnonotus simplex*	1			
19	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	2			
20	Black-naped Oriole	*Oriolus chinensis*	1	1		
21	**Abbott's Babbler**	*Malacocincla abbotti*	1	1		
22	Short-tailed Babbler	*Malacocincla malaccensis*	2			
23	Pin-striped Tit-Babbler	*Macronous gularis*	2	1		
24	Dark-necked Tailorbird	*Orthotomus atrogularis*	1	1		
25	Rufous-tailed Tailorbird	*Orthotomus sericeus*	1			
26	Asian Glossy Starling	*Aplonis panayensis*	1			
27	Javan Myna	*Acridotheres javanicus*	1	5		
28	Brown-throated Sunbird	*Anthrepetes malacensis*	2	1		
29	Van Hasselt's Sunbird	*Leptocoma brasiliana*	2	1		
30	Crimson Sunbird	*Aethopyga siparaja*	2	2		
31	Little Spiderhunter	*Arachnothera longirostra*	3			
32	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	2	1		
33	Oriental White-eye	*Zosterops palpebrosus*	1			
	Mammals					
1	Common Treeshrew	*Tupaia glis*	1	1		

2	Plantain Squirrel	*Callosciurus notatus*	1			
3	Slender Squirrel	*Sundasciurus tenuis*	3	1		
4	Wild Boar	*Sus scrofa*	(3)			
	Reptiles					
1	Common Sun Skink	*Eutropis multifasciatus*		2		
	Dragonflies					
1	Ornate Coraltail	*Ceriagrion cerinorubellum*		7		
2	**Fiery Coraltail**	*Ceriagrion chaoi*		5		
3	Common Blue Sprite	*Pseudagrion microcephalum*		1		
4	Common Flangetail	*Ictinogomphus decoratus*		1		
5	**Pond Adjutant**	*Aethriamanta gracilis*		12		
6	Blue Dasher	*Brachydiplax chalybea*		1		
7	Water Monarch	*Hydrobasileus croceus*		4		
8	Common Parasol	*Neurothemis fluctuans*		2		
9	**Banded Skimmer**	*Pseudothemis jorina*		1		
10	Common Redbolt	*Rhodothemis rufa*		8		
11	**Bronze Flutterer**	*Rhyothemis obsolence*		6		
12	Yellow-barred Flutterer	*Rhyothemis phyllis*		6		
13	**Sapphire Flutterer**	*Rhyothemis triangularis*		6		
14	Scarlet Basker	*Urothemis signata*		4		

Butterflies

1	Chocolate Grass Yellow	*Eurema sari sodalis*	1			
2	Archduke	*Lexias pardalis dirteana*	1			
3	Branded Imperial	*Eooxylides tharis distanti*	1			

Appendix 4 : Nocturnal Surveys

	Bold Print –	Locally Threatened				
	Bold Print & Capital Lettering –	Internationally Threatened	**Zone A**	**Zone F**	**Zone G**	**Zone D**
			Upper Seletar Peninsula	**Singapore Zoo**	**Night Safari**	**Unnamed Road along Project Western Boundary**
			02/05/15	**22/05/15**	**22/05/15**	**26/06/15**
	Birds					
1	Grey Heron	*Ardea cinerea*	7			
2	**Purple Heron**	*Ardea purpurea*			7	
3	Little Heron	*Butorides striatus*	2			
4	**Black-crowned Night Heron**	*Nycticorax nycticorax*	1		2	1
5	**Changeable Hawk-Eagle**	*Nisaetus limnaeetus*				3
6	Red-legged Crake	*Rallina fasciata*				1
7	Spotted Dove	*Streptopelia chinensis*				3
8	**Emerald Dove**	*Chalcophaps indica*				3
9	Long-tailed Parakeet	*Psittacula longicauda*			1	1
10	**Drongo Cuckoo**	*Surniculus lugubris*			1	
11	Collared Scops Owl	*Otus bakkamoena*	2		1	5
12	**Buffy Fish Owl**	*Ketupa ketupu*	2			
13	**Spotted Wood Owl**	*Strix seluputo*		2	1	
14	Large-tailed Nightjar	*Caprimulgus mucrurus*	2	4	6	3
15	Germain's Swiftlet	*Aerodramus germani*			1	10
16	White-throated Kingfisher	*Halcyon smyrnensis*			1	1
17	Collared Kingfisher	*Todiramphus chloris*				1
18	Blue-throated Bee-eater	*Merops viridis*				1
19	**RED-CROWNED BARBET**	*Megalaima rafflesii*	1			

20	Banded Woodpecker	*Chrysophelgma miniaceus*			1	1
21	Olive-winged Bulbul	*Pycnonotus plumosus*	3		1	
22	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	3		2	1
23	Black-naped Oriole	*Oriolus chinensis*			1	
24	Southern Jungle Crow	*Corvus macrorhynchos*				1
25	**Oriental Magpie-Robin**	*Copsychus saularis*			1	
26	Rufous-tailed Tailorbird	*Orthotomus sericeus*				1
27	Tiger Shrike	*Lanius tigrinus*	1			
28	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*			1	
E	**MILKY STORK**	*Mycteria cinerea*	2			
E	**PAINTED STORK**	*Mycteria leucocephala*				
	Mammals (N=netted)					
1	Malayan Colugo	*Galeopterus variegatus*		6	7	
2	House Shrew	*Suncus murinus*			1	
3	Common Fruit Bat	*Cynopterus brachyotis*		30	24 (5N)	7 (1N)
4	Pouched Tomb Bat	*Saccolaimus saccolaimus*			1	4
5	Whiskered Myotis	*Myotis muricola*		1	4	
6	Grey Large-footed Myotis	*Myotis hasselti*	2			
7	**Javan Pipistrelle**	*Pipistrellus javanicus*				14 (1)
8	Lesser Asiatic Yellow House Bat	*Scotophilus kuhlii*			3	39
9	**Greater Bamboo Bat**	*Tylonycteris robustula*				17
10	**Lesser Bamboo Bat**	*Tylonycteris pachypus*			4 (4N)	9
11	**Bamboo Bat**	*Tylonycteris sp.*			1	40
	Insectivorous Bat sp.	*?*		12		
12	**Horsfield's Flying Squirrel**	*Iomys horsfieldii*	1			
13	Plantain Squirrel	*Callosciurus notatus*		1	3	2
14	Slender Squirrel	*Sundasciurus tenuis*			3	3
15	Singapore Rat	*Rattus annandalei*			1	

	Rat sp			20		
	Reptiles					
1	Reticulated Python	*Broghammerus reticulatus*		1		
2	Oriental Whip Snake	*Ahaetulla prasina*		1		
3	Paradise Tree Snake	*Chrysopelea paradisi*			1 Slough	
4	**Malayan Racer**	*Coelognathus flavolineatus*	1 roadkill			
5	Painted Bronzeback	*Dendrelaphis pictus*				2
6	Striped Bronzeback	*Dendrelaphis caudolineatus*	1			
7	Flat-tailed Gecko	*Gehyra mutilata*		5	2	
8	Tokay Gecko	*Gecko gekko*		4	4	
9	Spotted House Gecko	*Gekko monarchus*		5	21	1
10	Spiny-tailed House Gecko	*Hemidactylus frenatus*	2		11	
11	Four-clawed Gecko	*Hemidactylus platyurus*		20	5	
12	**Lowland Dwarf Gecko**	*Hemiphyllodactylus typus*				1
13	Changeable Lizard	*Calotes versicolor*		1		
14	**Green-crested Lizard**	*Bronchocela cristatella*		4		
E	Giant Leaf Terrapin	*Heosemys grandis*				1
	Amphibians					
1	Asian Toad	*Duttaphrynus melanostictus*			2	
2	Black-eyed Litter Frog	*Leptobrachium nigrops*	7			
3	Field Frog	*Fejervarya limnocharis*			1	1
4	Malayan Giant Frog	*Limnonectes blythii*	2		5	9
5	Malesian Frog	*Limnonectes malesianus*	1			
6	Copper-cheeked Frog	*Hylarana labialis*				1
7	**Golden-eared Rough-sided Frog**	*Hylarana baramica*	1			
8	Common Tree Frog	*Polypedates leucomystax*			8	3

9	**Black-spotted Sticky Frog**	*Kalophrynus pleurostigma*			3	
10	Banded Bull Frog	*Kaloula pulchra*			2	
11	Painted Chorus Frog	*Microhyla butleri*			2	
12	Dark-sided Chorus Frog	*Microhyla heymonsi*	3		15	3
	Dragonfly					
1	**Spear-tailed Duskhawker**	*Gynacantha dohrni*				1

Note:
(1) There are two known pipistrelle species in Singapore, the Javan pipistrelle and Malaysian Noctule. The former is regularly seen in various parts of Singapore. There has been no confirmation of the latter species since 1984.

Nocturnal Part Two : August to October 2015

	Bold Print –	Locally Threatened			
	Bold Print & Capital Lettering –	Internationally Threatened	**Zone B**	**Zone E**	**Zone H**
			Steven Lee Woods	**Mandai Range Forest**	**Ulu Sembawang**
			22/08/15	**05/09/15**	**14/10/15**
	Birds				
1	**Black-crowned Night Heron**	*Nycticorax nycticorax*		3	2
2	**Changeable Hawk-Eagle**	*Nisaetus limnaeetus*		1	1
3	Red-legged Crake	*Rallina fasciata*		1	2
4	Collared Scops Owl	*Otus bakkamoena*	2	3	1
5	Brown Hawk Owl	*Ninox scutulata*		1	1
6	**Spotted Wood Owl**	*Strix seluputo*		1	
7	Large-tailed Nightjar	*Caprimulgus mucrurus*	1	4	2
8	Laced Woodpecker	*Picus vittatus*			1
9	Greater Racket-tailed Drongo	*Dicrurus paradiseus*		2	2
10	Black-naped Oriole	*Oriolus chinensis*		1	

11	**Pin-striped Tit Babbler**	*Macronus gularis*		5	2
E	**PAINTED STORK**	*Mycteria leucocephala*			
	Mammals (N=netted)				
1	Malayan Colugo	*Galeopterus variegatus*			2
2	Common Fruit Bat	*Cynopterus brachyotis*	12(7N)		6(4N)
3	Pouched Tomb Bat	*Saccolaimus saccolaimus*	1		
4	Whiskered Myotis	*Myotis muricola*			1
5	**Horsfield's Flying Squirrel**	*Iomys horsfieldii*			4
6	Slender Squirrel	*Sundasciurus tenuis*	1		
7	Lesser Mouse Deer	*Tragulus kancil*	1		
	Reptiles				
1	Sunbeam Snake	*Xenopeltis unicolor*			1
2	Oriental Whip Snake	*Ahaetulla prasina*	1		1
3	Painted Bronzeback	*Dendrelaphis pictus*	1		1
4	Striped Kukri	*Oligodon octolineatus*	1		
5	Spotted House Gecko	*Gekko monarchus*	3	5	
6	Spiny-tailed House Gecko	*Hemidactylus frenatus*	4	2	4
7	Changeable Lizard	*Calotes versicolor*		1	
8	**Green-crested Lizard**	*Bronchocela cristatella*	1		
	Amphibians				
1	Asian Toad	*Duttaphrynus melanostictus*	1		
2	Black-eyed Litter Frog	*Leptobrachium nigrops*		1	2
3	Field Frog	*Fejervarya limnocharis*	3		
4	Malayan Giant Frog	*Limnonectes blythii*	2	4	2
5	Copper-cheeked Frog	*Hylarana labialis*			2
6	Masked Rough-sided Frog	*Hylarana laterimaculata*	1		3
7	**Spotted Tree Frog**	***Nyctixalus pictus***	1	2	
8	Common Tree Frog	*Polypedates leucomystax*	3	4	4
9	**Black-spotted Sticky Frog**	*Kalophrynus pleurostigma*		1	

10	Painted Chorus Frog	*Microhyla butleri*	2		2
11	Dark-sided Chorus Frog	*Microhyla heymonsi*	10	6	7
	Fish				
1	Einthoven's Rasbora	*Rasbora einthovenii*			6
2	Two-spot Rasbora	*Rasbora elegans*			3
3	Saddle Barb	*Systomus banksii*			10
4	**Sunda Leaf Fish**	*Nandus nebulosus*			1

Appendix 5 : Additional Afternoon Herptile Surveys (Please refer to Serin Subaraj's Herptile Report for up-dated data)

	Bold Print – Locally Threatened	Bold Print & Capital Lettering – Internationally Threatened	**Zone B**	**Zone D**	**Zone E**	**Zone G**			
			Steven Lee Woods	**Unnamed Road along Project Western Boundary**	**Mandai Range Forest**	**Night Safari**			
		Afternoon Surveys	05/04/15	26/04/15	16/05/15	21/06/15			
No	**Common Names**	**Latin Names**							
1	Oriental Whip Snake	*Ahaetulla prasina*		1					
2	**Twin-barred Tree Snake**	*Chrysopelea pelias*				1 roadkill			
3	**Gold-ringed Cat Snake**	*Boiga dendrophila*			1				
4	Painted Bronzeback	*Dendrelaphis pictus*		1	1				
5	White-spotted Slug Snake	*Pareas margaritophorus*				1 roadkill			
6	**Blue Coral Snake**	*Calliophis bivirgatus*				1			
7	Malayan Water Monior	*Varanus salvator*				1			
8	Clouded Monitor	*Varanus nebulosus*				1			
9	Common Sun Skink	*Eutropis multifasciatus*		1					

10	Spotted House Gecko	*Gekko monarchus*				1			
12	Spiny-tailed House Gecko	*Hemidactylus frenatus*	1			2			
13	Changeable Lizard	*Calotes versicolor*	1	2	2				
	Amphibians								
1	Field Frog	*Fejervarya limnocharis*			1+20 tadpoles				
2	Malayan Giant Frog	*Limnonectes blythii*	1		3				
3	Common Greenback	*Hylarana erythraea*			1				
4	**Spotted Tree Frog**	*Nyctixalus pictus*	2						
5	Common Tree Frog	*Polypedates leucomystax*		1					
6	**Black-spotted Sticky Frog**	*Kalophrynus pleurostigma*		3					
7	Painted Chorus Frog	*Microhyla butleri*	1						
8	Dark-sided Chorus Frog	*Microhyla heymonsi*	3		4				

MANDAI PROJECT AREA - Mammal, Herptile and Odonate List

Subaraj Rajathurai

	Bold Print – Locally Threatened	Bold Print & Capital Lettering – Internationally Threatened		**Status in Red Data Bk**
c	Common	r - resident		CR-Critically Endangered
u	Uncommon	m – migrant		EN-Endangered
s	scarce	v – visitor		VU-Vulnerable
E	Escapee	i – introduced		DD-Data Deficient
	Blue – Addition to previous interim baseline checklist	Green – Forest Dependent		NE- Nationally Extinct
		Purple – Woodland Specialist		
		Red – Grassland Specialist		
		Grey – Aquatic Dependents		
No	**Common Names**	**Latin Names**	**Status**	**Remarks**
	Birds			
1	Grey Heron	*Ardea cinerea*	cr	VU
2	**Purple Heron**	*Ardea purpurea*	ur	EN
3	Little Heron	*Butorides striatus*	cr	
4	Chinese Pond Heron	*Ardeola bacchus*	cm	
5	**Black-crowned Night Heron**	*Nycticorax nycticorax*	ur	CR
6	Eastern Cattle Egret	*Bubulcus coromandus*	cm	
7	Yellow Bittern	*Ixobrychus sinensis*	sr/cm	
8	Osprey	*Pandion haliaetus*	um	
9	Oriental Honey-Buzzard	*Pernis ptilorhyncus*	cm	
10	Brahminy Kite	*Haliastur indus*	cr	
11	White-bellied Sea-Eagle	*Haliaeetus leucogaster*	cr	
12	**GREY-HEADED FISH-EAGLE**	*Ichthyophaga ichthyaetus*	sr	CR

13	**Crested Serpent-Eagle**	*Spilornis cheela*	sr/uv	CR
14	**Crested Goshawk**	*Accipiter trivirgatus*	ur	CR
15	Japanese Sparrowhawk	*Accipiter gularis*	cm	
16	Chinese Goshawk	*Accipiter soloensis*	cm	
17	**Changeable Hawk-Eagle**	*Nisaetus limnaeetus*	ur	EN
18	Slaty-breasted Rail	*Gallirallus striatus*	cr	
19	Red-legged Crake	*Rallina fasciata*	cr	VU
20	White-breasted Waterhen	*Amaurornis phoenicurus*	cr	
21	**MASKED FINFOOT**	*Heliopais personata*	sv	
22	Common Sandpiper	*Actitis hypoleucos*	cm	
23	Common Snipe	*Gallinago gallinago*	um	
24	Pintail Snipe	*Gallinago stenura*	cm	
25	**Thick-billed Green-Pigeon**	*Treron curvirostra*	ur	EN
26	Pink-necked Green-Pigeon	*Treron vernans*	cr	
27	Spotted Dove	*Streptopelia chinensis*	cr	
28	Zebra Dove	*Geopelia striata*	cr	
29	**Emerald Dove**	*Chalcophaps indica*	ur	
30	Rainbow Lorikeet	*Trichoglossus haematodus*	ui	
31	Rose-ringed Parakeet	*Psittacula krameri*	ui	
32	Red-breasted Parakeet	*Psittacula alexandri*	ci	
33	Long-tailed Parakeet	*Psittacula longicauda*	cr	
34	**BLUE-RUMPED PARROT**	*Psittinus cyanurus*	sr	CR
35	**Blue-crowned Hanging Parrot**	*Loriculus galgulus*	cr	EN
36	Indian Cuckoo	*Cuculus micropterus*	cm	
37	Himalayan Cuckoo	*Cuculus saturatus*	sm	
38	**Banded Bay Cuckoo**	*Cacomantis sonneratii*	ur	
39	**Plaintive Cuckoo**	*Cacomantis merulinus*	sr	
40	**Violet Cuckoo**	*Chrysococcyx xanthorhynchus*	ur	EN
41	Little Bronze-Cuckoo	*Chrysococcyx minutilus*	cr	
42	**Drongo Cuckoo**	*Surniculus lugubris*	sr	CR
43	Asian Koel	*Eudynamys scolopacea*	cr	

44	**Chestnut-bellied Malkoha**	*Phaenicophaeus sumatranus*	ur	
45	**Greater Coucal**	*Centropus sinensis*	ur	
46	Lesser Coucal	*Centropus bengalensis*	cr	
47	Collared Scops Owl	*Otus bakkamoena*	cr	
48	**Buffy Fish Owl**	*Ketupa ketupu*	sr	CR
49	Brown Hawk Owl	*Ninox scutulata*	cr	
50	**Spotted Wood Owl**	*Strix seloputo*	ur	CR
51	Large-tailed Nightjar	*Caprimulgus mucrurus*	cr	
52	Germain's Swiftlet	*Aerodramus germane*	cr	
53	Black-Nest Swiftlet	*Aerodramus maxima*	cr	
54	Himalayan Swiftlet	*Aerodramus brevirostris*	cm	
55	House Swift	*Apus affinis*	cr	
56	**Grey-rumped Treeswift**	*Hemiprocne longipennis*	ur	
57	**Blue-eared Kingfisher**	*Alcedo meninting*	ur	CR
58	Black-backed Kingfisher	*Ceyx erithaca*	um	
59	Stork-billed Kingfisher	*Halcyon capensis*	ur	
60	Ruddy Kingfisher	*Halcyon coromanda*	um	
61	White-throated Kingfisher	*Halcyon smyrnensis*	cr	
62	Collared Kingfisher	*Todiramphus chloris*	cr	
63	Blue-tailed Bee-eater	*Merops philippinus*	cm	
64	Blue-throated Bee-eater	*Merops viridis*	cr	
65	**Dollarbird**	*Eurystomus orientalis*	ur/cm	
66	**RED-CROWNED BARBET**	*Megalaima rafflesii*	ur	
67	Lineated Barbet	*Megalaima lineata*	ci	
68	Coppersmith Barbet	*Megalaima haemacephala*	cr	
69	**Rufous Woodpecker**	*Micropternus brachyurus*	ur	
70	Laced Woodpecker	*Picus vittatus*	cr	
71	Banded Woodpecker	*Chrysophelgma miniaceus*	cr	
72	Common Flameback	*Dinopium javanense*	cr	
73	Sunda Pygmy Woodpecker	*Dendrocopus moluccensis*	cr	
74	**MANGROVE PITTA**	*Pitta megarhyncha*	sv	CR
75	Barn Swallow	*Hirundo rustica*	cm	

76	House Swallow	*Hirundo tahitica*	cr	
77	Pied Triller	*Lalage nigra*	cr	
78	Ashy Minivet	*Pericrocotus divaricatus*	cm	
79	Common Iora	*Aegithina tiphia*	cr	
80	**Blue-winged Leafbird**	*Chloropsis cochinchinensis*	ur	
81	**STRAW-HEADED BULBUL**	*Pycnonotus zeylanicus*	ur	EN
82	Red-whiskered Bulbul	*Pycnonotus jocosus*	ui	
83	Yellow-vented Bulbul	*Pycnonotus goiavier*	cr	
84	Olive-winged Bulbul	*Pycnonotus plumosus*	cr	
85	Cream-vented Bulbul	*Pycnonotus simplex*	cr	
86	**Red-eyed Bulbul**	*Pycnonotus brunneus*	ur	EN
87	Ashy Bulbul	*Hemixos flavala*	uv	
88	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	cr	
89	Black-naped Oriole	*Oriolus chinensis*	cr	
90	Asian Fairy-Bluebird	*Irena puella*	cr	
91	House Crow	*Corvus splendens*	ci	
92	Southern Jungle Crow	*Corvus macrorhynchos*	ur	
93	**Abbott's Babbler**	*Malacocincla abbotti*	ur	
94	Short-tailed Babbler	*Malacocincla malaccensis*	cr	
95	Pin-striped Tit-Babbler	*Macronous gularis*	cr	
96	White-crested Laughingthrush	*Garrulax leucolophus*	ci	
97	Siberian Blue Robin	*Luscinia cyane*	cm	
98	**Oriental Magpie-Robin**	*Copsychus saularis*	ur	EN
99	**White-rumped Shama**	*Copsychus malabaricus*	ur	CR
100	Golden-bellied Gerygone	*Gerygone sulphurea*	cr	
101	Arctic Warbler	*Phylloscopus borealis*	cm	
102	Common Tailorbird	*Orthotomus sutorius*	cr	
103	Dark-necked Tailorbird	*Orthotomus atrogularis*	cr	
104	Rufous-tailed Tailorbird	*Orthotomus sericeus*	cr	
105	Yellow-bellied Prinia	*Prinia flaviventris*	cr	

106	Asian Brown Flycatcher	*Muscicapa dauurica*	cm	
107	Yellow-rumped Flycatcher	*Ficedula zanthopygia*	cm	
108	Blue-and-White Flycatcher	*Cyanoptila cyanomelana*	sm	
109	Pied Fantail	*Rhipidura javanica*	cr	
110	Forest Wagtail	*Dendronanthus indicus*	cm	
111	Paddyfield Pipit	*Anthus rufulus*	cr	
112	Brown Shrike	*Lanius cristatus*	cm	
113	Tiger Shrike	*Lanius tigrinus*	cm	
114	Asian Glossy Starling	*Aplonis panayensis*	cr	
115	Purple-backed Starling	*Sturnus sturninus*	cm	
116	Common Myna	*Acridotheres tristis*	cr	
117	Javan Myna	*Acridotheres javanicus*	ci	
118	**Common Hill Myna**	*Gracula religiosa*	ur	
119	Brown-throated Sunbird	*Anthrepetes malacensis*	cr	
120	Van Hasselt's Sunbird	*Leptocoma brasiliana*	cr	
121	Olive-backed Sunbird	*Cinnyris jugularis*	cr	
122	Crimson Sunbird	*Aethopyga siparaja*	cr	
123	Little Spiderhunter	*Arachnothera longirostra*	cr	
124	Yellow-eared Spiderhunter	*Arachnothera chrysogenys*	sv	CR
125	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	cr	
126	Scarlet-backed Flowerpecker	*Dicaeum cruentatum*	cr	
127	Oriental White-eye	*Zosterops palpebrosus*	ci/sv	
128	Baya Weaver	*Ploceus philippinus*	cr	
129	Scaly-breasted Munia	*Lonchura punctulata*	cr	
130	**Chestnut Munia**	*Lonchura atricapilla*	ur	
E	Common Peafowl	*Pavo cristatus*	-	
E	Red Junglefowl (hybrid)	*Gallus gallus*	-	
E	**MILKY STORK**	*Mycteria cinerea*	-	
E	**PAINTED STORK**	*Mycteria leucocephala*	-	

	Mammals			
1	**SUNDA PANGOLIN**	*Manis javanica*	sr	CR
2	Common Treeshrew	*Tupaia glis*	cr	
3	Malayan Colugo	*Galeopterus variegatus*	cr	
4	House Shrew	*Suncus murinus*	cr	
5	Malayan Flying Fox	*Pyeropus vampyrus*	sv	
6	Common Fruit Bat	*Cynopterus brachyotis*	cr	
7	**Cave Nectar Bat**	*Eonycteris spelaea*	ur	
8	Blyth's Horseshoe Bat	*Rhinolophus lepidus*	cr	
9	Pouched Tomb Bat	*Saccolaimus saccolaimus*	cr	
10	Whiskered Myotis	*Myotis muricola*	cr	
11	Grey Large-footed Myotis	*Myotis hasselti*	cr	
12	**Javan Pipistrelle**	*Pipistrellus javanicus*	ur	
13	Lesser Asiatic Yellow House Bat	*Scotophilus kuhlii*	cr	
14	**Greater Bamboo Bat**	*Tylonycteris robustula*	ur	
15	**Lesser Bamboo Bat**	*Tylonycteris pachypus*	sr	CR
16	**SUNDA SLOW LORIS**	*Nycticebus coucang*	sr	CR
17	**BANDED LEAF MONKEY**	*Presbytis femoralis*	sr	CR
18	Long-tailed Macaque	*Macaca fascicularis*	cr	
19	**Horsfield's Flying Squirrel**	*Iomys horsfieldii*	ur	EN
20	Plantain Squirrel	*Callosciurus notatus*	cr	
21	Slender Squirrel	*Sundasciurus tenuis*	cr	
22	Singapore Rat	*Rattus annandalei*	cr	
23	Oriental House Rat	*Rattus tanezumi*	cr	
24	**Malayan Porcupine**	*Hystrix brachyura*	sr	CR
25	**Common Palm Civet**	*Paradoxurus hermaphroditus*	ur	
26	Wild Boar	*Sus scrofa*	cr	
27	**Lesser Mousedeer**	*Tragulus kanchil*	sr	CR
28	**Sambar Deer**	*Rusa unicolor*	ui	
	Reptiles			

1	Brahminy Blind Snake	*Ramphotyphlops braminus*	cr	
2	**White-bellied Blind Snake**	*Typhlops muelleri*	sr	CR
3	Sunbeam Snake	*Xenopeltis unicolor*	cr	
4	Reticulated Python	*Malayopython reticulatus*	cr	
5	Oriental Whip Snake	*Ahaetulla prasina*	cr	
6	**Dog-toothed Cat Snake**	***Boiga cynodon***	ur	EN
7	**Yellow-ringed Cat Snake**	*Boiga dendrophila*	ur	VU
8	**Jasper Cat Snake**	***Boiga jaspidae***	sr	CR
9	**Pink-headed Reed Snake**	***Calamaria schlegeli***	ur	VU
10	Paradise Tree Snake	*Chrysopelea paradisi*	cr	
11	**Twin-barred Tree Snake**	*Chrysopelea pelias*	ur	VU
12	**Common Malayan Racer**	*Coelognathus flavolineatus*	ur	EN
13	**Elegant Bronzeback**	***Dendrelaphis formosus***	ur	EN
14	**Red-necked Bronzeback**	*Dendrelaphis kopsteini*	cr	VU
15	Painted Bronzeback	*Dendrelaphis pictus*	cr	
16	Striped Bronzeback	*Dendrelaphis caudolineatus*	cr	
17	**Red-tailed Racer**	*Gonyosoma oxycephalum*	sr	EN
18	Common Wolf Snake	*Lycodon capucinus*	cr	
19	Striped Kukri Snake	*Oligodon octolineatus*	cr	
20	**Dwarf Reed Snake**	***Pseudorabdion longiceps***	ur	EN
21	Keeled Rat Snake	*Ptyas carinata*	ur	
22	**White-bellied Rat Snake**	***Ptyas fusca***	ur	EN
23	Indochinese Rat Snake	*Ptyas korros*	cr	
24	**Puff-faced Water Snake**	*Homalopsis buccata*	ur	VU
25	**Blue-necked Keelback**	*Macropisthodon rhodomelas*	ur	EN
26	White-spotted Slug Snake	*Pareas margaritophorus*	ui	
27	**Blue Malayan Coral Snake**	*Calliophis bivirgatus*	ur	VU
28	**Banded Malayan Coral Snake**	***Calliophis intestinalis***	ur	VU
29	Black Spitting Cobra	*Naja sumatrana*	cr	
30	**King Cobra**	*Ophiophagus hannah*	sr	EN
31	Wagler's Pit Viper	*Tropidolaemus wagleri*	cr	EN

32	Malayan Water Monitor	*Varanus salvator*	cr	
33	Clouded Monitor	*Varanus nebulosus*	cr	
34	Common Sun Skink	*Eutropis multifasciatus*	cr	
35	**Yellow-striped Tree Skink**	*Lipinia vittigera*	ur	EN
36	Garden Supple Skink	*Lygosoma bowringii*	cr	
37	**Striped Sun Skink**	***Eutropis rugiferus***	ur	EN
38	**Peninsula Rock Gecko**	***Cnemaspis peninsularis***	ur	
39	**Singapore Bent-toed Gecko**	*Cyrtodactylus majulah*	ur	VU
40	Tokay Gecko	*Gekko gecko*	ui	
41	Spotted House Gecko	*Gekko monarchus*	cr	
42	Four-clawed Gecko	*Gehyra mutilata*	cr	
43	Spiny-tailed House Gecko	*Hemidactylus frenatus*	cr	
44	Flat-tailed Gecko	*Hemidactylus platyurus*	cr	
45	**Lowland Dwarf Gecko**	*Hemiphyllodactylus typus*	ur	VU
46	Maritime Gecko	*Lepidodactylus lugubris*	cr	
47	Common Flying Dragon	*Draco sumatranus*	cr	
48	**Black-bearded Flying Dragon**	*Draco melanopogon*	ur	VU
49	**Green-crested Lizard**	*Bronchocela cristatella*	ur	
50	Changeable Lizard	*Calotes versicolor*	ci	
51	Red-eared Slider	*Trachemys scripta*	ci	
52	Malayan Box Terrapin	*Cuora amboinensis*	cr	
53	**Malayan Flatshell Terrapin**	*Notochelys platynota*	sr	EN
54	Black Marsh Terrapin	*Siebenrockiella crassicollis*	ci	
55	**Asian Softshell Turtle**	*Amyda cartilaginea*	sr	EN
56	Giant Asian Pond Terrapin	*Heosemys grandis*	ui	
57	Bornean Giant River Terrapin	*Orlitia borneensis*	si	
E	Golden Tree Snake	*Chrysopelea ornata*	-	
	Amphibians			

1	Asian Toad	*Duttaphrynus melanostictus*	cr	
2	Four-ridged Toad	*Ingerophrynus quadriporcatus*	cr	
3	Black-eyed Litter Frog	*Leptobrachium nigrops*	cr	
4	Field Frog	*Fejervarya limnocharis*	cr	
5	Malayan Giant Frog	*Limnonectes blythii*	cr	
6	Malesian Frog	*Limnonectes malesianus*	cr	
7	Common Greenback	*Hylarana erythraea*	cr	
8	Copper-cheeked Frog	*Hylarana labialis*	cr	
9	**Golden-eared Rough-sided Frog**	*Hylarana baramica*	ur	VU
10	**Masked Rough-sided Frog**	*Hylarana laterimaculata*	ur	
11	**Spotted Tree Frog**	*Nyctixalus pictus*	ur	VU
12	Common Tree Frog	*Polypedates leucomystax*	cr	
13	Banded Bull Frog	*Kaloula pulchra*	ci	
14	**Black-spotted Sticky Frog**	*Kalophrynus pleurostigma*	ur	VU
15	Painted Chorus Frog	*Microhyla butleri*	cr	
16	Dark-sided Chorus Frog	*Microhyla heymonsi*	cr	
17	American Bullfrog	*Lithobates catesbeianus*	ci	
	Dragonflies			
1	Common Flashwing	*Vestalis amethystina*	cr	
2	**Golden Gem**	*Libellago lineata*	ur	
3	Ornate Coraltail	*Ceriagrion cerinorubellum*	cr	
4	**Fiery Coraltail**	*Ceriagrion chaoi*	sr	
5	Common Blue Sprite	*Pseudagrion microcephalum*	cr	
6	**Grey Sprite**	*Pseudagrion pruinosum*	ur	CR
7	**Telephone Sylvan**	*Coeliccia octogesima*	ur	
8	Yellow Featherlegs	*Copera marginipes*	cr	
9	**Orange-striped Threadtail**	*Prodasineura humeralis*	ur	CR
10	**Spoon-tailed Duskhawker**	*Gynacantha basiguttata*	ur	
11	**Spear-tailed Duskhawker**	*Gynacantha dohrni*	ur	
12	Common Flangetail	*Ictinogomphus decoratus*	cr	

13	Pond Cruiser	*Epophthalmia vittigera*	cr	
14	Trumpet Tail	*Acisoma panorpoides*	cr	
15	Pond Adjutant	*Aethriamanta gracilis*	cr	
16	**Grenadier**	*Agrionoptera insignis*	ur	
17	**Handsome Grenadier**	*Agrionoptera sexlineata*	ur	CR
18	Blue Dasher	*Brachydiplax chalybea*	cr	
19	**Sultan**	*Camacinia gigantea*	ur	CR
20	Common Scarlet	*Crocothemis servilia*	cr	
21	Dark-tipped Forest-skimmer	*Cratilla metallica*	cr	
22	Chalky Percher	*Diplacodes trivialis*	cr	
23	Water Monarch	*Hydrobasileus crococeus*	cr	
24	Scarlet Grenadier	*Lathrecista asiatica*	cr	
25	Coastal Glider	*Macrodiplax cora*	cr	
26	Common Parasol	*Neurothemis fluctuans*	cr	
27	Variable Sentinel	*Orchithemis pulcherrima*	cr	
28	Spine-tufted Skimmer	*Orthetrum chrysis*	cr	
29	Common Blue Skimmer	*Orthetrum glaucum*	cr	
30	Slender Blue Skimmer	*Orthetrum luzonicum*	cr	
31	Variegated Green Skimmer	*Orthetrum sabina*	cr	
32	Scarlet Skimmer	*Orthetrum testaceum*	cr	
33	Wandering Glider	*Pantala flavescens*	cr	
34	Common Chaser	*Potamarcha congener*	cr	
35	**Banded Skimmer**	*Pseudothemis jorina*	ur	CR
36	Common Redbolt	*Rhodothemis rufa*	cr	
37	**Bronze Flutterer**	*Rhyothemis obsolescens*	ur	CR
38	Yellow-barred Flutterer	*Rhyothemis phyllis*	cr	
39	**Sapphire Flutterer**	*Rhyothemis triangularis*	ur	
40	White-barred Duskhawk	*Tholymis tillarga*	cr	
41	Saddlebag Glider	*Tramea transmarina*	cr	
42	Dawn Dropwing	*Trithemis aurora*	cr	
43	Indigo Dropwing	*Trithemis festiva*	cr	

44	Scarlet Basker	*Urothemis signata*	cr	
45	Slender Duskdarter	*Zyxomma petiolatum*	cr	

MANDAI PROJECT AREA – Butterfly List

(Based on previously compiled area list by Khew Sin Khoon)

1	**Common Birdwing**	*Troides helena cerberus*	ur	VU
2	**Common Rose**	*Pachliopta aristolochiae asteris*	ur	VU
3	Common Mime	*Chilasa clytia clytia*	cr	
4	Lime Butterfly	*Papilio demoleus malayanus*	cr	
5	**Banded Swallowtail**	*Papilio demolion demolion*	ur	
6	Common Mormon	*Papilio polytes romulus*	cr	
7	Great Mormon	*Papilio memnon agenor*	cr	
8	Common Bluebottle	*Graphium sarpedon luctatius*	cr	
9	Blue Jay	*Graphium evemon eventus*	cr	
10	Tailed Jay	*Graphium agamemnon agamemnon*	cr	
11	**Five Bar Swordtail**	*Pathysa antiphates itamputi*	ur	
12	Painted Jezebel	*Delias hyparete metarete*	cr	
13	Psyche	*Leptosia nina malayana*	cr	
14	Striped Albatross	*Appias libythea olferna*	cr	
15	Mottled Emigrant	*Catopsilia pyranthe pyranthe*	cr	
16	Lemon Emigrant	*Catopsilia pomona pomona*	cr	
17	Orange Emigrant	*Catopsilia scylla cornelia*	cr	
18	Common Grass Yellow	*Eurema hecabe contubernalis*	cr	
19	**Forest Grass Yellow**	*Eurema simulatrix tecmessa*	ur	
20	Three Spot Grass Yellow	*Eurema blanda snelleni*	cr	
21	**Anderson's Grass Yellow**	*Eurema andersonii andersonii*	ur	
22	Chocolate Grass Yellow	*Eurema sari sodalis*	cr	
23	Tree Yellow	*Gandaca harina distanti*	cr	

24	Dark Glassy Tiger	*Parantica agleoides agleoides*	cr	
25	Blue Glassy Tiger	*Ideopsis vulgaris macrina*	cr	
26	**Common Tree Nymph**	*Idea stolli logani*	ur	
27	**Striped Black Crow**	*Euploea crameri bremeri*	ur	
28	Striped Blue Crow	*Euploea mulciber mulciber*	cr	
29	**Magpie Crow**	*Euploea radamanthus radamanthus*	ur	
30	**Common Evening Brown**	*Melanitis leda leda*	ur	
31	**Tawny Palmfly**	*Elymnias panthera panthera*	ur	
32	Common Palmfly	*Elymnias hypermnestra agina*	cr	
33	**Malayan Bush Brown**	*Mycalesis fusca fusca*	ur	
34	Dingy Bush Brown	*Mycalesis perseus*	cr	
35	**Perseoides Bush Brown**	*Mycalese perseoides perseoides*	sr	DD
36	Dark Brand Bush Brown	*Mycalesis mineus macromalayana*	cr	
37	**Long Brand Bush Brown**	*Mycalesis visala phamis*	ur	
38	Dark Grass Brown	*Orsotriaena medus cinerea*	cr	
39	**Malayan Six Ring**	*Ypthima fasciata torone*	sr	
40	Common Five Ring	*Ypthima baldus newboldi*	cr	
41	**Malayan Five Ring**	*Ypthima horsfieldii humei*	ur	
42	Common Faun	*Faunis canens arcesilas*	cr	
43	**Palm King**	*Amathusia phidippus phidippus*	sr	
44	**Angled Castor**	*Ariadne ariadne ariadne*	sr	
44a	Malayan Eggfly	*Hypolimnas anomala anomala*	cr	
45	Great Eggfly	*Hypolimnas bolina bolina*	cr	
45a	Jacintha Eggfly	*Hypolimnas bolina jacintha*	cr	
46	Autumn Leaf	*Doleschallia bisaltide bisaltide*	cr	
47	**Autumn Leaf**	*Doleschallia bisaltide pratipa*	sr	
48	Chocolate Pansy	*Junonia hedonia ida*	cr	
49	**Grey Pansy**	*Junonia atlites atlites*	ur	
50	Peacock Pansy	*Junonia almana javana*	cr	
51	Blue Pansy	*Junonia orithya wallacei*	cr	
52	Tawny Coster	*Acraea violae*	cr	
53	**Malay Lacewing**	*Cethosia hypsea hypsina*	ur	

54	Leopard Lacewing	*Cethosia cyane*	cr	
55	Leopard	*Phalanta phalantha phalantha*	cr	
56	Rustic	*Cupha erymanthis lotis*	cr	
57	Cruiser	*Vindula dejone erotella*	cr	
58	**Commander**	*Moduza procris milonia*	ur	
59	Knight	*Lebadea martha parkeri*	cr	
60	**Lance Sergeant**	*Athyma pravara helma*	sr	
61	**Dot-Dash Sergeant**	*Athyma nefte subrata*	sr	
62	Colour Sergeant	*Pandita sinope sinope*	cr	
63	**Colonel**	*Pandita sinope sinope*	sr	
64	Common Sailor	*Neptis hylas papaja*	cr	
65	Grey Sailor	*Neptis leucoporos cresina*	cr	
66	**Chocolate Sailor**	*Neptis harita harita*	sr	VU
67	Short Banded Sailor	*Phaedyma columella singa*	cr	
68	**Burmese Lascar**	*Lasippa heliodore dorelia*	sr	DD
69	Malayan Lascar	*Lasippa tiga siaka*	cr	
70	Common Lascar	*Pantoporia hordonia hordonia*	cr	
71	**Perak Lascar**	*Pantoporia paraka paraka*	ur	
72	Malay Viscount	*Tanaecia pelea pelea*	cr	
73	Horsfield's Baron	*Tanaecia iapis puseda*	cr	
74	Malay Baron	*Euthalia monina monina*	cr	
75	Baron	*Euthalia aconthea gurda*	cr	
76	Archduke	*Lexias pardalis dirteana*	cr	
77	Purple Duke	*Eulaceura osteria kumana*	cr	
78	**Courtesan**	*Euripus nyctelius euploeoides*	sr	CR
79	Plain Nawab	*Polyura hebe plautus*	cr	
80	**Spotted Judy**	*Abisara geza niya*	sr	
81	**Malay Tailed Judy**	*Abisara savitri savitri*	sr	
82	**Malayan Plum Judy**	*Abisara saturata kausambioides*	ur	
83	**Lesser Harlequin**	*Laxita thuisto thuisto*	sr	
84	**Sumatran Gem**	*Poritia sumatrae sumatrae*	sr	
85	**Pale Mottle**	*Logania marmorata*	ur	

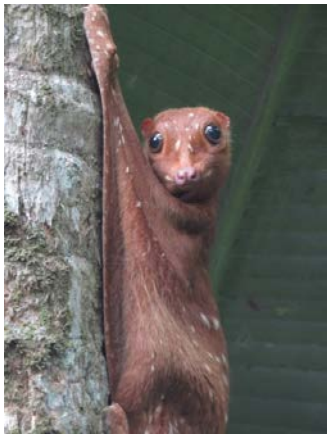
86	Bigg's Brownwing	*Miletus biggsii biggsii*	cr	
87	**Blue Brownwing**	*Miletus symethus petronius*	ur	
88	**Lesser Darkwing**	*Allotinus unicolor unicolor*	ur	
89	**Pale Mottle**	*Logania marmorata damis*	ur	
90	Malayan Sunbeam	*Curetis santana malayica*	cr	
91	**Elbowed Pierrot**	*Caleta elna elvira*	ur	
92	**Quaker**	*Neopithercops zalmora zalmora*	sr	
93	Common Hedge Blue	*Acytolepis puspa lambi*	cr	
94	Lesser Grass Blue	*Zizina otis lampa*	cr	
95	Pygmy Grass Blue	*Zizula hylax pygmaea*	cr	
96	Cycad Blue	*Chilades pandava pandava*	cr	
97	Gram Blue	*Euchrysops cnejus cnejus*	cr	
98	**Silver Forget-Me-Not**	*Catochrysops panormus exiguus*	sr	
99	Pea Blue	*Lampides boeticus*	cr	
100	**Metallic Caerulean**	*Jamides alecto ageladas*	sr	NE
101	Common Caerulean	*Jamides celeno aelianus*	cr	
102	**Sky Blue**	*Jamides caeruleus*	sr	DD
103	Rounded 6-Line Blue	*Nacaduba berenice icena*	cr	
104	**Dark Malayan Sixline Blue**	*Nacaduba calauria malayica*	sr	
105	Pointed Line Blue	*Ionolyce helicon merguiana*	cr	
106	Common Line Blue	*Prosotas nora superdates*	cr	
107	Tailless Line Blue	*Prosotas dubiosa lumpura*	cr	
108	Ciliate Blue	*Anthene emolus goberus*	cr	
109	**Pointed Ciliate Blue**	*Anthene lycaenina miya*	sr	
110		*Arhopala amphimuta amphimuta*	cr	NE
111	**Tailed Disc Oakblue**	*Arhopala atosia malayana*	sr	
112		*Arhopala major major*	cr	DD
113	**Vinous Oakblue**	*Arhopala athada athada*	ur	
114	**Aberrant Oakblue**	*Arhopala abseus abseus*	sr	
115	**Bifid Plushblue**	*Flos diardi capeta*	sr	
116	**Shining Plushblue**	*Flos fulgida singhapura*	sr	
117	**Darky Plushblue**	*Flos anniella anniella*	sr	

118	**Plain PlushBlue**	*Flos apidanus saturatus*	ur	
119		***Semanga superba deliciosa***	sr	
120	Acacia Blue	*Surendra vivarna amisena*	cr	
121	**Scarce Silverstreak**	*Iraota rochana boswelliana*	ur	
122	Yamfly	*Loxura atymnus fuconius*	cr	
123	Branded Imperial	*Eooxylides tharis distanti*	cr	
124	**Pygmy Posy**	*Drupadia rufotaenia rufotaenia*	sr	CR
125	**Great Imperial**	*Jacoona anasuja anasuja*	sr	DD
126	**Cornelian**	*Deudorix epijarbas cinnabarus*	sr	
127	**Yellow Flash**	*Rapala domitia domitia*	sr	
128	**Suffused Flash**	*Rapala suffusa barthema*	ur	
129	**Indigo Flash**	*Rapala varuna orseis*	sr	
130	**Orange Awlet**	*Burara harisa consobrina*	sr	
131	**Common Awl**	*Hasora badra badra*	ur	
132	**Plain Banded Awl**	*Hasora vitta vitta*	sr	
133	**Brown Awl**	*Badamia exclamationis*	sr	
134	**Hieroglyphic Flat**	*Odina hieroglyphica ortina*	sr	
135	**Common Snow Flat**	*Tagiades japetus atticus*	ur	
136	**Large Snow Flat**	*Tagiades gana gana*	sr	
137	**Ultra Snow Flat**	*Tagiades ultra*	sr	
138	**Malayan Snow Flat**	*Tagiades calligana*	sr	
139	**Chestnut Angle**	*Odontoptilum angulatum angulatum*	sr	
140	Bush Hopper	*Ampittia dioscorides camertes*	cr	
141	**Dark Banded Ace**	*Halpe ormenes vilasina*	sr	
142	Chestnut Bob	*Iambrix salsala salsala*	cr	
143	Chocolate Demon	*Ancistroides nigrita maura*	cr	
144	Banded Demon	*Notocrypta paralysos*	cr	
145	**Grass Demon**	*Udaspes folus*	ur	
146	Palm Bob	*Suastus gremius*	cr	
147	**Spotted Flitter**	*Zographetus doxus*	sr	
148	**Chequered Lancer**	*Plastingia naga*	ur	
149	**Yellow Chequered Lancer**	*Plastingia pellonia*	sr	

150	**Pugnacious Lancer**	*Pemara pugnans*	sr	
151	Yellow Vein Lancer	*Pyroneura latoia latoia*	cr	
152	**Banded Redeye**	*Gangara lebadea lebadea*	sr	NE
153	**Common Redeye**	*Matapa aria*	sr	
154		***Erionota torus***	sr	
155	Banana Skipper	*Erionota thrax thrax*	cr	
156	Coconut Skipper	*Hidari irava*	cr	
157	**White Spotted Palmer**	*Eetion elia*	sr	
158	Yellow Grass Dart	*Taractrocera archias quinta*	cr	
159	Common Dartlet	*Oriens gola pseudolus*	cr	
160	Lesser Dart	*Potanthus omaha omaha*	cr	
161	Besta Palm Dart	*Telicota besta bina*	cr	
162	**Palm Dart**	*Telicota augias augias*	sr	
163	Small Branded Swift	*Pelopidas mathias mathias*	cr	
164	Formosan Swift	*Borbo cinnara*	cr	
165	**Great Swift**	*Pelopidas assamensis*	sr	
166	**Conjoined Swift**	*Pelopidas conjunctus conjunctus*	sr	
167	Contiguous Swift	*Polytremis lubricans lubricans*	cr	
168	**Paintbrush Swift**	*Baoris oceia*	sr	
169	**Full Stop Swift**	*Caltoris cormasa*	sr	
170	**Philippine Swift**	*Caltoris philippina philippina*	sr	

FAUNA PHOTO SELECTION

Common Treeshrew



Malayan Colugo - juvenile

Lesser Bamboo Bat (Critically Endangered)

Common Malaysian Fruit Bats

Plantain Squirrel

Slender Squirrel

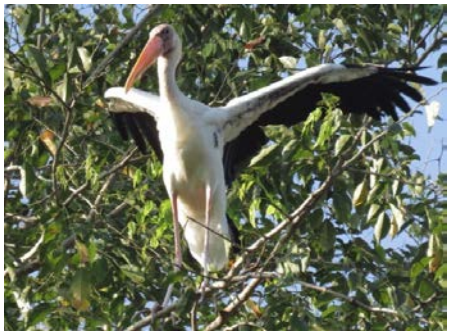
Long-tailed Macaque

probable Malayan Pangolin dig/burrow

Little Heron

Chinese Pond Heron

Purple Heron (Endangered)



Milky Stork (Free-flyer but Globally Threatened)

Himalayan Buzzard (*Buteo burmanicus)*

Crested Goshawk

Brahminy Kite

White-bellied Sea-Eagle

Grey-headed Fish-Eagle (Critically Endangered)

Changeable Hawk-Eagle (Endangered)

Common Peafowl

White-breasted Waterhen

Thick-billed Green-Pigeon (Endangered)

Pink-necked Green Pigeon

Zebra Dove

Emerald Dove male

Red-breasted Parakeet

Long-tailed Parakeet

Indian Cuckoo

Chestnut-bellied Malkoha

Lesser Coucal with prey

Large-tailed Nightjar

Collared Scops Owl juvenile

Brown Boobooks

Buffy Fish Owl (Critically Endangered)

Spotted Wood Owl (Endangered)

Stork-billed Kingfisher

White-throated Kingfisher

Blue-throated Bee-eater immature

Dollarbird

Rufous Woodpecker

Banded Woodpecker

Laced Woodpecker

Common Flameback

Straw-headed Bulbul

Red-whiskered Bulbul

Yellow-vented Bulbul

Olive-winged Bulbul – adult with juvenile

House Swallow

Greater Racket-tailed Drongo

Black-naped Oriole

Asian Fairy Bluebird

Oriental Magpie-Robin (Endangered)

Asian Brown Flycatcher

Brown Shrike

Tiger Shrike juvenile

Paddyfield Pipit

Javan Myna

Van Hasselt’s Sunbird female

Olive-backed Sunbird

Crimson Sunbird

Little Spiderhunter

Baya Weaver

Chestnut Munia

Scaly-breasted Munia

Malayan Sunbeam

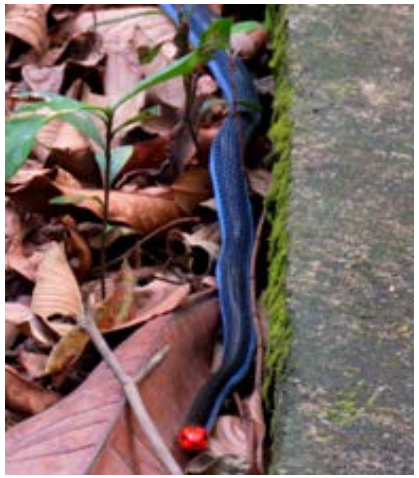
Oriental Whip Snake

Painted Bronzeback

Striped Bronzeback

Red-necked Bronzeback (Vulnerable)

Yellow-ringed Cat Snake (Vulnerable)



Blue Malayan Coral Snake (Vulnerable)

King Cobra juvenile (Endangered)

Black Spitting Cobra

Malayan Water Monitor

Clouded Monitor

Common Sun Skink

Striped Sun Skink (Endangered)

Yellow-striped Tree Skink (Endangered)

Green Crested Lizard

Black-bearded Flying Dragon (Vulnerable)

Common Flying Dragon

Spotted House Gecko

Tokay Gecko

Lowland Dwarf Gecko (Vulnerable)

Four-clawed Gecko

Common (Spiny-tailed) House Gecko

Flat-tailed Gecko

Gekko Monarchus

Malayan Box Terrapin

Giant Asian Pond Terrapin

Bornean Giant River Terrapin

Asian Softshell Turtle

Asian Toadlet

Four-ridged Toad

Black-eyed Litter Frog

Banded Bull Frog

Masked Rough-sided Frog

Golden-eared Rough-sided Frog (Vulnerable)

Common Greenback

Copper-cheeked Frog

Spotted Tree Frog (Vulnerable)

Common Tree Frog

Malesian Frog

Malesian Frog

Common Mormon

Common Bluebottle

Common Grass Yellow

Lemon Emigrant

Striped Blue Crow

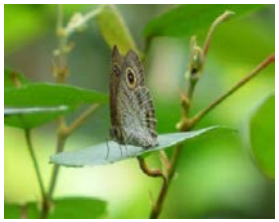
Palm King


Dingy Bush Brown

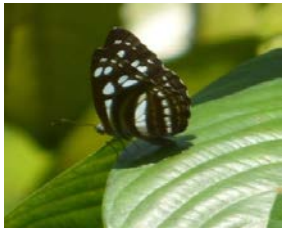

Perseoides Bush Brown


Dark Brand Bush Brown


Dark Grass Brown


Common Five Ring


Autumm Leaf


Dot- Dash Sergeant


Common Sailor


Spotted Judy


Quaker


Gram Blue


Common Caerulean


Pale Mottle

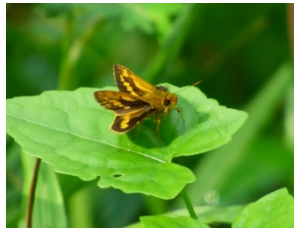

Common Disc Oakblue


Yellow Chequered Lancer


Chestnut Bob


Banded Demon


Grass Demon



Lesser Dart

Small Branded Swift

Formosan Swift

Golden Gem
(Critically Endangered)

Common Flashwing

Common Blue Sprite

Grey Sprite
(Critically Endangered)

Orange-striped Threadtail
(Critically Endangered)

Ornate Coraltail

Fiery Coraltail

Yellow Featherlegs

Spear-tailed Duskhawker

Common Flangetail

Trumpet Tail

Grenadier

Handsome Grenadier

Blue Dasher

Sultan(Critically Endangered)

Dark- tipped Forest-Skimmer

Common Scarlet female

Scarlet Grenadier

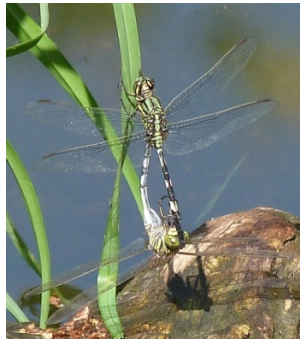
Common Parasol

Spine- tufted Skimmer

Common Blue Skimmer

Slender Blue Skimmer

Scarlet Skimmer



Variegated Green Skimmer

Common Chaser

Bronze Flutterer
(Critically Endangered)

Yellow-barred Flutterer

Sapphire Flutterer

Dawn Dropwing

Indigo Dropwing

Treehugger female

TERRESTRIAL VERTEBRATE, BUTTERFLY & ODONATE TRANSECTS

Annex 14.3

Camera Trap

Mandai Safari Park Biodiversity Survey
Camera Trapping Final Report

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1. Introduction

This study was commissioned to assess the status of terrestrial mammals at the sites and environs of the proposed Mandai Safari Park and relocated Bird Park (Fang, 2014; Anon, 2015; Mok, 2015; Philomin, 2015).

Many animals that live in rainforests tend to be shy, and avoid the presence of humans and human trails. Therefore, traditional transect survey methods may not yield substantial data on the presence of rare or cryptic species (Mohd Azlan, 2009). Hence, camera trapping has proven to be a useful method to detect the presence of many terrestrial rainforest mammals, and to study their distribution and behaviour.

Based on published literature, the medium-sized mammal species in the forested area of Mandai Road include the Sunda pangolin (*Manis javanica*), Sumatran palm civet (*Paradoxurus musangus*), sambar (*Rusa unicolor*), and wild pig (*Sus scrofa*) (Teo & Rajathurai, 1997; Spykerman, 2010; Chua, 2014a; Chua, 2014b). These species may be recorded using camera traps in the survey. Ground-dwelling birds and small mammals such as rats (Muridae) and squirrels (Sciuridae) may also be recorded, but may not be readily identified to species-level from camera trap photos.

The aim of the camera trapping component of this biodiversity survey is to assess the current terrestrial mammal diversity and distribution, as well as to characterise the patterns of their movement and habitat use within the survey area.

2. Methods

2.1. Study areas

The camera trapping study was conducted in the forested study areas designated as Zones A, B, D and E in the vicinity of the proposed Mandai Rainforest Park (Fig. 1). Based on vegetation classification by Yee et al. (2011), the vegetation study by Neo, L. and ground truthing, habitats in the areas were identified as 1) mature secondary forest (A and E), abandoned plantations (B), and grassland and abandoned plantations (D).

2.2. Camera trapping

The forested part of the survey areas A, B, D and E were divided into nine 6.25 ha (250 m x 250 m) square plots, with one camera trap positioned in the middle of each square (±50 m) (Fig. 1). From May to Sep 2015, one unbaited Reconyx PC800 camera trap was positioned in

each plot to monitor animal trails. Camera trap units were mounted about 30 cm above the ground, and as far as possible, were oriented to face north or south. The camera traps were set to be active 24-hours each day with the motion sensor set to high sensitivity, 3 pictures per trigger, 1 s picture interval, and a 15 s quiet period after each trigger.

Barring breakdowns or theft, the aim was to achieve a camera trapping effort of at least 40 camera trap nights per camera trap site (Si *et al.*, 2014). This is to increase the chance of capturing capture species to that occur at lower densities, and for species to be habituated to the trap, if necessary. A camera trap night is defined as a continuous 24-h period of camera trap operation.

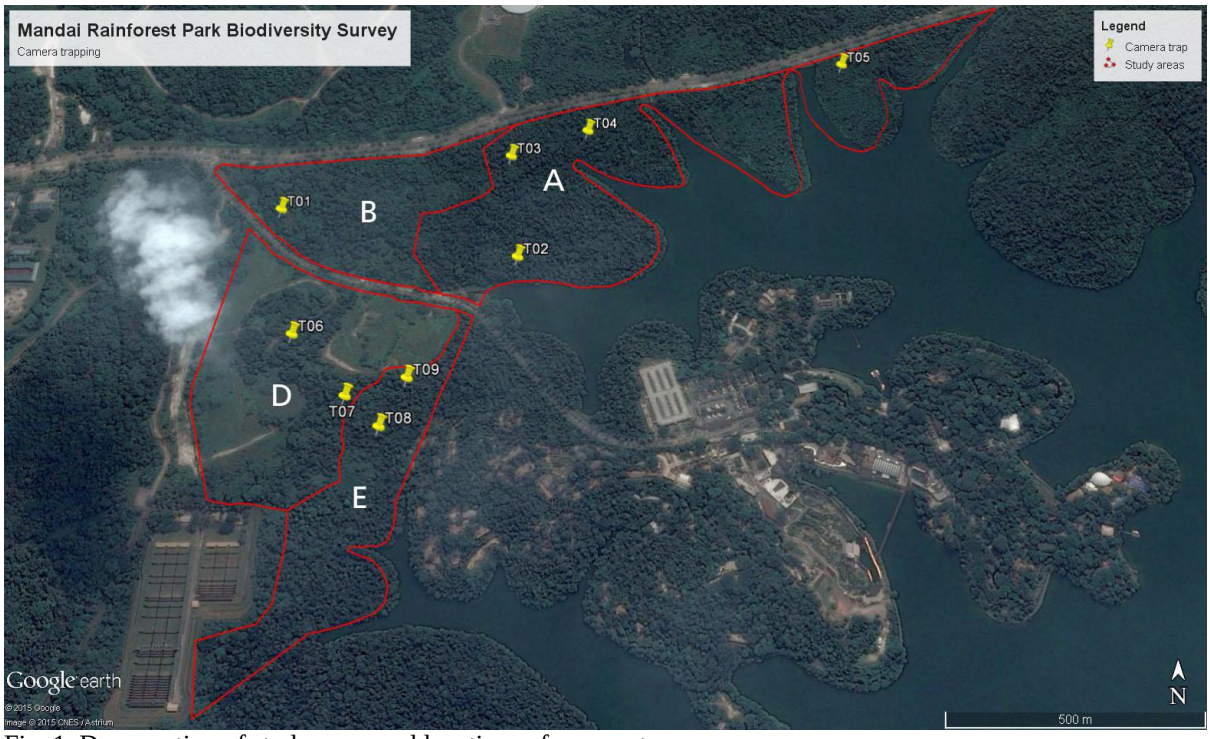

Fig. 1. Demarcation of study areas and locations of camera traps.

2.3. Data analyses

Camera trap images were managed in Camera Base 1.61 (Tobler, 2013). Output from the software were used to generate species rarefaction curves for richness estimate with EstimateS 9.1 (Cowell, 2013).The second order Jackknife species richness estimator, which is typically the best performing estimator, was used to estimate species richness based on the camera trap data (O'Brien, 2008).

Habitat use analyses for internationally and nationally threatened species were performed using the software PRESENCE 6.9 using a single species single season occupancy model (MacKenzie *et al*., 2006). The model assumes that sites are independent, and closed during the survey period. While the assumptions may be violated owing to spatial autocorrelation between camera trap sites, the spacing of camera traps optimised for target species (6.25 ha optimised for Sunda pangolin [*Manis javanica*] home range [Lim & Ng, 2007]) was an effort to reduce this effect. For the second assumption, the relatively short survey period (128 days) approximated a closed system of having no births and deaths, and migration. Camera Base was used to output the camera trap data in three-day occasions, and a single habitat covariate

of a binary category of abandoned plantation (AP) or mature secondary forest (MF), was used to assess occupancy patterns across the study sites. The significance of the covariate was assessed using the Akaike Information Criterion (AIC) (i.e., "best model" with lowest AIC).

The activity pattern of internationally and nationally threatened species was quantified per hour based on camera trap data. Independent photographic records were compiled per hour in a 24-hour daily cycle and expressed as a percentage of the total number of independent records. Independent records at a station were separated by at least an hour between camera triggers or were of different individuals. Temporal classification for activity are nocturnal activity was from 2000 h to 0559 h, crepuscular activity from 1800 h to 1959 h and 0600 h to 0759 h, and diurnal activity from 0800 h to 1759 h. R version 3.2.2. (R Development Core Team, 2009) with the overlap package (Meredith & Ridout) was used to construct the activity patterns of the species based on the statistical methodology developed by Ridout & Linkie (2009).

3. Results

Camera trap survey effort totalled 475 camera trap nights, with an average of 52.8 trap nights at each trap site (Table 1). Camera trap T01, T03 and T04 were active for 11, 24 and 37 trap nights respectively owing to equipment breakdown or battery issues.

Table 1. Camera trap effort (trap nights) for camera traps in the study areas.

	Camera Trap (Zone)								
	T01 (B)	T02 (A)	T03 (A)	T04 (A)	T05 (A)	T06 (D)	T07 (D)	T08 (E)	T09 (E)
Trap nights	11	57	24	37	76	96	70	53	51

3.1. Diversity and distribution

Nine species of terrestrial mammals were recorded by camera traps in the study areas, including humans (Table 2; Appendix A). Plantain squirrels (*Callosciurus notatus*), slender squirrel (*Sundasciurus tenius*), clouded monitors (*Varanus nebulosus*), Malayan water monitor (*V. salvator*) and several species of birds were also recorded, but excluded from the analysis as they were non-target species.

All nine terrestrial mammal species were recorded at Zone E. Zones A and D had comparable species richness, with eight species recorded, lacking only the lesser mousedeer (*Tragulus kanchil*). Three species were recorded in Zone B.

Both the species rarefaction curve and Jackknife 2 richness estimator reached an asymtote of nine species by the end of the study (Fig. 2).

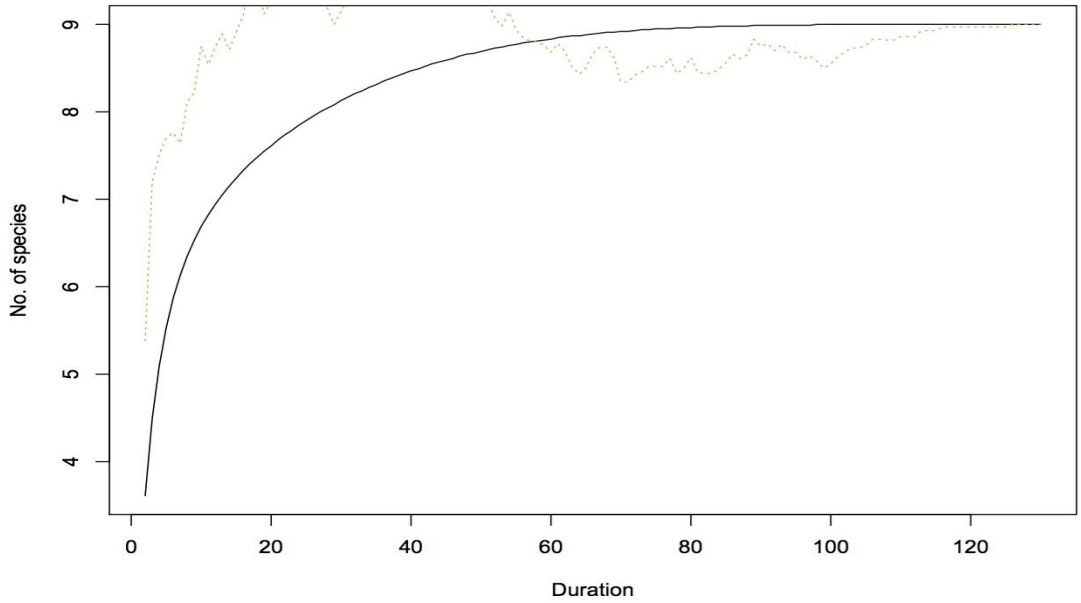

Fig. 2. Species rarefaction curve over the duration of the study (sampling effort) (black line). Dotted green line = Jackknife 2 species richness estimator.

Table 2. Summary of terrestrial mammal species recorded by camera traps in the study areas. Zone legend: 1 = species present.

Species recorded	Zone				Number of photos
	A	B	D	E	
Order Scandentia					
Common treeshrew (*Tupaia glis*)	1		1	1	61
Order Primates					
Human (*Homo sapien*)	1	1	1	1	316
Long-tailed macaque (*Macaca fascicularis*)	1		1	1	37
Order Rodentia					
Rattus sp.	1	1	1	1	89
Order Artiodactyla					
Lesser mousedeer (*Tragulus kanchil*)				1	4
Sambar (*Rusa unicolor*)	1		1	1	39
Wild pig (*Sus scrofa*)	1	1	1	1	283
Order Pholidota					
Sunda pangolin (*Manis javanica*)	1		1	1	5
Order Carnivora					
Sumatran palm civet (*Paradoxurus musangus*)	1		1	1	5

3.2. Habitat use and activity pattern

Occupancy modelling provided some evidence that the occupancy of lesser mousedeer was positively influenced by mature secondary forest habitat. The models suggest that sambar and Sunda pangolin occupancy in the study areas were not strongly influenced by differences between mature secondary forests and abandoned plantations. The data suggests that the probability of detection for each species was constant during the study.

Table 3. Summary of probability models for lesser mousedeer, sambar and Sunda pangolin across sites. The best fit models had the lowest AIC score.

Species	Model	AIC	ΔAIC	AIC wgt	No. of parameters	Deviance
Lesser mousedeer	**psi(MS), p(constant)**	**37.93**	**0.00**	**0.523**	**3**	**31.93**
	1 group, p(constant)	38.11	0.18	0.478	2	34.11
	1 group, p(survey specific)	102.54	64.61	0.000	44	14.54
Sambar	**1 group, p(constant)**	**142.88**	**0.00**	**0.657**	**2**	**138.88**
	psi(MS), p(constant)	144.18	1.30	0.343	3	138.18
	1 group, p(survey specific)	198.18	55.3	0.000	44	110.18
Sunda pangolin	**1 group, p(constant)**	**49.21**	**0.00**	**0.718**	**2**	**45.2**
	psi(MS), p(constant)	51.08	1.87	0.282	3	45.1
	1 group, p(survey specific)	114.96	65.75	0.000	44	27.0

The lesser mousedeer and sambar were nocturnal and crepuscular, while the Sunda pangolin was fully nocturnal (Fig. 3). Owing to the small number of photographs taken of the target species, analysis of movement pattern was not feasible.

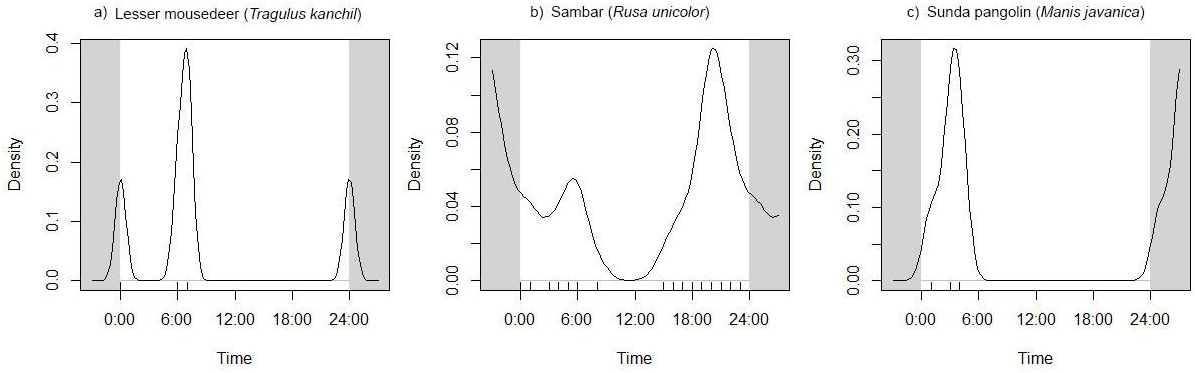

Fig. 3. Activity pattern of a) lesser mousedeer (n=4), b) sambar (n=39), and c) Sunda pangolin (n=5).

Discussion

This study recorded all medium and large terrestrial mammals known to occur in the area, and also recorded the lesser mousedeer, which locality presence was not noted in published literature. Evidence from the species rarefaction curve and Jackknife estimator supports that the survey effort was sufficient to detect all species potentially detectable by camera trapping, and that additional survey effort would not yield additional species.

Zone E, consisting of mature secondary forest, had the highest recorded terrestrial mammal species richness and is part of the Central Catchment Nature Reserve. It is also the only zone in the study area where the nationally critically endangered lesser mousedeer was recorded (Lim *et al.*, 2008). It is possible that a breeding population is present, as pairs of mousedeer were recorded by camera traps in the area (Fig. 4).

Fig. 4. Pair of lesser mousedeer at camera trap T08 (Zone E).

The presence of the lesser mousedeer was positively influenced by mature secondary forest. This is consistent with studies by Heydon & Bulloh (1997), where their densities were negatively correlated with habitat disturbance. However, it is to be noted that lesser mousedeer was not recorded in Zone A, where the habitat is also characterised by mature secondary forest. A possible reason could be that the isolated and fragmented peninsular of Zone A may not support a viable population of lesser mousedeer, or that the number of mousedeer there was too small to be detected. It would thus be important to maintain the integrity of the mature secondary forests in order to ensure that the population of this nationally critically endangered species remains protected. Movement and dispersal of lesser mousedeer between Zones A and E may be facilitated by an ecological corridor, which could potentially benefit other terrestrial species as well. Corridors targeted at this species would need to take into account their need for dense undergrowth, and food resources to sustain their energetic requirements (Heydon & Bulloh, 1997; Matsubayashi *et al.*, 2003).

Other terrestrial mammals recorded during the study were widespread in the study areas. Although majority of the terrestrial mammal species detected, including the Sunda pangolin and sambar, appear be tolerant of disturbed habitats such as the abandoned plantations in Zones B and D, the response of each species to habitat disturbance (such as during the construction of the proposed project) remains to be established.

Particular attention should be paid to the internationally critically endangered Sunda pangolin (Challender *et al.*, 2014), which was infrequently detected in the study (n=5). The protection of the habitat, and range of the species may be critical to the survival of the species, which is internationally threated owing to illegal wildlife trade for pangolin scales and meat. While the

best occupancy model indicates that presence of the Sunda pangolin is not strongly influenced by mature secondary forest, the second model with a difference of 1.87 AIC units between the two models indicate that although it is not the best, it still has a reasonable level of support (Table 3). This also underscores the need to protect mature secondary forests for the species. Like the lesser mousedeer, the Sunda pangolin is also active at night, and may be sensitive to noise and disturbance. Other than the protection of key habitats, the designation of sufficient buffer areas to ameliorate negative edge effect would be necessary to maintain the structural integrity of the forest, and the biodiversity it sustains (Mesquita *et al.*, 1999).

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Appendix A

Common treeshrew (*Tupaia glis*)

Human (*Homo sapien*)

Long-tailed macaque (*Macaca fascicularis*)

Rattus sp.

Lesser mousedeer (*Tragulus kanchil*)

Sambar (*Rusa unicolor*)

Wild pig (*Sus scrofa*)

Sunda pangolin (*Manis javanica*)

Sumatran palm civet (*Paradoxurus musangus*)

Captures

Date	Time	Camera 1	Camera 2

Mandai Safari Park EIA

Start Date: 21/5/2015 **End Date:** 27/9/2015

Acridotheres javanicus

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6/7/2015	9:46:22 A	T06	
6/7/2015	1:19:57 P	T06	
6/7/2015	1:19:58 P	T06	
6/7/2015	1:19:59 P	T06	
6/7/2015	1:20:00 P	T06	
6/7/2015	1:20:01 P	T06	
6/7/2015	6:41:49 P	T06	
6/7/2015	6:41:51 P	T06	

Date	Time	Camera 1	Camera 2
6/7/2015	6:41:52 P	T06	
6/7/2015	6:41:53 P	T06	
6/7/2015	6:41:54 P	T06	
6/7/2015	7:04:18 P	T06	
6/7/2015	7:04:20 P	T06	
6/7/2015	7:04:21 P	T06	
6/7/2015	7:04:22 P	T06	
6/7/2015	7:04:23 P	T06	
7/7/2015	5:24:19 A	T06	
7/7/2015	5:24:22 A	T06	
7/7/2015	5:24:23 A	T06	
7/7/2015	5:24:24 A	T06	
7/7/2015	5:24:25 A	T06	
7/7/2015	6:41:13 A	T06	
7/7/2015	6:41:16 A	T06	
7/7/2015	6:41:17 A	T06	
7/7/2015	6:41:18 A	T06	
7/7/2015	6:41:19 A	T06	
7/7/2015	6:07:46 P	T06	
7/7/2015	6:07:49 P	T06	
7/7/2015	6:07:50 P	T06	
7/7/2015	6:07:51 P	T06	
7/7/2015	6:07:52 P	T06	
7/7/2015	8:49:27 P	T06	
7/7/2015	8:49:29 P	T06	
7/7/2015	8:49:30 P	T06	
7/7/2015	8:49:31 P	T06	
7/7/2015	8:49:32 P	T06	
8/7/2015	6:19:29 A	T06	
8/7/2015	6:19:32 A	T06	
8/7/2015	6:19:33 A	T06	
8/7/2015	6:19:34 A	T06	
8/7/2015	6:19:35 A	T06	
8/7/2015	6:36:51 P	T06	
8/7/2015	6:36:53 P	T06	
8/7/2015	6:36:54 P	T06	
8/7/2015	6:36:55 P	T06	
8/7/2015	6:36:56 P	T06	
9/7/2015	4:55:51 A	T06	

Date	Time	Camera 1	Camera 2
9/7/2015	4:55:53 A	T06	
9/7/2015	4:55:54 A	T06	
9/7/2015	4:55:55 A	T06	
9/7/2015	4:55:56 A	T06	
9/7/2015	8:45:39 P	T06	
9/7/2015	8:45:41 P	T06	
9/7/2015	8:45:42 P	T06	
9/7/2015	8:45:43 P	T06	
9/7/2015	8:45:44 P	T06	
9/7/2015	9:05:43 P	T09	
9/7/2015	9:05:44 P	T09	
9/7/2015	9:05:45 P	T09	
9/7/2015	9:05:46 P	T09	
9/7/2015	9:05:47 P	T09	
9/7/2015	11:20:29 P	T06	
9/7/2015	11:20:32 P	T06	
9/7/2015	11:20:33 P	T06	
9/7/2015	11:20:34 P	T06	
9/7/2015	11:20:35 P	T06	
10/7/2015	8:09:30 A	T06	
10/7/2015	8:09:32 A	T06	
10/7/2015	8:09:33 A	T06	
10/7/2015	8:09:34 A	T06	
10/7/2015	8:09:35 A	T06	
10/7/2015	1:25:22 P	T06	
10/7/2015	1:25:24 P	T06	
10/7/2015	1:25:25 P	T06	
10/7/2015	1:25:26 P	T06	
10/7/2015	1:25:27 P	T06	
10/7/2015	6:42:33 P	T06	
10/7/2015	6:42:35 P	T06	
10/7/2015	6:42:36 P	T06	
10/7/2015	6:42:37 P	T06	
10/7/2015	6:42:38 P	T06	
10/7/2015	7:22:06 P	T06	
10/7/2015	7:22:08 P	T06	
10/7/2015	7:22:09 P	T06	
10/7/2015	7:22:10 P	T06	
10/7/2015	7:22:11 P	T06	

Date	Time	Camera 1	Camera 2
11/7/2015	5:00:09 A	T06	
11/7/2015	5:00:12 A	T06	
11/7/2015	5:00:13 A	T06	
11/7/2015	5:00:14 A	T06	
11/7/2015	5:00:15 A	T06	
11/7/2015	5:06:34 A	T06	
11/7/2015	5:06:37 A	T06	
11/7/2015	5:06:40 A	T06	
11/7/2015	5:06:41 A	T06	
11/7/2015	5:06:42 A	T06	
11/7/2015	6:45:46 A	T06	
11/7/2015	6:45:49 A	T06	
11/7/2015	6:45:50 A	T06	
11/7/2015	6:45:51 A	T06	
11/7/2015	6:45:52 A	T06	
11/7/2015	8:49:27 A	T06	
11/7/2015	8:49:29 A	T06	
11/7/2015	8:49:30 A	T06	
11/7/2015	8:49:31 A	T06	
11/7/2015	8:49:32 A	T06	
11/7/2015	2:24:04 P	T07	
11/7/2015	2:24:05 P	T07	
11/7/2015	2:24:06 P	T07	
11/7/2015	2:24:07 P	T07	
11/7/2015	2:24:08 P	T07	
12/7/2015	2:22:16 A	T06	
12/7/2015	2:22:18 A	T06	
12/7/2015	2:22:19 A	T06	
12/7/2015	2:22:20 A	T06	
12/7/2015	2:22:21 A	T06	
12/7/2015	7:43:19 A	T06	
12/7/2015	7:43:22 A	T06	
12/7/2015	7:43:23 A	T06	
12/7/2015	7:43:24 A	T06	
12/7/2015	7:43:25 A	T06	
12/7/2015	8:23:38 A	T06	
12/7/2015	8:23:40 A	T06	
12/7/2015	8:23:41 A	T06	
12/7/2015	8:23:42 A	T06	

Date	Time	Camera 1	Camera 2
12/7/2015	8:23:43 A	T06	
12/7/2015	4:36:33 P	T06	
12/7/2015	4:36:36 P	T06	
12/7/2015	4:36:37 P	T06	
12/7/2015	4:36:38 P	T06	
12/7/2015	4:36:39 P	T06	
13/7/2015	3:14:01 P	T06	
13/7/2015	3:14:03 P	T06	
13/7/2015	3:14:04 P	T06	
13/7/2015	3:14:05 P	T06	
13/7/2015	3:14:06 P	T06	
13/7/2015	4:52:51 P	T06	
13/7/2015	4:52:53 P	T06	
13/7/2015	4:52:54 P	T06	
13/7/2015	4:52:55 P	T06	
13/7/2015	4:52:56 P	T06	
13/7/2015	6:36:03 P	T06	
13/7/2015	6:36:05 P	T06	
13/7/2015	6:36:06 P	T06	
13/7/2015	6:36:07 P	T06	
13/7/2015	6:36:08 P	T06	
14/7/2015	5:22:59 A	T06	
14/7/2015	5:23:00 A	T06	
14/7/2015	5:23:01 A	T06	
14/7/2015	5:23:02 A	T06	
14/7/2015	5:23:03 A	T06	
14/7/2015	6:08:26 A	T06	
14/7/2015	6:08:28 A	T06	
14/7/2015	6:08:29 A	T06	
14/7/2015	6:08:30 A	T06	
14/7/2015	6:08:31 A	T06	
14/7/2015	7:05:09 A	T06	
14/7/2015	7:05:12 A	T06	
14/7/2015	7:05:13 A	T06	
14/7/2015	7:05:14 A	T06	
14/7/2015	7:05:15 A	T06	
14/7/2015	7:52:25 A	T06	
14/7/2015	7:52:27 A	T06	
14/7/2015	7:52:28 A	T06	

Date	Time	Camera 1	Camera 2
14/7/2015	7:52:29 A	T06	
14/7/2015	7:52:30 A	T06	
15/7/2015	11:09:59 A	T06	
15/7/2015	11:10:00 A	T06	
15/7/2015	11:10:01 A	T06	
15/7/2015	11:10:02 A	T06	
15/7/2015	11:10:03 A	T06	
16/7/2015	3:48:07 P	T06	
16/7/2015	3:48:10 P	T06	
16/7/2015	3:48:11 P	T06	
16/7/2015	3:48:12 P	T06	
16/7/2015	3:48:13 P	T06	
16/7/2015	5:02:46 P	T06	
16/7/2015	5:02:48 P	T06	
16/7/2015	5:02:49 P	T06	
16/7/2015	5:02:50 P	T06	
16/7/2015	5:02:51 P	T06	
17/7/2015	2:45:08 P	T06	
17/7/2015	2:45:10 P	T06	
17/7/2015	2:45:11 P	T06	
17/7/2015	2:45:12 P	T06	
17/7/2015	2:45:13 P	T06	
18/7/2015	5:48:11 A	T06	
18/7/2015	5:48:12 A	T06	
18/7/2015	5:48:13 A	T06	
18/7/2015	5:48:14 A	T06	
18/7/2015	5:48:15 A	T06	
18/7/2015	3:19:06 P	T06	
18/7/2015	3:19:07 P	T06	
18/7/2015	3:19:08 P	T06	
18/7/2015	3:19:09 P	T06	
18/7/2015	3:19:10 P	T06	
19/7/2015	2:20:24 A	T06	
19/7/2015	2:20:26 A	T06	
19/7/2015	2:20:27 A	T06	
19/7/2015	2:20:28 A	T06	
19/7/2015	2:20:29 A	T06	
19/7/2015	7:26:21 A	T06	
19/7/2015	7:26:23 A	T06	

Date	Time	Camera 1	Camera 2
19/7/2015	7:26:24 A	T06	
19/7/2015	7:26:25 A	T06	
19/7/2015	7:26:26 A	T06	
20/7/2015	4:25:18 P	T06	
20/7/2015	4:25:19 P	T06	
20/7/2015	4:25:20 P	T06	
20/7/2015	4:25:21 P	T06	
20/7/2015	4:25:22 P	T06	
20/7/2015	8:17:25 P	T06	
20/7/2015	8:17:27 P	T06	
20/7/2015	8:17:29 P	T06	
20/7/2015	8:17:30 P	T06	
20/7/2015	8:17:31 P	T06	
21/7/2015	7:03:14 A	T06	
21/7/2015	7:03:15 A	T06	
21/7/2015	7:03:16 A	T06	
21/7/2015	7:03:17 A	T06	
21/7/2015	7:03:18 A	T06	
21/7/2015	4:28:56 P	T06	
21/7/2015	4:28:58 P	T06	
21/7/2015	4:28:59 P	T06	
21/7/2015	4:29:00 P	T06	
21/7/2015	4:29:01 P	T06	
22/7/2015	8:06:34 A	T06	
22/7/2015	8:06:35 A	T06	
22/7/2015	8:06:36 A	T06	
22/7/2015	8:06:37 A	T06	
22/7/2015	8:06:38 A	T06	
22/7/2015	11:36:29 P	T09	
22/7/2015	11:36:30 P	T09	
22/7/2015	11:36:31 P	T09	
22/7/2015	11:36:32 P	T09	
22/7/2015	11:36:33 P	T09	
23/7/2015	3:32:44 A	T08	
23/7/2015	3:32:45 A	T08	
23/7/2015	3:32:46 A	T08	
23/7/2015	3:32:47 A	T08	
23/7/2015	3:32:48 A	T08	
24/7/2015	8:54:23 A	T07	

Date	Time	Camera 1	Camera 2
24/7/2015	8:54:24 A	T07	
24/7/2015	8:54:25 A	T07	
24/7/2015	8:54:26 A	T07	
24/7/2015	8:54:27 A	T07	
24/7/2015	5:23:29 P	T07	
24/7/2015	5:23:30 P	T07	
24/7/2015	5:23:31 P	T07	
24/7/2015	5:23:32 P	T07	
24/7/2015	5:23:33 P	T07	
24/7/2015	5:54:51 P	T09	
24/7/2015	5:54:52 P	T09	
24/7/2015	5:54:53 P	T09	
24/7/2015	5:54:54 P	T09	
24/7/2015	5:54:55 P	T09	
24/7/2015	7:29:08 P	T06	
24/7/2015	7:29:11 P	T06	
24/7/2015	7:29:12 P	T06	
24/7/2015	7:29:13 P	T06	
24/7/2015	7:29:14 P	T06	
25/7/2015	6:48:27 A	T08	
25/7/2015	6:48:28 A	T08	
25/7/2015	6:48:29 A	T08	
25/7/2015	6:48:30 A	T08	
25/7/2015	6:48:31 A	T08	
25/7/2015	8:36:33 A	T06	
25/7/2015	8:36:35 A	T06	
25/7/2015	8:36:36 A	T06	
25/7/2015	8:36:37 A	T06	
25/7/2015	8:36:38 A	T06	
25/7/2015	9:25:32 A	T06	
25/7/2015	9:25:34 A	T06	
25/7/2015	9:25:35 A	T06	
25/7/2015	9:25:36 A	T06	
25/7/2015	9:25:37 A	T06	
26/7/2015	6:51:37 A	T08	
26/7/2015	6:51:38 A	T08	
26/7/2015	6:51:40 A	T08	
26/7/2015	6:51:41 A	T08	
26/7/2015	6:51:42 A	T08	

Date	Time	Camera 1	Camera 2
26/7/2015	6:54:48 A	T08	
26/7/2015	6:54:49 A	T08	
26/7/2015	6:54:50 A	T08	
26/7/2015	6:54:51 A	T08	
26/7/2015	6:54:52 A	T08	
27/7/2015	5:56:44 A	T06	
27/7/2015	5:56:45 A	T06	
27/7/2015	5:56:46 A	T06	
27/7/2015	5:56:47 A	T06	
27/7/2015	5:56:48 A	T06	
27/7/2015	9:28:17 A	T06	
27/7/2015	9:28:18 A	T06	
27/7/2015	9:28:19 A	T06	
27/7/2015	9:28:20 A	T06	
27/7/2015	9:28:21 A	T06	
28/7/2015	1:56:18 A	T06	
28/7/2015	1:56:19 A	T06	
28/7/2015	1:56:20 A	T06	
28/7/2015	1:56:21 A	T06	
28/7/2015	1:56:22 A	T06	
29/7/2015	10:22:28 P	T06	
29/7/2015	10:22:29 P	T06	
29/7/2015	10:22:30 P	T06	
29/7/2015	10:22:31 P	T06	
29/7/2015	10:22:32 P	T06	
29/7/2015	11:36:14 P	T06	
29/7/2015	11:36:15 P	T06	
29/7/2015	11:36:16 P	T06	
29/7/2015	11:36:17 P	T06	
29/7/2015	11:36:18 P	T06	
30/7/2015	1:21:54 A	T06	
30/7/2015	1:21:56 A	T06	
30/7/2015	1:21:57 A	T06	
30/7/2015	1:21:58 A	T06	
30/7/2015	1:21:59 A	T06	
30/7/2015	1:34:13 P	T07	
30/7/2015	1:34:14 P	T07	
30/7/2015	1:34:16 P	T07	
30/7/2015	1:34:17 P	T07	

Date	Time	Camera 1	Camera 2
30/7/2015	1:34:18 P	T07	
31/7/2015	8:57:41 A	T07	
31/7/2015	8:57:43 A	T07	
31/7/2015	8:57:44 A	T07	
31/7/2015	8:57:45 A	T07	
31/7/2015	8:57:46 A	T07	
31/7/2015	9:12:53 A	T06	
31/7/2015	9:12:54 A	T06	
31/7/2015	9:12:55 A	T06	
31/7/2015	9:12:57 A	T06	
31/7/2015	9:12:58 A	T06	
31/7/2015	9:30:57 A	T06	
31/7/2015	9:30:58 A	T06	
31/7/2015	9:30:59 A	T06	
31/7/2015	9:31:00 A	T06	
31/7/2015	9:31:01 A	T06	
31/7/2015	5:05:23 P	T06	
31/7/2015	5:05:25 P	T06	
31/7/2015	5:05:26 P	T06	
31/7/2015	5:05:27 P	T06	
31/7/2015	5:05:28 P	T06	
31/7/2015	5:14:05 P	T06	
31/7/2015	5:14:07 P	T06	
31/7/2015	5:14:08 P	T06	
31/7/2015	5:14:09 P	T06	
31/7/2015	5:14:10 P	T06	
2/8/2015	5:41:02 P	T06	
2/8/2015	5:41:04 P	T06	
2/8/2015	5:41:05 P	T06	
2/8/2015	5:41:06 P	T06	
2/8/2015	5:41:07 P	T06	
4/8/2015	4:11:07 P	T01	
4/8/2015	4:11:08 P	T01	
4/8/2015	4:11:09 P	T01	
4/8/2015	4:11:10 P	T01	
4/8/2015	4:11:11 P	T01	
4/8/2015	4:18:25 P	T01	
4/8/2015	4:18:26 P	T01	
4/8/2015	4:18:27 P	T01	

Date	Time	Camera 1	Camera 2
4/8/2015	4:18:28 P	T01	
4/8/2015	4:18:29 P	T01	
4/8/2015	5:02:26 P	T01	
4/8/2015	5:02:27 P	T01	
4/8/2015	5:02:28 P	T01	
4/8/2015	5:02:29 P	T01	
4/8/2015	5:02:30 P	T01	
4/8/2015	5:21:58 P	T07	
4/8/2015	5:22:00 P	T07	
4/8/2015	5:22:01 P	T07	
4/8/2015	5:22:02 P	T07	
4/8/2015	5:22:03 P	T07	
4/8/2015	5:36:22 P	T01	
4/8/2015	5:36:23 P	T01	
4/8/2015	5:36:24 P	T01	
4/8/2015	5:36:25 P	T01	
4/8/2015	5:36:26 P	T01	
5/8/2015	9:01:57 A	T01	
5/8/2015	9:01:59 A	T01	
5/8/2015	9:02:00 A	T01	
5/8/2015	9:02:01 A	T01	
5/8/2015	9:02:02 A	T01	
5/8/2015	10:42:47 A	T01	
5/8/2015	10:42:48 A	T01	
5/8/2015	10:42:49 A	T01	
5/8/2015	10:42:50 A	T01	
5/8/2015	10:42:51 A	T01	
5/8/2015	10:52:42 A	T01	
5/8/2015	10:52:43 A	T01	
5/8/2015	10:52:44 A	T01	
5/8/2015	10:52:45 A	T01	
5/8/2015	10:52:46 A	T01	
5/8/2015	7:03:53 P	T07	
5/8/2015	7:03:54 P	T07	
5/8/2015	7:03:55 P	T07	
5/8/2015	7:03:56 P	T07	
5/8/2015	7:03:57 P	T07	
5/8/2015	7:39:12 P	T01	
5/8/2015	7:39:13 P	T01	

Date	Time	Camera 1	Camera 2
5/8/2015	7:39:14 P	T01	
5/8/2015	7:39:15 P	T01	
5/8/2015	7:39:16 P	T01	
5/8/2015	10:47:12 P	T06	
5/8/2015	10:47:13 P	T06	
5/8/2015	10:47:14 P	T06	
5/8/2015	10:47:15 P	T06	
5/8/2015	10:47:16 P	T06	
6/8/2015	9:28:13 A	T01	
6/8/2015	9:28:14 A	T01	
6/8/2015	9:28:15 A	T01	
6/8/2015	9:28:16 A	T01	
6/8/2015	9:28:17 A	T01	
6/8/2015	9:28:42 A	T01	
6/8/2015	9:28:43 A	T01	
6/8/2015	9:28:44 A	T01	
6/8/2015	9:28:45 A	T01	
6/8/2015	9:28:46 A	T01	
6/8/2015	9:33:57 A	T01	
6/8/2015	9:33:58 A	T01	
6/8/2015	9:33:59 A	T01	
6/8/2015	9:34:00 A	T01	
6/8/2015	9:34:01 A	T01	
6/8/2015	9:38:06 A	T01	
6/8/2015	9:38:07 A	T01	
6/8/2015	9:38:08 A	T01	
6/8/2015	9:38:09 A	T01	
6/8/2015	9:38:10 A	T01	
6/8/2015	9:39:30 A	T01	
6/8/2015	9:39:31 A	T01	
6/8/2015	9:39:32 A	T01	
6/8/2015	9:39:33 A	T01	
6/8/2015	9:39:34 A	T01	
6/8/2015	9:45:17 A	T01	
6/8/2015	9:45:18 A	T01	
6/8/2015	9:45:19 A	T01	
6/8/2015	9:45:20 A	T01	
6/8/2015	9:45:21 A	T01	
6/8/2015	9:46:32 A	T01	

Date	Time	Camera 1	Camera 2
6/8/2015	9:46:33 A	T01	
6/8/2015	9:46:34 A	T01	
6/8/2015	9:46:35 A	T01	
6/8/2015	9:46:36 A	T01	
6/8/2015	9:48:15 A	T01	
6/8/2015	9:48:17 A	T01	
6/8/2015	9:48:18 A	T01	
6/8/2015	9:48:19 A	T01	
6/8/2015	9:48:20 A	T01	
6/8/2015	9:58:22 A	T01	
6/8/2015	9:58:23 A	T01	
6/8/2015	9:58:24 A	T01	
6/8/2015	9:58:25 A	T01	
6/8/2015	9:58:26 A	T01	
6/8/2015	11:51:24 A	T03	
6/8/2015	11:51:26 A	T03	
6/8/2015	11:51:27 A	T03	
6/8/2015	11:51:28 A	T03	
6/8/2015	11:51:29 A	T03	
6/8/2015	7:23:39 P	T01	
6/8/2015	7:23:40 P	T01	
6/8/2015	7:23:41 P	T01	
6/8/2015	7:23:42 P	T01	
6/8/2015	7:23:43 P	T01	
6/8/2015	7:25:50 P	T01	
6/8/2015	7:25:51 P	T01	
6/8/2015	7:25:52 P	T01	
6/8/2015	7:25:53 P	T01	
6/8/2015	7:25:54 P	T01	
6/8/2015	9:51:25 P	T07	
6/8/2015	9:51:26 P	T07	
6/8/2015	9:51:27 P	T07	
6/8/2015	9:51:28 P	T07	
6/8/2015	9:51:29 P	T07	
7/8/2015	9:01:13 P	T06	
7/8/2015	9:01:14 P	T06	
7/8/2015	9:01:15 P	T06	
7/8/2015	9:01:16 P	T06	
7/8/2015	9:01:17 P	T06	

Date	Time	Camera 1	Camera 2
8/8/2015	2:19:29 A	T07	
8/8/2015	2:19:30 A	T07	
8/8/2015	2:19:31 A	T07	
8/8/2015	2:19:32 A	T07	
8/8/2015	2:19:33 A	T07	
8/8/2015	8:58:46 P	T06	
8/8/2015	8:58:47 P	T06	
8/8/2015	8:58:48 P	T06	
8/8/2015	8:58:49 P	T06	
8/8/2015	8:58:50 P	T06	
13/8/2015	2:55:25 P	T06	
13/8/2015	2:55:27 P	T06	
13/8/2015	2:55:28 P	T06	
13/8/2015	2:55:29 P	T06	
13/8/2015	2:55:30 P	T06	
13/8/2015	6:32:04 P	T06	
13/8/2015	6:32:05 P	T06	
13/8/2015	6:32:06 P	T06	
13/8/2015	6:32:07 P	T06	
13/8/2015	6:32:08 P	T06	
14/8/2015	4:35:50 A	T07	
14/8/2015	4:35:51 A	T07	
14/8/2015	4:35:52 A	T07	
14/8/2015	4:35:53 A	T07	
14/8/2015	4:35:54 A	T07	
14/8/2015	5:50:14 A	T07	
14/8/2015	5:50:15 A	T07	
14/8/2015	5:50:16 A	T07	
14/8/2015	5:50:17 A	T07	
14/8/2015	5:50:18 A	T07	
14/8/2015	7:39:05 A	T07	
14/8/2015	7:39:06 A	T07	
14/8/2015	7:39:07 A	T07	
14/8/2015	7:39:08 A	T07	
14/8/2015	7:39:09 A	T07	
14/8/2015	9:21:05 P	T07	
14/8/2015	9:21:06 P	T07	
14/8/2015	9:21:07 P	T07	
14/8/2015	9:21:08 P	T07	

Date	Time	Camera 1	Camera 2
14/8/2015	9:21:09 P	T07	
15/8/2015	6:25:25 P	T07	
15/8/2015	6:25:26 P	T07	
15/8/2015	6:25:27 P	T07	
15/8/2015	6:25:28 P	T07	
15/8/2015	6:25:29 P	T07	
16/8/2015	2:30:33 A	T07	
16/8/2015	2:30:34 A	T07	
16/8/2015	2:30:35 A	T07	
16/8/2015	2:30:36 A	T07	
16/8/2015	2:30:37 A	T07	
16/8/2015	6:39:18 P	T07	
16/8/2015	6:39:19 P	T07	
16/8/2015	6:39:20 P	T07	
16/8/2015	6:39:21 P	T07	
16/8/2015	6:39:22 P	T07	
18/8/2015	12:28:00 A	T07	
18/8/2015	12:28:01 A	T07	
18/8/2015	12:28:02 A	T07	
18/8/2015	12:28:03 A	T07	
18/8/2015	12:28:04 A	T07	
18/8/2015	5:51:03 P	T02	
18/8/2015	5:51:04 P	T02	
18/8/2015	5:51:05 P	T02	
18/8/2015	5:51:06 P	T02	
18/8/2015	5:51:07 P	T02	
18/8/2015	7:36:31 P	T07	
18/8/2015	7:36:32 P	T07	
18/8/2015	7:36:33 P	T07	
18/8/2015	7:36:34 P	T07	
18/8/2015	7:36:35 P	T07	
19/8/2015	4:38:24 A	T07	
19/8/2015	4:38:25 A	T07	
19/8/2015	4:38:26 A	T07	
19/8/2015	4:38:27 A	T07	
19/8/2015	4:38:28 A	T07	
19/8/2015	12:08:23 P	T03	
19/8/2015	12:08:25 P	T03	
19/8/2015	12:08:26 P	T03	

Date	Time	Camera 1	Camera 2
19/8/2015	12:08:27 P	T03	
19/8/2015	12:08:28 P	T03	
19/8/2015	12:36:39 P	T03	
19/8/2015	12:36:41 P	T03	
19/8/2015	12:36:42 P	T03	
19/8/2015	12:36:43 P	T03	
19/8/2015	12:36:44 P	T03	
20/8/2015	10:48:52 A	T07	
20/8/2015	10:48:53 A	T07	
20/8/2015	10:48:54 A	T07	
20/8/2015	10:48:55 A	T07	
20/8/2015	10:48:56 A	T07	
20/8/2015	8:54:52 P	T07	
20/8/2015	8:54:53 P	T07	
20/8/2015	8:54:54 P	T07	
20/8/2015	8:54:55 P	T07	
20/8/2015	8:54:56 P	T07	
20/8/2015	10:39:20 P	T07	
20/8/2015	10:39:21 P	T07	
20/8/2015	10:39:22 P	T07	
20/8/2015	10:39:23 P	T07	
20/8/2015	10:39:24 P	T07	
20/8/2015	11:05:17 P	T07	
20/8/2015	11:05:18 P	T07	
20/8/2015	11:05:19 P	T07	
20/8/2015	11:05:20 P	T07	
20/8/2015	11:05:21 P	T07	
20/8/2015	11:53:13 P	T07	
20/8/2015	11:53:14 P	T07	
20/8/2015	11:53:15 P	T07	
20/8/2015	11:53:16 P	T07	
20/8/2015	11:53:17 P	T07	
21/8/2015	12:05:39 A	T07	
21/8/2015	12:05:40 A	T07	
21/8/2015	12:05:41 A	T07	
21/8/2015	12:05:42 A	T07	
21/8/2015	12:05:43 A	T07	
21/8/2015	8:46:48 A	T07	
21/8/2015	8:46:49 A	T07	

Date	Time	Camera 1	Camera 2
21/8/2015	8:46:50 A	T07	
21/8/2015	8:46:51 A	T07	
21/8/2015	8:46:52 A	T07	
22/8/2015	6:46:44 P	T06	
22/8/2015	6:46:45 P	T06	
22/8/2015	6:46:46 P	T06	
22/8/2015	6:46:47 P	T06	
22/8/2015	6:46:48 P	T06	
25/8/2015	8:26:17 A	T06	
25/8/2015	8:26:18 A	T06	
25/8/2015	8:26:19 A	T06	
25/8/2015	8:26:20 A	T06	
25/8/2015	8:26:21 A	T06	
25/8/2015	9:43:33 A	T06	
25/8/2015	9:43:34 A	T06	
25/8/2015	9:43:35 A	T06	
25/8/2015	9:43:36 A	T06	
25/8/2015	9:43:37 A	T06	
25/8/2015	5:43:59 P	T02	
25/8/2015	5:44:00 P	T02	
25/8/2015	5:44:01 P	T02	
25/8/2015	5:44:02 P	T02	
25/8/2015	5:44:03 P	T02	
25/8/2015	7:11:34 P	T06	
25/8/2015	7:11:35 P	T06	
25/8/2015	7:11:36 P	T06	
25/8/2015	7:11:37 P	T06	
25/8/2015	7:11:38 P	T06	
27/8/2015	12:09:07 P	T06	
27/8/2015	12:09:08 P	T06	
27/8/2015	12:09:09 P	T06	
27/8/2015	12:09:10 P	T06	
27/8/2015	12:09:11 P	T06	
28/8/2015	12:40:51 P	T03	
28/8/2015	12:40:52 P	T03	
28/8/2015	12:40:53 P	T03	
28/8/2015	12:40:54 P	T03	
28/8/2015	12:40:55 P	T03	
29/8/2015	8:57:47 A	T06	

Date	Time	Camera 1	Camera 2
29/8/2015	8:57:49 A	T06	
29/8/2015	8:57:50 A	T06	
29/8/2015	8:57:51 A	T06	
29/8/2015	8:57:52 A	T06	
31/8/2015	6:48:49 P	T06	
31/8/2015	6:48:50 P	T06	
31/8/2015	6:48:51 P	T06	
31/8/2015	6:48:52 P	T06	
31/8/2015	6:48:53 P	T06	
1/9/2015	8:09:15 A	T06	
1/9/2015	8:09:16 A	T06	
1/9/2015	8:09:17 A	T06	
1/9/2015	8:09:18 A	T06	
1/9/2015	8:09:19 A	T06	
1/9/2015	8:40:22 A	T06	
1/9/2015	8:40:24 A	T06	
1/9/2015	8:40:25 A	T06	
1/9/2015	8:40:26 A	T06	
1/9/2015	8:40:27 A	T06	
1/9/2015	9:37:09 A	T06	
1/9/2015	9:37:10 A	T06	
1/9/2015	9:37:11 A	T06	
1/9/2015	9:37:12 A	T06	
1/9/2015	9:37:13 A	T06	
1/9/2015	9:48:48 A	T06	
1/9/2015	9:48:49 A	T06	
1/9/2015	9:48:50 A	T06	
1/9/2015	9:48:51 A	T06	
1/9/2015	9:48:52 A	T06	
9/9/2015	9:30:32 A	T06	
9/9/2015	9:30:33 A	T06	
9/9/2015	9:30:34 A	T06	
9/9/2015	9:30:35 A	T06	
9/9/2015	9:30:36 A	T06	
20/9/2015	1:19:32 P	T06	
20/9/2015	1:19:33 P	T06	
20/9/2015	1:19:34 P	T06	
20/9/2015	1:19:35 P	T06	
20/9/2015	1:19:36 P	T06	

Date	Time	Camera 1	Camera 2
21/9/2015	8:56:22 A	T06	
21/9/2015	8:56:24 A	T06	
21/9/2015	8:56:25 A	T06	
21/9/2015	8:56:26 A	T06	
21/9/2015	8:56:27 A	T06	
21/9/2015	9:00:03 A	T06	
21/9/2015	9:00:04 A	T06	
21/9/2015	9:00:05 A	T06	
21/9/2015	9:00:06 A	T06	
21/9/2015	9:00:07 A	T06	
22/9/2015	12:30:16 P	T06	
22/9/2015	12:30:17 P	T06	
22/9/2015	12:30:18 P	T06	
22/9/2015	12:30:19 P	T06	
22/9/2015	12:30:20 P	T06	

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22/6/2015	1:50:17 P	T07	
22/6/2015	1:50:19 P	T07	
22/6/2015	1:50:20 P	T07	
22/6/2015	1:50:21 P	T07	
22/6/2015	1:50:22 P	T07	
28/6/2015	7:16:09 P	T07	
28/6/2015	7:16:11 P	T07	
28/6/2015	7:16:12 P	T07	
28/6/2015	7:16:13 P	T07	
28/6/2015	7:16:14 P	T07	
3/7/2015	5:43:46 P	T05	
3/7/2015	5:43:47 P	T05	
3/7/2015	5:43:48 P	T05	
3/7/2015	5:43:49 P	T05	
3/7/2015	5:43:50 P	T05	
8/7/2015	8:11:15 A	T07	
8/7/2015	8:11:17 A	T07	
8/7/2015	8:11:18 A	T07	
8/7/2015	8:11:19 A	T07	
8/7/2015	8:11:20 A	T07	
9/7/2015	3:05:58 P	T09	

Date	Time	Camera 1	Camera 2
9/7/2015	3:05:59 P	T09	
9/7/2015	3:06:00 P	T09	
9/7/2015	3:06:01 P	T09	
9/7/2015	3:06:02 P	T09	
10/7/2015	3:34:48 P	T09	
10/7/2015	3:34:50 P	T09	
10/7/2015	3:34:51 P	T09	
10/7/2015	3:34:52 P	T09	
10/7/2015	3:34:53 P	T09	
11/7/2015	2:23:40 P	T07	
11/7/2015	2:23:41 P	T07	
11/7/2015	2:23:42 P	T07	
11/7/2015	2:23:43 P	T07	
11/7/2015	2:23:44 P	T07	
12/7/2015	2:02:47 P	T05	
12/7/2015	2:02:49 P	T05	
12/7/2015	2:02:50 P	T05	
12/7/2015	2:02:51 P	T05	
12/7/2015	2:02:52 P	T05	
12/7/2015	4:27:46 P	T09	
12/7/2015	4:27:47 P	T09	
12/7/2015	4:27:48 P	T09	
12/7/2015	4:27:49 P	T09	
12/7/2015	4:27:50 P	T09	
20/7/2015	4:52:11 P	T09	
20/7/2015	4:52:12 P	T09	
20/7/2015	4:52:13 P	T09	
20/7/2015	4:52:14 P	T09	
20/7/2015	4:52:15 P	T09	
21/7/2015	4:19:37 P	T07	
21/7/2015	4:19:38 P	T07	
21/7/2015	4:19:39 P	T07	
21/7/2015	4:19:40 P	T07	
21/7/2015	4:19:41 P	T07	
22/7/2015	1:56:19 P	T07	
22/7/2015	1:56:21 P	T07	
22/7/2015	1:56:22 P	T07	
22/7/2015	1:56:23 P	T07	
22/7/2015	1:56:24 P	T07	

Date	Time	Camera 1	Camera 2
23/7/2015	12:50:06 P	T05	
23/7/2015	12:50:07 P	T05	
23/7/2015	12:50:08 P	T05	
23/7/2015	12:50:09 P	T05	
23/7/2015	12:50:10 P	T05	
26/7/2015	1:22:11 P	T09	
26/7/2015	1:22:12 P	T09	
26/7/2015	1:22:13 P	T09	
26/7/2015	1:22:14 P	T09	
26/7/2015	1:22:15 P	T09	
27/7/2015	6:13:24 P	T09	
27/7/2015	6:13:26 P	T09	
27/7/2015	6:13:27 P	T09	
27/7/2015	6:13:28 P	T09	
27/7/2015	6:13:29 P	T09	
29/7/2015	4:34:23 P	T07	
29/7/2015	4:34:24 P	T07	
29/7/2015	4:34:25 P	T07	
29/7/2015	4:34:26 P	T07	
29/7/2015	4:34:27 P	T07	
5/8/2015	11:29:19 A	T06	
5/8/2015	11:29:20 A	T06	
5/8/2015	11:29:21 A	T06	
5/8/2015	11:29:22 A	T06	
5/8/2015	11:29:23 A	T06	
5/8/2015	12:21:58 P	T07	
5/8/2015	12:21:59 P	T07	
5/8/2015	12:22:00 P	T07	
5/8/2015	12:22:01 P	T07	
5/8/2015	12:22:02 P	T07	
5/8/2015	12:29:20 P	T06	
5/8/2015	12:29:22 P	T06	
5/8/2015	12:29:23 P	T06	
5/8/2015	12:29:24 P	T06	
5/8/2015	12:29:25 P	T06	
5/8/2015	12:31:12 P	T07	
5/8/2015	12:31:13 P	T07	
5/8/2015	12:31:14 P	T07	
5/8/2015	12:31:15 P	T07	

Date	Time	Camera 1	Camera 2
5/8/2015	12:31:16 P	T07	
5/8/2015	1:44:12 P	T03	
5/8/2015	1:44:13 P	T03	
5/8/2015	1:44:14 P	T03	
5/8/2015	1:44:15 P	T03	
5/8/2015	1:44:16 P	T03	
5/8/2015	1:44:32 P	T03	
5/8/2015	1:44:33 P	T03	
5/8/2015	1:44:34 P	T03	
5/8/2015	1:44:35 P	T03	
5/8/2015	1:44:36 P	T03	
5/8/2015	5:09:50 P	T09	
5/8/2015	5:09:51 P	T09	
5/8/2015	5:09:52 P	T09	
5/8/2015	5:09:53 P	T09	
5/8/2015	5:09:54 P	T09	
6/8/2015	11:23:14 A	T09	
6/8/2015	11:23:15 A	T09	
6/8/2015	11:23:16 A	T09	
6/8/2015	11:23:17 A	T09	
6/8/2015	11:23:18 A	T09	
6/8/2015	11:29:42 A	T06	
6/8/2015	11:29:44 A	T06	
6/8/2015	11:29:45 A	T06	
6/8/2015	11:29:46 A	T06	
6/8/2015	11:29:47 A	T06	
6/8/2015	12:08:23 P	T07	
6/8/2015	12:08:24 P	T07	
6/8/2015	12:08:25 P	T07	
6/8/2015	12:08:26 P	T07	
6/8/2015	12:08:27 P	T07	
6/8/2015	12:08:43 P	T07	
6/8/2015	12:08:44 P	T07	
6/8/2015	12:08:45 P	T07	
6/8/2015	12:08:46 P	T07	
6/8/2015	12:08:47 P	T07	
9/8/2015	3:32:20 P	T07	
9/8/2015	3:32:21 P	T07	
9/8/2015	3:32:22 P	T07	

Date	Time	Camera 1	Camera 2
9/8/2015	3:32:23 P	T07	
9/8/2015	3:32:24 P	T07	
10/8/2015	6:22:28 P	T07	
10/8/2015	6:22:29 P	T07	
10/8/2015	6:22:30 P	T07	
10/8/2015	6:22:31 P	T07	
10/8/2015	6:22:32 P	T07	
11/8/2015	3:46:09 P	T07	
11/8/2015	3:46:10 P	T07	
11/8/2015	3:46:11 P	T07	
11/8/2015	3:46:12 P	T07	
11/8/2015	3:46:13 P	T07	
13/8/2015	12:18:47 P	T06	
13/8/2015	12:18:48 P	T06	
13/8/2015	12:18:49 P	T06	
13/8/2015	12:18:50 P	T06	
13/8/2015	12:18:51 P	T06	
15/8/2015	1:20:49 P	T03	
15/8/2015	1:20:51 P	T03	
15/8/2015	1:20:52 P	T03	
15/8/2015	1:20:53 P	T03	
15/8/2015	1:20:54 P	T03	
15/8/2015	1:47:40 P	T03	
15/8/2015	1:47:41 P	T03	
15/8/2015	1:47:42 P	T03	
15/8/2015	1:47:43 P	T03	
15/8/2015	1:47:44 P	T03	
18/8/2015	5:49:56 P	T02	
18/8/2015	5:49:58 P	T02	
18/8/2015	5:49:59 P	T02	
18/8/2015	5:50:00 P	T02	
18/8/2015	5:50:01 P	T02	
18/8/2015	5:51:56 P	T02	
18/8/2015	5:51:57 P	T02	
18/8/2015	5:51:58 P	T02	
18/8/2015	5:51:59 P	T02	
18/8/2015	5:52:00 P	T02	
19/8/2015	3:28:21 P	T03	
19/8/2015	3:28:22 P	T03	

Date	Time	Camera 1	Camera 2
19/8/2015	3:28:23 P	T03	
19/8/2015	3:28:24 P	T03	
19/8/2015	3:28:25 P	T03	
19/8/2015	4:35:53 P	T03	
19/8/2015	4:35:55 P	T03	
19/8/2015	4:35:56 P	T03	
19/8/2015	4:35:57 P	T03	
19/8/2015	4:35:58 P	T03	
23/8/2015	4:52:04 P	T03	
23/8/2015	4:52:05 P	T03	
23/8/2015	4:52:06 P	T03	
23/8/2015	4:52:07 P	T03	
23/8/2015	4:52:08 P	T03	
26/8/2015	11:30:21 A	T06	
26/8/2015	11:30:22 A	T06	
26/8/2015	11:30:23 A	T06	
26/8/2015	11:30:24 A	T06	
26/8/2015	11:30:25 A	T06	
28/8/2015	9:38:50 A	T03	
28/8/2015	9:38:52 A	T03	
28/8/2015	9:38:53 A	T03	
28/8/2015	9:38:54 A	T03	
28/8/2015	9:38:55 A	T03	
28/8/2015	2:44:11 P	T03	
28/8/2015	2:44:13 P	T03	
28/8/2015	2:44:14 P	T03	
28/8/2015	2:44:15 P	T03	
28/8/2015	2:44:16 P	T03	

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9/7/2015	5:37:55 P	T02	
9/7/2015	5:37:56 P	T02	
9/7/2015	5:37:57 P	T02	
9/7/2015	5:37:58 P	T02	
9/7/2015	5:37:59 P	T02	
19/7/2015	12:22:32 P	T09	
19/7/2015	12:22:33 P	T09	
19/7/2015	12:22:34 P	T09	

Date	Time	Camera 1	Camera 2
19/7/2015	12:22:35 P	T09	
19/7/2015	12:22:36 P	T09	
12/9/2015	12:06:53 P	T06	
12/9/2015	12:06:54 P	T06	
12/9/2015	12:06:55 P	T06	
12/9/2015	12:06:56 P	T06	
12/9/2015	12:06:57 P	T06	

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14/6/2015	3:04:44 P	T07	
14/6/2015	3:04:45 P	T07	
14/6/2015	3:04:46 P	T07	
14/6/2015	3:04:47 P	T07	
14/6/2015	3:04:48 P	T07	
7/8/2015	9:50:22 A	T08	
7/8/2015	9:50:24 A	T08	
7/8/2015	9:50:25 A	T08	
7/8/2015	9:50:26 A	T08	
7/8/2015	9:50:27 A	T08	
7/8/2015	9:50:42 A	T08	
7/8/2015	9:50:43 A	T08	
7/8/2015	9:50:44 A	T08	
7/8/2015	9:50:45 A	T08	
7/8/2015	9:50:46 A	T08	
7/8/2015	9:51:01 A	T08	
7/8/2015	9:51:02 A	T08	
7/8/2015	9:51:03 A	T08	
7/8/2015	9:51:04 A	T08	
7/8/2015	9:51:05 A	T08	
7/8/2015	9:51:39 A	T08	
7/8/2015	9:51:40 A	T08	
7/8/2015	9:51:41 A	T08	
7/8/2015	9:51:42 A	T08	
7/8/2015	9:51:43 A	T08	
7/8/2015	9:51:59 A	T08	
7/8/2015	9:52:01 A	T08	
7/8/2015	9:52:02 A	T08	
7/8/2015	9:52:03 A	T08	

Date	Time	Camera 1	Camera 2
7/8/2015	9:52:04 A	T08	
17/9/2015	8:03:00 A	T06	
17/9/2015	8:03:02 A	T06	
17/9/2015	8:03:03 A	T06	
17/9/2015	8:03:04 A	T06	
17/9/2015	8:03:05 A	T06	

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21/5/2015	2:52:43 P	T04	
21/5/2015	2:52:44 P	T04	
21/5/2015	2:52:45 P	T04	
21/5/2015	2:52:46 P	T04	
21/5/2015	2:52:47 P	T04	
4/6/2015	3:50:20 P	T05	
4/6/2015	3:50:22 P	T05	
4/6/2015	3:50:23 P	T05	
4/6/2015	3:50:24 P	T05	
4/6/2015	3:50:25 P	T05	
12/6/2015	7:34:02 A	T06	
12/6/2015	7:34:03 A	T06	
12/6/2015	7:34:04 A	T06	
12/6/2015	7:34:05 A	T06	
12/6/2015	7:34:06 A	T06	
13/6/2015	10:03:36 A	T06	
13/6/2015	10:03:38 A	T06	
13/6/2015	10:03:39 A	T06	
13/6/2015	10:03:40 A	T06	
13/6/2015	10:03:41 A	T06	
13/6/2015	5:23:37 P	T06	
13/6/2015	5:23:39 P	T06	
13/6/2015	5:23:40 P	T06	
13/6/2015	5:23:41 P	T06	
13/6/2015	5:23:42 P	T06	
14/6/2015	7:18:53 A	T06	
14/6/2015	7:18:56 A	T06	
14/6/2015	7:18:57 A	T06	
14/6/2015	7:18:58 A	T06	
14/6/2015	7:18:59 A	T06	

Date	Time	Camera 1	Camera 2
14/6/2015	8:13:05 A	T06	
14/6/2015	8:13:07 A	T06	
14/6/2015	8:13:08 A	T06	
14/6/2015	8:13:09 A	T06	
14/6/2015	8:13:10 A	T06	
14/6/2015	12:53:13 P	T06	
14/6/2015	12:53:15 P	T06	
14/6/2015	12:53:16 P	T06	
14/6/2015	12:53:17 P	T06	
14/6/2015	12:53:18 P	T06	
14/6/2015	3:11:43 P	T06	
14/6/2015	3:11:45 P	T06	
14/6/2015	3:11:46 P	T06	
14/6/2015	3:11:47 P	T06	
14/6/2015	3:11:48 P	T06	
14/6/2015	4:55:44 P	T06	
14/6/2015	4:55:45 P	T06	
14/6/2015	4:55:46 P	T06	
14/6/2015	4:55:47 P	T06	
14/6/2015	4:55:48 P	T06	
14/6/2015	5:34:37 P	T06	
14/6/2015	5:34:39 P	T06	
14/6/2015	5:34:40 P	T06	
14/6/2015	5:34:41 P	T06	
14/6/2015	5:34:42 P	T06	
14/6/2015	5:36:04 P	T06	
14/6/2015	5:36:05 P	T06	
14/6/2015	5:36:06 P	T06	
14/6/2015	5:36:07 P	T06	
14/6/2015	5:36:08 P	T06	
14/6/2015	5:36:24 P	T06	
14/6/2015	5:36:25 P	T06	
14/6/2015	5:36:26 P	T06	
14/6/2015	5:36:27 P	T06	
14/6/2015	5:36:28 P	T06	
15/6/2015	6:33:49 A	T06	
15/6/2015	6:33:50 A	T06	
15/6/2015	6:33:51 A	T06	
15/6/2015	6:33:52 A	T06	

Date	Time	Camera 1	Camera 2
15/6/2015	6:33:53 A	T06	
15/6/2015	8:54:24 A	T06	
15/6/2015	8:54:25 A	T06	
15/6/2015	8:54:26 A	T06	
15/6/2015	8:54:27 A	T06	
15/6/2015	8:54:28 A	T06	
15/6/2015	8:55:08 A	T06	
15/6/2015	8:55:10 A	T06	
15/6/2015	8:55:11 A	T06	
15/6/2015	8:55:12 A	T06	
15/6/2015	8:55:13 A	T06	
15/6/2015	1:11:42 P	T06	
15/6/2015	1:11:43 P	T06	
15/6/2015	1:11:44 P	T06	
15/6/2015	1:11:45 P	T06	
15/6/2015	1:11:46 P	T06	
15/6/2015	1:12:06 P	T06	
15/6/2015	1:12:07 P	T06	
15/6/2015	1:12:08 P	T06	
15/6/2015	1:12:09 P	T06	
15/6/2015	1:12:10 P	T06	
15/6/2015	3:45:16 P	T06	
15/6/2015	3:45:17 P	T06	
15/6/2015	3:45:18 P	T06	
15/6/2015	3:45:19 P	T06	
15/6/2015	3:45:20 P	T06	
16/6/2015	4:45:35 P	T06	
16/6/2015	4:45:37 P	T06	
16/6/2015	4:45:38 P	T06	
16/6/2015	4:45:39 P	T06	
16/6/2015	4:45:40 P	T06	
16/6/2015	6:36:07 P	T06	
16/6/2015	6:36:09 P	T06	
16/6/2015	6:36:10 P	T06	
16/6/2015	6:36:11 P	T06	
16/6/2015	6:36:12 P	T06	
17/6/2015	2:33:26 P	T06	
17/6/2015	2:33:27 P	T06	
17/6/2015	2:33:29 P	T06	

Date	Time	Camera 1	Camera 2
17/6/2015	2:33:30 P	T06	
17/6/2015	2:33:31 P	T06	
17/6/2015	5:35:56 P	T06	
17/6/2015	5:35:57 P	T06	
17/6/2015	5:35:58 P	T06	
17/6/2015	5:35:59 P	T06	
17/6/2015	5:36:00 P	T06	
18/6/2015	9:20:06 A	T07	
18/6/2015	9:20:07 A	T07	
18/6/2015	9:20:08 A	T07	
18/6/2015	9:20:09 A	T07	
18/6/2015	9:20:10 A	T07	
18/6/2015	9:20:30 A	T07	
18/6/2015	9:20:32 A	T07	
18/6/2015	9:20:33 A	T07	
18/6/2015	9:20:34 A	T07	
18/6/2015	9:20:35 A	T07	
18/6/2015	9:20:51 A	T07	
18/6/2015	9:20:52 A	T07	
18/6/2015	9:20:53 A	T07	
18/6/2015	9:20:54 A	T07	
18/6/2015	9:20:55 A	T07	
18/6/2015	9:22:18 A	T07	
18/6/2015	9:22:19 A	T07	
18/6/2015	9:22:20 A	T07	
18/6/2015	9:22:21 A	T07	
18/6/2015	9:22:22 A	T07	
18/6/2015	9:22:45 A	T07	
18/6/2015	9:22:46 A	T07	
18/6/2015	9:22:47 A	T07	
18/6/2015	9:22:48 A	T07	
18/6/2015	9:22:49 A	T07	
18/6/2015	9:23:13 A	T07	
18/6/2015	9:23:14 A	T07	
18/6/2015	9:23:15 A	T07	
18/6/2015	9:23:16 A	T07	
18/6/2015	9:23:17 A	T07	
18/6/2015	9:23:35 A	T07	
18/6/2015	9:23:36 A	T07	

Date	Time	Camera 1	Camera 2
18/6/2015	9:23:37 A	T07	
18/6/2015	9:23:38 A	T07	
18/6/2015	9:23:39 A	T07	
18/6/2015	9:23:56 A	T07	
18/6/2015	9:23:57 A	T07	
18/6/2015	9:23:58 A	T07	
18/6/2015	9:23:59 A	T07	
18/6/2015	9:24:00 A	T07	
18/6/2015	9:24:17 A	T07	
18/6/2015	9:24:18 A	T07	
18/6/2015	9:24:19 A	T07	
18/6/2015	9:24:20 A	T07	
18/6/2015	9:24:21 A	T07	
18/6/2015	9:24:36 A	T07	
18/6/2015	9:24:37 A	T07	
18/6/2015	9:24:38 A	T07	
18/6/2015	9:24:39 A	T07	
18/6/2015	9:24:40 A	T07	
18/6/2015	9:25:43 A	T07	
18/6/2015	9:25:44 A	T07	
18/6/2015	9:25:45 A	T07	
18/6/2015	9:25:46 A	T07	
18/6/2015	9:25:47 A	T07	
18/6/2015	9:26:05 A	T07	
18/6/2015	9:26:06 A	T07	
18/6/2015	9:26:07 A	T07	
18/6/2015	9:26:08 A	T07	
18/6/2015	9:26:09 A	T07	
18/6/2015	9:27:26 A	T07	
18/6/2015	9:27:27 A	T07	
18/6/2015	9:27:28 A	T07	
18/6/2015	9:27:29 A	T07	
18/6/2015	9:27:30 A	T07	
18/6/2015	3:07:27 P	T06	
18/6/2015	3:07:29 P	T06	
18/6/2015	3:07:30 P	T06	
18/6/2015	3:07:31 P	T06	
18/6/2015	3:07:32 P	T06	
19/6/2015	1:23:04 A	T06	

Date	Time	Camera 1	Camera 2
19/6/2015	1:23:06 A	T06	
19/6/2015	1:23:08 A	T06	
19/6/2015	1:23:09 A	T06	
19/6/2015	1:23:10 A	T06	
19/6/2015	2:19:42 P	T06	
19/6/2015	2:19:43 P	T06	
19/6/2015	2:19:44 P	T06	
19/6/2015	2:19:45 P	T06	
19/6/2015	2:19:46 P	T06	
19/6/2015	4:04:03 P	T06	
19/6/2015	4:04:04 P	T06	
19/6/2015	4:04:05 P	T06	
19/6/2015	4:04:06 P	T06	
19/6/2015	4:04:07 P	T06	
19/6/2015	4:04:23 P	T06	
19/6/2015	4:04:24 P	T06	
19/6/2015	4:04:25 P	T06	
19/6/2015	4:04:26 P	T06	
19/6/2015	4:04:27 P	T06	
19/6/2015	4:05:00 P	T06	
19/6/2015	4:05:01 P	T06	
19/6/2015	4:05:02 P	T06	
19/6/2015	4:05:03 P	T06	
19/6/2015	4:05:04 P	T06	
19/6/2015	5:48:54 P	T06	
19/6/2015	5:48:56 P	T06	
19/6/2015	5:48:57 P	T06	
19/6/2015	5:48:58 P	T06	
19/6/2015	5:48:59 P	T06	
19/6/2015	5:49:29 P	T06	
19/6/2015	5:49:31 P	T06	
19/6/2015	5:49:32 P	T06	
19/6/2015	5:49:33 P	T06	
19/6/2015	5:49:34 P	T06	
19/6/2015	6:07:15 P	T06	
19/6/2015	6:07:17 P	T06	
19/6/2015	6:07:18 P	T06	
19/6/2015	6:07:19 P	T06	
19/6/2015	6:07:20 P	T06	

Date	Time	Camera 1	Camera 2
20/6/2015	8:24:00 A	T06	
20/6/2015	8:24:02 A	T06	
20/6/2015	8:24:03 A	T06	
20/6/2015	8:24:04 A	T06	
20/6/2015	8:24:05 A	T06	
20/6/2015	11:12:46 A	T06	
20/6/2015	11:12:47 A	T06	
20/6/2015	11:12:48 A	T06	
20/6/2015	11:12:49 A	T06	
20/6/2015	11:12:50 A	T06	
20/6/2015	11:36:10 A	T06	
20/6/2015	11:36:11 A	T06	
20/6/2015	11:36:12 A	T06	
20/6/2015	11:36:13 A	T06	
20/6/2015	11:36:14 A	T06	
20/6/2015	1:49:04 P	T06	
20/6/2015	1:49:06 P	T06	
20/6/2015	1:49:07 P	T06	
20/6/2015	1:49:08 P	T06	
20/6/2015	1:49:09 P	T06	
20/6/2015	5:48:33 P	T06	
20/6/2015	5:48:34 P	T06	
20/6/2015	5:48:35 P	T06	
20/6/2015	5:48:36 P	T06	
20/6/2015	5:48:37 P	T06	
20/6/2015	5:58:11 P	T06	
20/6/2015	5:58:12 P	T06	
20/6/2015	5:58:13 P	T06	
20/6/2015	5:58:14 P	T06	
20/6/2015	5:58:15 P	T06	
20/6/2015	5:59:32 P	T06	
20/6/2015	5:59:33 P	T06	
20/6/2015	5:59:34 P	T06	
20/6/2015	5:59:35 P	T06	
20/6/2015	5:59:36 P	T06	
20/6/2015	6:00:59 P	T06	
20/6/2015	6:01:00 P	T06	
20/6/2015	6:01:01 P	T06	
20/6/2015	6:01:02 P	T06	

Date	Time	Camera 1	Camera 2
20/6/2015	6:01:03 P	T06	
20/6/2015	6:01:30 P	T06	
20/6/2015	6:01:31 P	T06	
20/6/2015	6:01:32 P	T06	
20/6/2015	6:01:33 P	T06	
20/6/2015	6:01:34 P	T06	
20/6/2015	6:06:46 P	T06	
20/6/2015	6:06:47 P	T06	
20/6/2015	6:06:48 P	T06	
20/6/2015	6:06:49 P	T06	
20/6/2015	6:06:50 P	T06	
20/6/2015	6:13:13 P	T06	
20/6/2015	6:13:15 P	T06	
20/6/2015	6:13:16 P	T06	
20/6/2015	6:13:17 P	T06	
20/6/2015	6:13:18 P	T06	
20/6/2015	11:30:05 P	T06	
20/6/2015	11:30:08 P	T06	
20/6/2015	11:30:09 P	T06	
20/6/2015	11:30:10 P	T06	
20/6/2015	11:30:11 P	T06	
20/6/2015	11:37:35 P	T06	
20/6/2015	11:37:37 P	T06	
20/6/2015	11:37:38 P	T06	
20/6/2015	11:37:40 P	T06	
20/6/2015	11:37:41 P	T06	
20/6/2015	11:51:36 P	T06	
20/6/2015	11:51:37 P	T06	
20/6/2015	11:51:39 P	T06	
20/6/2015	11:51:40 P	T06	
20/6/2015	11:51:41 P	T06	
21/6/2015	12:13:46 A	T06	
21/6/2015	12:13:49 A	T06	
21/6/2015	12:13:51 A	T06	
21/6/2015	12:13:52 A	T06	
21/6/2015	12:13:53 A	T06	
21/6/2015	6:05:02 A	T06	
21/6/2015	6:05:03 A	T06	
21/6/2015	6:05:05 A	T06	

Date	Time	Camera 1	Camera 2
21/6/2015	6:05:06 A	T06	
21/6/2015	6:05:07 A	T06	
21/6/2015	9:20:22 A	T06	
21/6/2015	9:20:23 A	T06	
21/6/2015	9:20:24 A	T06	
21/6/2015	9:20:25 A	T06	
21/6/2015	9:20:26 A	T06	
21/6/2015	1:49:00 P	T06	
21/6/2015	1:49:01 P	T06	
21/6/2015	1:49:02 P	T06	
21/6/2015	1:49:03 P	T06	
21/6/2015	1:49:04 P	T06	
21/6/2015	1:49:38 P	T06	
21/6/2015	1:49:40 P	T06	
21/6/2015	1:49:41 P	T06	
21/6/2015	1:49:42 P	T06	
21/6/2015	1:49:43 P	T06	
21/6/2015	1:49:58 P	T06	
21/6/2015	1:49:59 P	T06	
21/6/2015	1:50:00 P	T06	
21/6/2015	1:50:01 P	T06	
21/6/2015	1:50:02 P	T06	
21/6/2015	1:50:22 P	T06	
21/6/2015	1:50:23 P	T06	
21/6/2015	1:50:24 P	T06	
21/6/2015	1:50:25 P	T06	
21/6/2015	1:50:26 P	T06	
21/6/2015	2:05:03 P	T06	
21/6/2015	2:05:05 P	T06	
21/6/2015	2:05:06 P	T06	
21/6/2015	2:05:07 P	T06	
21/6/2015	2:05:08 P	T06	
21/6/2015	2:09:08 P	T06	
21/6/2015	2:09:10 P	T06	
21/6/2015	2:09:11 P	T06	
21/6/2015	2:09:12 P	T06	
21/6/2015	2:09:13 P	T06	
21/6/2015	2:09:49 P	T06	
21/6/2015	2:09:50 P	T06	

Date	Time	Camera 1	Camera 2
21/6/2015	2:09:51 P	T06	
21/6/2015	2:09:52 P	T06	
21/6/2015	2:09:53 P	T06	
21/6/2015	2:15:15 P	T06	
21/6/2015	2:15:16 P	T06	
21/6/2015	2:15:17 P	T06	
21/6/2015	2:15:18 P	T06	
21/6/2015	2:15:19 P	T06	
21/6/2015	2:19:44 P	T06	
21/6/2015	2:19:45 P	T06	
21/6/2015	2:19:46 P	T06	
21/6/2015	2:19:47 P	T06	
21/6/2015	2:19:48 P	T06	
21/6/2015	2:22:28 P	T06	
21/6/2015	2:22:29 P	T06	
21/6/2015	2:22:30 P	T06	
21/6/2015	2:22:31 P	T06	
21/6/2015	2:22:32 P	T06	
21/6/2015	2:33:22 P	T06	
21/6/2015	2:33:23 P	T06	
21/6/2015	2:33:24 P	T06	
21/6/2015	2:33:25 P	T06	
21/6/2015	2:33:26 P	T06	
21/6/2015	3:28:25 P	T06	
21/6/2015	3:28:26 P	T06	
21/6/2015	3:28:27 P	T06	
21/6/2015	3:28:28 P	T06	
21/6/2015	3:28:29 P	T06	
21/6/2015	3:41:34 P	T06	
21/6/2015	3:41:36 P	T06	
21/6/2015	3:41:37 P	T06	
21/6/2015	3:41:38 P	T06	
21/6/2015	3:41:39 P	T06	
21/6/2015	4:16:13 P	T09	
21/6/2015	4:16:14 P	T09	
21/6/2015	4:16:15 P	T09	
21/6/2015	4:16:16 P	T09	
21/6/2015	4:16:17 P	T09	
21/6/2015	4:55:11 P	T06	

Date	Time	Camera 1	Camera 2
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21/6/2015	4:55:13 P	T06	
21/6/2015	4:55:14 P	T06	
21/6/2015	4:55:15 P	T06	
21/6/2015	4:55:31 P	T06	
21/6/2015	4:55:33 P	T06	
21/6/2015	4:55:34 P	T06	
21/6/2015	4:55:35 P	T06	
21/6/2015	4:55:36 P	T06	
21/6/2015	5:31:40 P	T09	
21/6/2015	5:31:42 P	T09	
21/6/2015	5:31:43 P	T09	
21/6/2015	5:31:44 P	T09	
21/6/2015	5:31:45 P	T09	
22/6/2015	5:44:51 P	T09	
22/6/2015	5:44:52 P	T09	
22/6/2015	5:44:53 P	T09	
22/6/2015	5:44:54 P	T09	
22/6/2015	5:44:55 P	T09	
23/6/2015	9:04:51 A	T07	
23/6/2015	9:04:52 A	T07	
23/6/2015	9:04:53 A	T07	
23/6/2015	9:04:54 A	T07	
23/6/2015	9:04:55 A	T07	
23/6/2015	9:05:25 A	T07	
23/6/2015	9:05:26 A	T07	
23/6/2015	9:05:27 A	T07	
23/6/2015	9:05:28 A	T07	
23/6/2015	9:05:29 A	T07	
23/6/2015	9:05:46 A	T07	
23/6/2015	9:05:47 A	T07	
23/6/2015	9:05:48 A	T07	
23/6/2015	9:05:49 A	T07	
23/6/2015	9:05:50 A	T07	
23/6/2015	9:06:32 A	T07	
23/6/2015	9:06:33 A	T07	
23/6/2015	9:06:34 A	T07	
23/6/2015	9:06:35 A	T07	
23/6/2015	9:06:36 A	T07	

Date	Time	Camera 1	Camera 2
23/6/2015	9:30:48 A	T07	
23/6/2015	9:30:49 A	T07	
23/6/2015	9:30:50 A	T07	
23/6/2015	9:30:51 A	T07	
23/6/2015	9:30:52 A	T07	
23/6/2015	9:31:07 A	T07	
23/6/2015	9:31:08 A	T07	
23/6/2015	9:31:09 A	T07	
23/6/2015	9:31:10 A	T07	
23/6/2015	9:31:11 A	T07	
23/6/2015	9:31:26 A	T07	
23/6/2015	9:31:27 A	T07	
23/6/2015	9:31:28 A	T07	
23/6/2015	9:31:29 A	T07	
23/6/2015	9:31:30 A	T07	
23/6/2015	9:32:03 A	T07	
23/6/2015	9:32:05 A	T07	
23/6/2015	9:32:06 A	T07	
23/6/2015	9:32:07 A	T07	
23/6/2015	9:32:08 A	T07	
23/6/2015	9:33:14 A	T07	
23/6/2015	9:33:15 A	T07	
23/6/2015	9:33:16 A	T07	
23/6/2015	9:33:17 A	T07	
23/6/2015	9:33:18 A	T07	
23/6/2015	9:33:38 A	T07	
23/6/2015	9:33:39 A	T07	
23/6/2015	9:33:40 A	T07	
23/6/2015	9:33:41 A	T07	
23/6/2015	9:33:42 A	T07	
23/6/2015	9:34:06 A	T07	
23/6/2015	9:34:07 A	T07	
23/6/2015	9:34:08 A	T07	
23/6/2015	9:34:09 A	T07	
23/6/2015	9:34:10 A	T07	
23/6/2015	12:49:11 P	T07	
23/6/2015	12:49:12 P	T07	
23/6/2015	12:49:13 P	T07	
23/6/2015	12:49:14 P	T07	

Date	Time	Camera 1	Camera 2
23/6/2015	12:49:15 P	T07	
25/6/2015	2:30:40 P	T06	
25/6/2015	2:30:42 P	T06	
25/6/2015	2:30:43 P	T06	
25/6/2015	2:30:44 P	T06	
25/6/2015	2:30:45 P	T06	
25/6/2015	3:46:50 P	T06	
25/6/2015	3:46:52 P	T06	
25/6/2015	3:46:53 P	T06	
25/6/2015	3:46:54 P	T06	
25/6/2015	3:46:55 P	T06	
26/6/2015	6:00:52 A	T06	
26/6/2015	6:00:53 A	T06	
26/6/2015	6:00:54 A	T06	
26/6/2015	6:00:55 A	T06	
26/6/2015	6:00:56 A	T06	
26/6/2015	6:02:09 A	T06	
26/6/2015	6:02:11 A	T06	
26/6/2015	6:02:12 A	T06	
26/6/2015	6:02:13 A	T06	
26/6/2015	6:02:14 A	T06	
26/6/2015	4:39:26 P	T06	
26/6/2015	4:39:28 P	T06	
26/6/2015	4:39:29 P	T06	
26/6/2015	4:39:30 P	T06	
26/6/2015	4:39:31 P	T06	
27/6/2015	2:09:58 A	T06	
27/6/2015	2:10:00 A	T06	
27/6/2015	2:10:01 A	T06	
27/6/2015	2:10:02 A	T06	
27/6/2015	2:10:03 A	T06	
27/6/2015	2:11:06 A	T06	
27/6/2015	2:11:08 A	T06	
27/6/2015	2:11:10 A	T06	
27/6/2015	2:11:11 A	T06	
27/6/2015	2:11:12 A	T06	
27/6/2015	6:10:05 A	T06	
27/6/2015	6:10:06 A	T06	
27/6/2015	6:10:08 A	T06	

Date	Time	Camera 1	Camera 2
27/6/2015	6:10:09 A	T06	
27/6/2015	6:10:10 A	T06	
27/6/2015	6:10:27 A	T06	
27/6/2015	6:10:29 A	T06	
27/6/2015	6:10:30 A	T06	
27/6/2015	6:10:31 A	T06	
27/6/2015	6:10:32 A	T06	
27/6/2015	6:12:01 A	T06	
27/6/2015	6:12:03 A	T06	
27/6/2015	6:12:04 A	T06	
27/6/2015	6:12:05 A	T06	
27/6/2015	6:12:06 A	T06	
27/6/2015	7:46:31 A	T06	
27/6/2015	7:46:33 A	T06	
27/6/2015	7:46:34 A	T06	
27/6/2015	7:46:35 A	T06	
27/6/2015	7:46:36 A	T06	
27/6/2015	7:50:44 A	T06	
27/6/2015	7:50:45 A	T06	
27/6/2015	7:50:46 A	T06	
27/6/2015	7:50:47 A	T06	
27/6/2015	7:50:48 A	T06	
27/6/2015	9:17:34 A	T06	
27/6/2015	9:17:36 A	T06	
27/6/2015	9:17:37 A	T06	
27/6/2015	9:17:38 A	T06	
27/6/2015	9:17:39 A	T06	
27/6/2015	9:18:07 A	T06	
27/6/2015	9:18:08 A	T06	
27/6/2015	9:18:09 A	T06	
27/6/2015	9:18:10 A	T06	
27/6/2015	9:18:11 A	T06	
27/6/2015	10:40:54 A	T06	
27/6/2015	10:40:55 A	T06	
27/6/2015	10:40:56 A	T06	
27/6/2015	10:40:57 A	T06	
27/6/2015	10:40:58 A	T06	
27/6/2015	10:41:14 A	T06	
27/6/2015	10:41:15 A	T06	

Date	Time	Camera 1	Camera 2
27/6/2015	10:41:16 A	T06	
27/6/2015	10:41:17 A	T06	
27/6/2015	10:41:18 A	T06	
27/6/2015	10:41:39 A	T06	
27/6/2015	10:41:40 A	T06	
27/6/2015	10:41:41 A	T06	
27/6/2015	10:41:42 A	T06	
27/6/2015	10:41:43 A	T06	
27/6/2015	1:29:38 P	T06	
27/6/2015	1:29:40 P	T06	
27/6/2015	1:29:41 P	T06	
27/6/2015	1:29:42 P	T06	
27/6/2015	1:29:43 P	T06	
27/6/2015	2:22:26 P	T06	
27/6/2015	2:22:27 P	T06	
27/6/2015	2:22:28 P	T06	
27/6/2015	2:22:29 P	T06	
27/6/2015	2:22:30 P	T06	
27/6/2015	3:09:57 P	T06	
27/6/2015	3:09:59 P	T06	
27/6/2015	3:10:00 P	T06	
27/6/2015	3:10:01 P	T06	
27/6/2015	3:10:02 P	T06	
27/6/2015	4:46:22 P	T06	
27/6/2015	4:46:23 P	T06	
27/6/2015	4:46:24 P	T06	
27/6/2015	4:46:25 P	T06	
27/6/2015	4:46:26 P	T06	
27/6/2015	6:19:31 P	T06	
27/6/2015	6:19:32 P	T06	
27/6/2015	6:19:33 P	T06	
27/6/2015	6:19:34 P	T06	
27/6/2015	6:19:35 P	T06	
27/6/2015	9:16:33 P	T06	
27/6/2015	9:16:35 P	T06	
27/6/2015	9:16:36 P	T06	
27/6/2015	9:16:37 P	T06	
27/6/2015	9:16:38 P	T06	
27/6/2015	9:56:48 P	T06	

Date	Time	Camera 1	Camera 2
27/6/2015	9:56:51 P	T06	
27/6/2015	9:56:52 P	T06	
27/6/2015	9:56:53 P	T06	
27/6/2015	9:56:54 P	T06	
27/6/2015	9:59:48 P	T06	
27/6/2015	9:59:50 P	T06	
27/6/2015	9:59:51 P	T06	
27/6/2015	9:59:52 P	T06	
27/6/2015	9:59:53 P	T06	
27/6/2015	10:27:36 P	T06	
27/6/2015	10:27:40 P	T06	
27/6/2015	10:27:41 P	T06	
27/6/2015	10:27:43 P	T06	
27/6/2015	10:27:44 P	T06	
28/6/2015	2:05:45 A	T06	
28/6/2015	2:05:47 A	T06	
28/6/2015	2:05:48 A	T06	
28/6/2015	2:05:49 A	T06	
28/6/2015	2:05:50 A	T06	
28/6/2015	2:15:15 A	T06	
28/6/2015	2:15:18 A	T06	
28/6/2015	2:15:19 A	T06	
28/6/2015	2:15:20 A	T06	
28/6/2015	2:15:21 A	T06	
28/6/2015	5:54:01 A	T06	
28/6/2015	5:54:02 A	T06	
28/6/2015	5:54:03 A	T06	
28/6/2015	5:54:04 A	T06	
28/6/2015	5:54:05 A	T06	
28/6/2015	6:47:41 A	T06	
28/6/2015	6:47:44 A	T06	
28/6/2015	6:47:45 A	T06	
28/6/2015	6:47:46 A	T06	
28/6/2015	6:47:47 A	T06	
28/6/2015	6:54:10 A	T06	
28/6/2015	6:54:12 A	T06	
28/6/2015	6:54:13 A	T06	
28/6/2015	6:54:14 A	T06	
28/6/2015	6:54:15 A	T06	

Date	Time	Camera 1	Camera 2
28/6/2015	8:56:03 A	T06	
28/6/2015	8:56:05 A	T06	
28/6/2015	8:56:06 A	T06	
28/6/2015	8:56:07 A	T06	
28/6/2015	8:56:08 A	T06	
28/6/2015	8:56:35 A	T06	
28/6/2015	8:56:38 A	T06	
28/6/2015	8:56:39 A	T06	
28/6/2015	8:56:40 A	T06	
28/6/2015	8:56:41 A	T06	
28/6/2015	11:01:50 A	T06	
28/6/2015	11:01:51 A	T06	
28/6/2015	11:01:52 A	T06	
28/6/2015	11:01:53 A	T06	
28/6/2015	11:01:54 A	T06	
28/6/2015	1:06:55 P	T06	
28/6/2015	1:06:57 P	T06	
28/6/2015	1:06:58 P	T06	
28/6/2015	1:06:59 P	T06	
28/6/2015	1:07:00 P	T06	
28/6/2015	1:21:58 P	T06	
28/6/2015	1:21:59 P	T06	
28/6/2015	1:22:01 P	T06	
28/6/2015	1:22:02 P	T06	
28/6/2015	1:22:03 P	T06	
28/6/2015	3:43:39 P	T06	
28/6/2015	3:43:41 P	T06	
28/6/2015	3:43:42 P	T06	
28/6/2015	3:43:43 P	T06	
28/6/2015	3:43:44 P	T06	
28/6/2015	3:46:17 P	T06	
28/6/2015	3:46:18 P	T06	
28/6/2015	3:46:19 P	T06	
28/6/2015	3:46:20 P	T06	
28/6/2015	3:46:21 P	T06	
28/6/2015	3:54:53 P	T06	
28/6/2015	3:54:54 P	T06	
28/6/2015	3:54:55 P	T06	
28/6/2015	3:54:56 P	T06	

Date	Time	Camera 1	Camera 2
28/6/2015	3:54:57 P	T06	
28/6/2015	4:26:01 P	T06	
28/6/2015	4:26:02 P	T06	
28/6/2015	4:26:03 P	T06	
28/6/2015	4:26:04 P	T06	
28/6/2015	4:26:05 P	T06	
28/6/2015	4:28:51 P	T06	
28/6/2015	4:28:52 P	T06	
28/6/2015	4:28:53 P	T06	
28/6/2015	4:28:54 P	T06	
28/6/2015	4:28:55 P	T06	
28/6/2015	4:35:10 P	T06	
28/6/2015	4:35:12 P	T06	
28/6/2015	4:35:13 P	T06	
28/6/2015	4:35:14 P	T06	
28/6/2015	4:35:15 P	T06	
28/6/2015	4:35:33 P	T06	
28/6/2015	4:35:34 P	T06	
28/6/2015	4:35:35 P	T06	
28/6/2015	4:35:36 P	T06	
28/6/2015	4:35:37 P	T06	
28/6/2015	6:03:25 P	T06	
28/6/2015	6:03:27 P	T06	
28/6/2015	6:03:28 P	T06	
28/6/2015	6:03:29 P	T06	
28/6/2015	6:03:30 P	T06	
28/6/2015	11:18:28 P	T06	
28/6/2015	11:18:29 P	T06	
28/6/2015	11:18:31 P	T06	
28/6/2015	11:18:32 P	T06	
28/6/2015	11:18:33 P	T06	
29/6/2015	1:45:35 A	T06	
29/6/2015	1:45:36 A	T06	
29/6/2015	1:45:37 A	T06	
29/6/2015	1:45:38 A	T06	
29/6/2015	1:45:39 A	T06	
29/6/2015	6:13:18 A	T06	
29/6/2015	6:13:21 A	T06	
29/6/2015	6:13:22 A	T06	

Date	Time	Camera 1	Camera 2
29/6/2015	6:13:23 A	T06	
29/6/2015	6:13:24 A	T06	
29/6/2015	6:46:18 A	T06	
29/6/2015	6:46:20 A	T06	
29/6/2015	6:46:21 A	T06	
29/6/2015	6:46:22 A	T06	
29/6/2015	6:46:23 A	T06	
29/6/2015	7:05:39 A	T06	
29/6/2015	7:05:40 A	T06	
29/6/2015	7:05:41 A	T06	
29/6/2015	7:05:42 A	T06	
29/6/2015	7:05:43 A	T06	
29/6/2015	9:07:55 A	T09	
29/6/2015	9:07:57 A	T09	
29/6/2015	9:07:58 A	T09	
29/6/2015	9:07:59 A	T09	
29/6/2015	9:08:00 A	T09	
29/6/2015	9:08:21 A	T09	
29/6/2015	9:08:22 A	T09	
29/6/2015	9:08:23 A	T09	
29/6/2015	9:08:24 A	T09	
29/6/2015	9:08:25 A	T09	
29/6/2015	10:33:04 A	T09	
29/6/2015	10:33:05 A	T09	
29/6/2015	10:33:06 A	T09	
29/6/2015	10:33:07 A	T09	
29/6/2015	10:33:08 A	T09	
29/6/2015	1:47:08 P	T06	
29/6/2015	1:47:09 P	T06	
29/6/2015	1:47:10 P	T06	
29/6/2015	1:47:11 P	T06	
29/6/2015	1:47:12 P	T06	
29/6/2015	4:35:06 P	T06	
29/6/2015	4:35:07 P	T06	
29/6/2015	4:35:08 P	T06	
29/6/2015	4:35:09 P	T06	
29/6/2015	4:35:10 P	T06	
29/6/2015	5:00:06 P	T06	
29/6/2015	5:00:08 P	T06	

Date	Time	Camera 1	Camera 2
29/6/2015	5:00:09 P	T06	
29/6/2015	5:00:10 P	T06	
29/6/2015	5:00:11 P	T06	
29/6/2015	5:16:55 P	T06	
29/6/2015	5:16:56 P	T06	
29/6/2015	5:16:57 P	T06	
29/6/2015	5:16:58 P	T06	
29/6/2015	5:16:59 P	T06	
29/6/2015	11:19:45 P	T06	
29/6/2015	11:19:47 P	T06	
29/6/2015	11:19:49 P	T06	
29/6/2015	11:19:50 P	T06	
29/6/2015	11:19:51 P	T06	
30/6/2015	5:44:13 A	T06	
30/6/2015	5:44:16 A	T06	
30/6/2015	5:44:17 A	T06	
30/6/2015	5:44:18 A	T06	
30/6/2015	5:44:19 A	T06	
30/6/2015	7:03:49 A	T06	
30/6/2015	7:03:50 A	T06	
30/6/2015	7:03:51 A	T06	
30/6/2015	7:03:52 A	T06	
30/6/2015	7:03:53 A	T06	
30/6/2015	8:03:04 A	T06	
30/6/2015	8:03:06 A	T06	
30/6/2015	8:03:07 A	T06	
30/6/2015	8:03:08 A	T06	
30/6/2015	8:03:09 A	T06	
30/6/2015	10:15:32 A	T06	
30/6/2015	10:15:33 A	T06	
30/6/2015	10:15:34 A	T06	
30/6/2015	10:15:35 A	T06	
30/6/2015	10:15:36 A	T06	
30/6/2015	10:39:33 A	T06	
30/6/2015	10:39:35 A	T06	
30/6/2015	10:39:36 A	T06	
30/6/2015	10:39:37 A	T06	
30/6/2015	10:39:38 A	T06	
30/6/2015	12:09:21 P	T06	

Date	Time	Camera 1	Camera 2
30/6/2015	12:09:22 P	T06	
30/6/2015	12:09:23 P	T06	
30/6/2015	12:09:24 P	T06	
30/6/2015	12:09:25 P	T06	
30/6/2015	1:22:40 P	T06	
30/6/2015	1:22:41 P	T06	
30/6/2015	1:22:42 P	T06	
30/6/2015	1:22:43 P	T06	
30/6/2015	1:22:44 P	T06	
30/6/2015	1:23:09 P	T06	
30/6/2015	1:23:10 P	T06	
30/6/2015	1:23:11 P	T06	
30/6/2015	1:23:12 P	T06	
30/6/2015	1:23:13 P	T06	
1/7/2015	5:38:46 A	T06	
1/7/2015	5:38:49 A	T06	
1/7/2015	5:38:50 A	T06	
1/7/2015	5:38:51 A	T06	
1/7/2015	5:38:52 A	T06	
1/7/2015	5:41:17 A	T06	
1/7/2015	5:41:19 A	T06	
1/7/2015	5:41:20 A	T06	
1/7/2015	5:41:21 A	T06	
1/7/2015	5:41:22 A	T06	
1/7/2015	6:39:09 A	T06	
1/7/2015	6:39:11 A	T06	
1/7/2015	6:39:12 A	T06	
1/7/2015	6:39:13 A	T06	
1/7/2015	6:39:14 A	T06	
1/7/2015	9:22:48 A	T06	
1/7/2015	9:22:50 A	T06	
1/7/2015	9:22:51 A	T06	
1/7/2015	9:22:52 A	T06	
1/7/2015	9:22:53 A	T06	
1/7/2015	9:51:45 A	T06	
1/7/2015	9:51:47 A	T06	
1/7/2015	9:51:48 A	T06	
1/7/2015	9:51:49 A	T06	
1/7/2015	9:51:50 A	T06	

Date	Time	Camera 1	Camera 2
1/7/2015	11:01:17 A	T06	
1/7/2015	11:01:18 A	T06	
1/7/2015	11:01:19 A	T06	
1/7/2015	11:01:20 A	T06	
1/7/2015	11:01:21 A	T06	
1/7/2015	11:54:47 A	T06	
1/7/2015	11:54:48 A	T06	
1/7/2015	11:54:49 A	T06	
1/7/2015	11:54:50 A	T06	
1/7/2015	11:54:51 A	T06	
1/7/2015	3:07:14 P	T06	
1/7/2015	3:07:16 P	T06	
1/7/2015	3:07:17 P	T06	
1/7/2015	3:07:18 P	T06	
1/7/2015	3:07:19 P	T06	
1/7/2015	3:07:59 P	T06	
1/7/2015	3:08:00 P	T06	
1/7/2015	3:08:01 P	T06	
1/7/2015	3:08:02 P	T06	
1/7/2015	3:08:03 P	T06	
1/7/2015	3:09:05 P	T06	
1/7/2015	3:09:06 P	T06	
1/7/2015	3:09:07 P	T06	
1/7/2015	3:09:08 P	T06	
1/7/2015	3:09:09 P	T06	
1/7/2015	3:43:14 P	T06	
1/7/2015	3:43:16 P	T06	
1/7/2015	3:43:17 P	T06	
1/7/2015	3:43:18 P	T06	
1/7/2015	3:43:19 P	T06	
1/7/2015	4:16:07 P	T06	
1/7/2015	4:16:09 P	T06	
1/7/2015	4:16:10 P	T06	
1/7/2015	4:16:11 P	T06	
1/7/2015	4:16:12 P	T06	
1/7/2015	6:32:55 P	T06	
1/7/2015	6:32:57 P	T06	
1/7/2015	6:32:58 P	T06	
1/7/2015	6:32:59 P	T06	

Date	Time	Camera 1	Camera 2
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1/7/2015	7:05:11 P	T06	
1/7/2015	7:05:12 P	T06	
1/7/2015	7:05:13 P	T06	
1/7/2015	7:05:14 P	T06	
1/7/2015	10:01:58 P	T06	
1/7/2015	10:02:00 P	T06	
1/7/2015	10:02:03 P	T06	
1/7/2015	10:02:04 P	T06	
1/7/2015	10:02:05 P	T06	
1/7/2015	10:55:39 P	T06	
1/7/2015	10:55:40 P	T06	
1/7/2015	10:55:42 P	T06	
1/7/2015	10:55:43 P	T06	
1/7/2015	10:55:44 P	T06	
1/7/2015	11:03:47 P	T06	
1/7/2015	11:03:48 P	T06	
1/7/2015	11:03:49 P	T06	
1/7/2015	11:03:50 P	T06	
1/7/2015	11:03:51 P	T06	
2/7/2015	1:31:20 A	T06	
2/7/2015	1:31:22 A	T06	
2/7/2015	1:31:23 A	T06	
2/7/2015	1:31:24 A	T06	
2/7/2015	1:31:25 A	T06	
2/7/2015	1:31:41 A	T06	
2/7/2015	1:31:43 A	T06	
2/7/2015	1:31:44 A	T06	
2/7/2015	1:31:45 A	T06	
2/7/2015	1:31:46 A	T06	
2/7/2015	4:37:00 A	T06	
2/7/2015	4:37:02 A	T06	
2/7/2015	4:37:03 A	T06	
2/7/2015	4:37:04 A	T06	
2/7/2015	4:37:05 A	T06	
2/7/2015	6:30:54 A	T06	
2/7/2015	6:30:56 A	T06	
2/7/2015	6:30:57 A	T06	

Date	Time	Camera 1	Camera 2
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2/7/2015	6:30:59 A	T06	
2/7/2015	7:56:55 A	T06	
2/7/2015	7:56:56 A	T06	
2/7/2015	7:56:57 A	T06	
2/7/2015	7:56:58 A	T06	
2/7/2015	7:56:59 A	T06	
2/7/2015	12:13:30 P	T06	
2/7/2015	12:13:31 P	T06	
2/7/2015	12:13:33 P	T06	
2/7/2015	12:13:34 P	T06	
2/7/2015	12:13:35 P	T06	
2/7/2015	1:41:42 P	T06	
2/7/2015	1:41:43 P	T06	
2/7/2015	1:41:44 P	T06	
2/7/2015	1:41:45 P	T06	
2/7/2015	1:41:46 P	T06	
2/7/2015	1:51:34 P	T06	
2/7/2015	1:51:36 P	T06	
2/7/2015	1:51:37 P	T06	
2/7/2015	1:51:38 P	T06	
2/7/2015	1:51:39 P	T06	
2/7/2015	1:52:20 P	T06	
2/7/2015	1:52:22 P	T06	
2/7/2015	1:52:23 P	T06	
2/7/2015	1:52:24 P	T06	
2/7/2015	1:52:25 P	T06	
2/7/2015	3:03:41 P	T06	
2/7/2015	3:03:43 P	T06	
2/7/2015	3:03:44 P	T06	
2/7/2015	3:03:45 P	T06	
2/7/2015	3:03:46 P	T06	
2/7/2015	3:20:21 P	T06	
2/7/2015	3:20:22 P	T06	
2/7/2015	3:20:24 P	T06	
2/7/2015	3:20:25 P	T06	
2/7/2015	3:20:26 P	T06	
2/7/2015	3:37:46 P	T06	
2/7/2015	3:37:48 P	T06	

Date	Time	Camera 1	Camera 2
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2/7/2015	3:37:51 P	T06	
2/7/2015	3:49:13 P	T07	
2/7/2015	3:49:14 P	T07	
2/7/2015	3:49:15 P	T07	
2/7/2015	3:49:16 P	T07	
2/7/2015	3:49:17 P	T07	
2/7/2015	4:19:41 P	T06	
2/7/2015	4:19:42 P	T06	
2/7/2015	4:19:43 P	T06	
2/7/2015	4:19:44 P	T06	
2/7/2015	4:19:45 P	T06	
2/7/2015	5:32:20 P	T06	
2/7/2015	5:32:21 P	T06	
2/7/2015	5:32:22 P	T06	
2/7/2015	5:32:23 P	T06	
2/7/2015	5:32:24 P	T06	
2/7/2015	11:38:47 P	T06	
2/7/2015	11:38:48 P	T06	
2/7/2015	11:38:49 P	T06	
2/7/2015	11:38:50 P	T06	
2/7/2015	11:38:51 P	T06	
3/7/2015	8:29:52 A	T06	
3/7/2015	8:29:53 A	T06	
3/7/2015	8:29:54 A	T06	
3/7/2015	8:29:55 A	T06	
3/7/2015	8:29:56 A	T06	
3/7/2015	11:29:11 A	T06	
3/7/2015	11:29:13 A	T06	
3/7/2015	11:29:14 A	T06	
3/7/2015	11:29:15 A	T06	
3/7/2015	11:29:16 A	T06	
3/7/2015	1:44:49 P	T06	
3/7/2015	1:44:51 P	T06	
3/7/2015	1:44:52 P	T06	
3/7/2015	1:44:53 P	T06	
3/7/2015	1:44:54 P	T06	
3/7/2015	2:06:25 P	T06	

Date	Time	Camera 1	Camera 2
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3/7/2015	2:06:27 P	T06	
3/7/2015	2:06:28 P	T06	
3/7/2015	2:06:29 P	T06	
3/7/2015	2:28:12 P	T06	
3/7/2015	2:28:13 P	T06	
3/7/2015	2:28:15 P	T06	
3/7/2015	2:28:16 P	T06	
3/7/2015	2:28:17 P	T06	
3/7/2015	2:55:08 P	T06	
3/7/2015	2:55:09 P	T06	
3/7/2015	2:55:10 P	T06	
3/7/2015	2:55:11 P	T06	
3/7/2015	2:55:12 P	T06	
3/7/2015	3:31:13 P	T06	
3/7/2015	3:31:14 P	T06	
3/7/2015	3:31:15 P	T06	
3/7/2015	3:31:16 P	T06	
3/7/2015	3:31:17 P	T06	
3/7/2015	3:31:44 P	T06	
3/7/2015	3:31:45 P	T06	
3/7/2015	3:31:46 P	T06	
3/7/2015	3:31:47 P	T06	
3/7/2015	3:31:48 P	T06	
3/7/2015	3:42:46 P	T06	
3/7/2015	3:42:48 P	T06	
3/7/2015	3:42:49 P	T06	
3/7/2015	3:42:50 P	T06	
3/7/2015	3:42:51 P	T06	
3/7/2015	4:08:05 P	T06	
3/7/2015	4:08:06 P	T06	
3/7/2015	4:08:07 P	T06	
3/7/2015	4:08:08 P	T06	
3/7/2015	4:08:09 P	T06	
3/7/2015	4:08:36 P	T06	
3/7/2015	4:08:37 P	T06	
3/7/2015	4:08:38 P	T06	
3/7/2015	4:08:39 P	T06	
3/7/2015	4:08:40 P	T06	

Date	Time	Camera 1	Camera 2
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3/7/2015	8:14:40 P	T06	
3/7/2015	8:14:42 P	T06	
3/7/2015	8:14:43 P	T06	
3/7/2015	8:14:44 P	T06	
3/7/2015	8:28:17 P	T06	
3/7/2015	8:28:18 P	T06	
3/7/2015	8:28:19 P	T06	
3/7/2015	8:28:20 P	T06	
3/7/2015	8:28:21 P	T06	
3/7/2015	8:52:51 P	T06	
3/7/2015	8:52:52 P	T06	
3/7/2015	8:52:53 P	T06	
3/7/2015	8:52:54 P	T06	
3/7/2015	8:52:55 P	T06	
3/7/2015	11:19:08 P	T06	
3/7/2015	11:19:10 P	T06	
3/7/2015	11:19:11 P	T06	
3/7/2015	11:19:12 P	T06	
3/7/2015	11:19:13 P	T06	
3/7/2015	11:19:59 P	T06	
3/7/2015	11:20:00 P	T06	
3/7/2015	11:20:01 P	T06	
3/7/2015	11:20:02 P	T06	
3/7/2015	11:20:03 P	T06	
3/7/2015	11:39:50 P	T06	
3/7/2015	11:39:51 P	T06	
3/7/2015	11:39:52 P	T06	
3/7/2015	11:39:54 P	T06	
3/7/2015	11:39:55 P	T06	
4/7/2015	12:33:42 A	T06	
4/7/2015	12:33:44 A	T06	
4/7/2015	12:33:45 A	T06	
4/7/2015	12:33:46 A	T06	
4/7/2015	12:33:47 A	T06	
4/7/2015	1:07:15 A	T06	
4/7/2015	1:07:17 A	T06	
4/7/2015	1:07:18 A	T06	
4/7/2015	1:07:19 A	T06	

Date	Time	Camera 1	Camera 2
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4/7/2015	1:22:55 A	T06	
4/7/2015	1:22:57 A	T06	
4/7/2015	1:22:58 A	T06	
4/7/2015	1:23:00 A	T06	
4/7/2015	1:23:01 A	T06	
4/7/2015	1:47:16 A	T06	
4/7/2015	1:47:19 A	T06	
4/7/2015	1:47:20 A	T06	
4/7/2015	1:47:21 A	T06	
4/7/2015	1:47:22 A	T06	
4/7/2015	3:04:57 A	T06	
4/7/2015	3:04:59 A	T06	
4/7/2015	3:05:00 A	T06	
4/7/2015	3:05:01 A	T06	
4/7/2015	3:05:02 A	T06	
4/7/2015	6:04:07 A	T06	
4/7/2015	6:04:09 A	T06	
4/7/2015	6:04:10 A	T06	
4/7/2015	6:04:11 A	T06	
4/7/2015	6:04:12 A	T06	
4/7/2015	6:48:28 A	T06	
4/7/2015	6:48:30 A	T06	
4/7/2015	6:48:32 A	T06	
4/7/2015	6:48:33 A	T06	
4/7/2015	6:48:34 A	T06	
4/7/2015	7:02:14 A	T06	
4/7/2015	7:02:17 A	T06	
4/7/2015	7:02:18 A	T06	
4/7/2015	7:02:19 A	T06	
4/7/2015	7:02:20 A	T06	
4/7/2015	7:02:42 A	T06	
4/7/2015	7:02:44 A	T06	
4/7/2015	7:02:45 A	T06	
4/7/2015	7:02:46 A	T06	
4/7/2015	7:02:47 A	T06	
4/7/2015	10:54:26 A	T06	
4/7/2015	10:54:27 A	T06	
4/7/2015	10:54:28 A	T06	

Date	Time	Camera 1	Camera 2
4/7/2015	10:54:29 A	T06	
4/7/2015	10:54:30 A	T06	
4/7/2015	1:19:34 P	T06	
4/7/2015	1:19:35 P	T06	
4/7/2015	1:19:37 P	T06	
4/7/2015	1:19:38 P	T06	
4/7/2015	1:19:39 P	T06	
4/7/2015	1:20:31 P	T06	
4/7/2015	1:20:33 P	T06	
4/7/2015	1:20:34 P	T06	
4/7/2015	1:20:35 P	T06	
4/7/2015	1:20:36 P	T06	
4/7/2015	1:29:26 P	T06	
4/7/2015	1:29:27 P	T06	
4/7/2015	1:29:28 P	T06	
4/7/2015	1:29:29 P	T06	
4/7/2015	1:29:30 P	T06	
4/7/2015	1:38:49 P	T06	
4/7/2015	1:38:50 P	T06	
4/7/2015	1:38:51 P	T06	
4/7/2015	1:38:52 P	T06	
4/7/2015	1:38:53 P	T06	
4/7/2015	2:12:49 P	T06	
4/7/2015	2:12:51 P	T06	
4/7/2015	2:12:52 P	T06	
4/7/2015	2:12:53 P	T06	
4/7/2015	2:12:54 P	T06	
4/7/2015	3:03:18 P	T06	
4/7/2015	3:03:19 P	T06	
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4/7/2015	3:03:21 P	T06	
4/7/2015	3:03:22 P	T06	
4/7/2015	3:38:02 P	T06	
4/7/2015	3:38:03 P	T06	
4/7/2015	3:38:05 P	T06	
4/7/2015	3:38:06 P	T06	
4/7/2015	3:38:07 P	T06	
4/7/2015	3:45:45 P	T06	
4/7/2015	3:45:46 P	T06	

Date	Time	Camera 1	Camera 2
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4/7/2015	3:45:49 P	T06	
4/7/2015	3:45:50 P	T06	
4/7/2015	4:02:55 P	T06	
4/7/2015	4:02:56 P	T06	
4/7/2015	4:02:58 P	T06	
4/7/2015	4:02:59 P	T06	
4/7/2015	4:03:00 P	T06	
4/7/2015	5:34:22 P	T06	
4/7/2015	5:34:23 P	T06	
4/7/2015	5:34:24 P	T06	
4/7/2015	5:34:25 P	T06	
4/7/2015	5:34:26 P	T06	
4/7/2015	11:49:56 P	T06	
4/7/2015	11:49:57 P	T06	
4/7/2015	11:49:59 P	T06	
4/7/2015	11:50:00 P	T06	
4/7/2015	11:50:01 P	T06	
4/7/2015	11:50:21 P	T06	
4/7/2015	11:50:23 P	T06	
4/7/2015	11:50:24 P	T06	
4/7/2015	11:50:25 P	T06	
4/7/2015	11:50:26 P	T06	
5/7/2015	5:40:39 A	T06	
5/7/2015	5:40:41 A	T06	
5/7/2015	5:40:42 A	T06	
5/7/2015	5:40:43 A	T06	
5/7/2015	5:40:44 A	T06	
5/7/2015	9:20:32 A	T06	
5/7/2015	9:20:33 A	T06	
5/7/2015	9:20:35 A	T06	
5/7/2015	9:20:36 A	T06	
5/7/2015	9:20:37 A	T06	
5/7/2015	9:49:21 A	T06	
5/7/2015	9:49:22 A	T06	
5/7/2015	9:49:23 A	T06	
5/7/2015	9:49:24 A	T06	
5/7/2015	9:49:25 A	T06	
5/7/2015	9:49:56 A	T06	

Date	Time	Camera 1	Camera 2
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5/7/2015	9:50:00 A	T06	
5/7/2015	10:32:54 A	T06	
5/7/2015	10:32:55 A	T06	
5/7/2015	10:32:56 A	T06	
5/7/2015	10:32:57 A	T06	
5/7/2015	10:32:58 A	T06	
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5/7/2015	10:33:43 A	T06	
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5/7/2015	10:50:23 A	T06	
5/7/2015	10:50:24 A	T06	
5/7/2015	10:50:25 A	T06	
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5/7/2015	11:30:57 A	T06	
5/7/2015	11:30:58 A	T06	
5/7/2015	11:30:59 A	T06	
5/7/2015	11:36:34 A	T06	
5/7/2015	11:36:35 A	T06	
5/7/2015	11:36:36 A	T06	
5/7/2015	11:36:37 A	T06	
5/7/2015	11:36:38 A	T06	
5/7/2015	11:55:03 A	T06	
5/7/2015	11:55:04 A	T06	
5/7/2015	11:55:05 A	T06	
5/7/2015	11:55:06 A	T06	
5/7/2015	11:55:07 A	T06	
5/7/2015	12:08:16 P	T06	
5/7/2015	12:08:18 P	T06	
5/7/2015	12:08:19 P	T06	
5/7/2015	12:08:20 P	T06	
5/7/2015	12:08:21 P	T06	

Date	Time	Camera 1	Camera 2
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5/7/2015	1:01:33 P	T06	
5/7/2015	1:01:34 P	T06	
5/7/2015	1:01:35 P	T06	
5/7/2015	1:38:09 P	T06	
5/7/2015	1:38:11 P	T06	
5/7/2015	1:38:12 P	T06	
5/7/2015	1:38:13 P	T06	
5/7/2015	1:38:14 P	T06	
5/7/2015	1:41:53 P	T06	
5/7/2015	1:41:54 P	T06	
5/7/2015	1:41:55 P	T06	
5/7/2015	1:41:57 P	T06	
5/7/2015	1:41:58 P	T06	
5/7/2015	1:42:58 P	T06	
5/7/2015	1:42:59 P	T06	
5/7/2015	1:43:00 P	T06	
5/7/2015	1:43:01 P	T06	
5/7/2015	1:43:02 P	T06	
5/7/2015	1:44:19 P	T06	
5/7/2015	1:44:20 P	T06	
5/7/2015	1:44:21 P	T06	
5/7/2015	1:44:22 P	T06	
5/7/2015	1:44:23 P	T06	
5/7/2015	1:44:53 P	T06	
5/7/2015	1:44:54 P	T06	
5/7/2015	1:44:55 P	T06	
5/7/2015	1:44:56 P	T06	
5/7/2015	1:44:57 P	T06	
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5/7/2015	2:29:23 P	T09	
5/7/2015	2:29:24 P	T09	
5/7/2015	2:29:25 P	T09	
5/7/2015	2:29:26 P	T09	
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5/7/2015	4:17:25 P	T06	
5/7/2015	4:17:26 P	T06	
5/7/2015	4:17:27 P	T06	

Date	Time	Camera 1	Camera 2
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5/7/2015	4:43:02 P	T06	
5/7/2015	4:43:03 P	T06	
5/7/2015	4:43:04 P	T06	
5/7/2015	4:43:05 P	T06	
5/7/2015	5:13:28 P	T06	
5/7/2015	5:13:29 P	T06	
5/7/2015	5:13:30 P	T06	
5/7/2015	5:13:31 P	T06	
5/7/2015	5:13:32 P	T06	
5/7/2015	6:12:21 P	T06	
5/7/2015	6:12:22 P	T06	
5/7/2015	6:12:23 P	T06	
5/7/2015	6:12:24 P	T06	
5/7/2015	6:12:25 P	T06	
5/7/2015	6:18:40 P	T06	
5/7/2015	6:18:42 P	T06	
5/7/2015	6:18:43 P	T06	
5/7/2015	6:18:44 P	T06	
5/7/2015	6:18:45 P	T06	
5/7/2015	6:19:01 P	T06	
5/7/2015	6:19:02 P	T06	
5/7/2015	6:19:03 P	T06	
5/7/2015	6:19:04 P	T06	
5/7/2015	6:19:05 P	T06	
5/7/2015	6:19:24 P	T06	
5/7/2015	6:19:25 P	T06	
5/7/2015	6:19:26 P	T06	
5/7/2015	6:19:27 P	T06	
5/7/2015	6:19:28 P	T06	
5/7/2015	6:39:48 P	T06	
5/7/2015	6:39:50 P	T06	
5/7/2015	6:39:51 P	T06	
5/7/2015	6:39:52 P	T06	
5/7/2015	6:39:53 P	T06	
5/7/2015	7:07:30 P	T06	
5/7/2015	7:07:32 P	T06	
5/7/2015	7:07:33 P	T06	

Date	Time	Camera 1	Camera 2
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5/7/2015	7:07:35 P	T06	
5/7/2015	10:52:30 P	T06	
5/7/2015	10:52:32 P	T06	
5/7/2015	10:52:33 P	T06	
5/7/2015	10:52:34 P	T06	
5/7/2015	10:52:35 P	T06	
6/7/2015	12:34:33 A	T06	
6/7/2015	12:34:35 A	T06	
6/7/2015	12:34:36 A	T06	
6/7/2015	12:34:37 A	T06	
6/7/2015	12:34:38 A	T06	
6/7/2015	12:35:02 A	T06	
6/7/2015	12:35:04 A	T06	
6/7/2015	12:35:05 A	T06	
6/7/2015	12:35:06 A	T06	
6/7/2015	12:35:07 A	T06	
6/7/2015	3:11:47 A	T06	
6/7/2015	3:11:48 A	T06	
6/7/2015	3:11:49 A	T06	
6/7/2015	3:11:50 A	T06	
6/7/2015	3:11:51 A	T06	
6/7/2015	6:46:50 A	T06	
6/7/2015	6:46:52 A	T06	
6/7/2015	6:46:53 A	T06	
6/7/2015	6:46:54 A	T06	
6/7/2015	6:46:55 A	T06	
6/7/2015	7:33:19 A	T06	
6/7/2015	7:33:21 A	T06	
6/7/2015	7:33:22 A	T06	
6/7/2015	7:33:23 A	T06	
6/7/2015	7:33:24 A	T06	
6/7/2015	8:05:41 A	T06	
6/7/2015	8:05:42 A	T06	
6/7/2015	8:05:43 A	T06	
6/7/2015	8:05:44 A	T06	
6/7/2015	8:05:45 A	T06	
6/7/2015	10:18:57 A	T06	
6/7/2015	10:18:58 A	T06	

Date	Time	Camera 1	Camera 2
6/7/2015	10:18:59 A	T06	
6/7/2015	10:19:00 A	T06	
6/7/2015	10:19:01 A	T06	
6/7/2015	11:11:49 A	T06	
6/7/2015	11:11:51 A	T06	
6/7/2015	11:11:52 A	T06	
6/7/2015	11:11:53 A	T06	
6/7/2015	11:11:54 A	T06	
6/7/2015	11:14:02 A	T06	
6/7/2015	11:14:04 A	T06	
6/7/2015	11:14:05 A	T06	
6/7/2015	11:14:06 A	T06	
6/7/2015	11:14:07 A	T06	
6/7/2015	12:00:26 P	T06	
6/7/2015	12:00:28 P	T06	
6/7/2015	12:00:29 P	T06	
6/7/2015	12:00:30 P	T06	
6/7/2015	12:00:31 P	T06	
6/7/2015	1:46:21 P	T06	
6/7/2015	1:46:22 P	T06	
6/7/2015	1:46:23 P	T06	
6/7/2015	1:46:24 P	T06	
6/7/2015	1:46:25 P	T06	
7/7/2015	5:10:13 A	T06	
7/7/2015	5:10:14 A	T06	
7/7/2015	5:10:15 A	T06	
7/7/2015	5:10:16 A	T06	
7/7/2015	5:10:17 A	T06	
7/7/2015	8:15:57 A	T06	
7/7/2015	8:15:59 A	T06	
7/7/2015	8:16:00 A	T06	
7/7/2015	8:16:01 A	T06	
7/7/2015	8:16:02 A	T06	
7/7/2015	9:38:25 A	T06	
7/7/2015	9:38:26 A	T06	
7/7/2015	9:38:27 A	T06	
7/7/2015	9:38:28 A	T06	
7/7/2015	9:38:29 A	T06	
7/7/2015	1:35:09 P	T06	

Date	Time	Camera 1	Camera 2
7/7/2015	1:35:11 P	T06	
7/7/2015	1:35:12 P	T06	
7/7/2015	1:35:13 P	T06	
7/7/2015	1:35:14 P	T06	
7/7/2015	2:15:44 P	T06	
7/7/2015	2:15:46 P	T06	
7/7/2015	2:15:47 P	T06	
7/7/2015	2:15:48 P	T06	
7/7/2015	2:15:49 P	T06	
7/7/2015	3:03:09 P	T06	
7/7/2015	3:03:11 P	T06	
7/7/2015	3:03:12 P	T06	
7/7/2015	3:03:13 P	T06	
7/7/2015	3:03:14 P	T06	
7/7/2015	4:02:34 P	T06	
7/7/2015	4:02:36 P	T06	
7/7/2015	4:02:37 P	T06	
7/7/2015	4:02:38 P	T06	
7/7/2015	4:02:39 P	T06	
7/7/2015	4:04:05 P	T06	
7/7/2015	4:04:07 P	T06	
7/7/2015	4:04:08 P	T06	
7/7/2015	4:04:09 P	T06	
7/7/2015	4:04:10 P	T06	
7/7/2015	4:52:24 P	T06	
7/7/2015	4:52:25 P	T06	
7/7/2015	4:52:26 P	T06	
7/7/2015	4:52:27 P	T06	
7/7/2015	4:52:28 P	T06	
7/7/2015	5:26:47 P	T06	
7/7/2015	5:26:49 P	T06	
7/7/2015	5:26:50 P	T06	
7/7/2015	5:26:51 P	T06	
7/7/2015	5:26:52 P	T06	
7/7/2015	5:38:58 P	T06	
7/7/2015	5:38:59 P	T06	
7/7/2015	5:39:00 P	T06	
7/7/2015	5:39:01 P	T06	
7/7/2015	5:39:02 P	T06	

Date	Time	Camera 1	Camera 2
7/7/2015	6:24:58 P	T06	
7/7/2015	6:24:59 P	T06	
7/7/2015	6:25:01 P	T06	
7/7/2015	6:25:02 P	T06	
7/7/2015	6:25:03 P	T06	
7/7/2015	6:53:31 P	T07	
7/7/2015	6:53:32 P	T07	
7/7/2015	6:53:33 P	T07	
7/7/2015	6:53:34 P	T07	
7/7/2015	6:53:35 P	T07	
7/7/2015	7:15:11 P	T06	
7/7/2015	7:15:13 P	T06	
7/7/2015	7:15:14 P	T06	
7/7/2015	7:15:15 P	T06	
7/7/2015	7:15:16 P	T06	
8/7/2015	4:58:28 A	T06	
8/7/2015	4:58:30 A	T06	
8/7/2015	4:58:31 A	T06	
8/7/2015	4:58:32 A	T06	
8/7/2015	4:58:33 A	T06	
8/7/2015	5:43:07 A	T06	
8/7/2015	5:43:10 A	T06	
8/7/2015	5:43:11 A	T06	
8/7/2015	5:43:12 A	T06	
8/7/2015	5:43:13 A	T06	
8/7/2015	9:27:21 A	T06	
8/7/2015	9:27:22 A	T06	
8/7/2015	9:27:23 A	T06	
8/7/2015	9:27:24 A	T06	
8/7/2015	9:27:25 A	T06	
8/7/2015	11:09:48 A	T06	
8/7/2015	11:09:50 A	T06	
8/7/2015	11:09:51 A	T06	
8/7/2015	11:09:52 A	T06	
8/7/2015	11:09:53 A	T06	
8/7/2015	11:13:01 A	T06	
8/7/2015	11:13:02 A	T06	
8/7/2015	11:13:03 A	T06	
8/7/2015	11:13:04 A	T06	

Date	Time	Camera 1	Camera 2
8/7/2015	11:13:05 A	T06	
8/7/2015	12:54:14 P	T06	
8/7/2015	12:54:15 P	T06	
8/7/2015	12:54:16 P	T06	
8/7/2015	12:54:17 P	T06	
8/7/2015	12:54:18 P	T06	
8/7/2015	3:42:41 P	T06	
8/7/2015	3:42:43 P	T06	
8/7/2015	3:42:44 P	T06	
8/7/2015	3:42:45 P	T06	
8/7/2015	3:42:46 P	T06	
8/7/2015	4:19:36 P	T06	
8/7/2015	4:19:37 P	T06	
8/7/2015	4:19:38 P	T06	
8/7/2015	4:19:39 P	T06	
8/7/2015	4:19:40 P	T06	
8/7/2015	5:17:15 P	T09	
8/7/2015	5:17:16 P	T09	
8/7/2015	5:17:17 P	T09	
8/7/2015	5:17:18 P	T09	
8/7/2015	5:17:19 P	T09	
8/7/2015	5:37:12 P	T06	
8/7/2015	5:37:13 P	T06	
8/7/2015	5:37:14 P	T06	
8/7/2015	5:37:15 P	T06	
8/7/2015	5:37:16 P	T06	
8/7/2015	6:47:05 P	T06	
8/7/2015	6:47:06 P	T06	
8/7/2015	6:47:07 P	T06	
8/7/2015	6:47:08 P	T06	
8/7/2015	6:47:09 P	T06	
8/7/2015	7:03:16 P	T06	
8/7/2015	7:03:17 P	T06	
8/7/2015	7:03:19 P	T06	
8/7/2015	7:03:20 P	T06	
8/7/2015	7:03:21 P	T06	
9/7/2015	7:24:38 A	T06	
9/7/2015	7:24:40 A	T06	
9/7/2015	7:24:41 A	T06	

Date	Time	Camera 1	Camera 2
9/7/2015	7:24:42 A	T06	
9/7/2015	7:24:43 A	T06	
9/7/2015	10:28:37 A	T01	
9/7/2015	10:28:38 A	T01	
9/7/2015	10:28:40 A	T01	
9/7/2015	10:28:41 A	T01	
9/7/2015	10:28:42 A	T01	
9/7/2015	10:32:15 A	T01	
9/7/2015	10:32:17 A	T01	
9/7/2015	10:32:18 A	T01	
9/7/2015	10:32:19 A	T01	
9/7/2015	10:32:20 A	T01	
9/7/2015	12:44:55 P	T06	
9/7/2015	12:44:56 P	T06	
9/7/2015	12:44:57 P	T06	
9/7/2015	12:44:58 P	T06	
9/7/2015	12:44:59 P	T06	
9/7/2015	12:57:49 P	T06	
9/7/2015	12:57:50 P	T06	
9/7/2015	12:57:51 P	T06	
9/7/2015	12:57:52 P	T06	
9/7/2015	12:57:53 P	T06	
9/7/2015	2:46:24 P	T09	
9/7/2015	2:46:26 P	T09	
9/7/2015	2:46:27 P	T09	
9/7/2015	2:46:28 P	T09	
9/7/2015	2:46:29 P	T09	
9/7/2015	6:37:03 P	T06	
9/7/2015	6:37:05 P	T06	
9/7/2015	6:37:06 P	T06	
9/7/2015	6:37:07 P	T06	
9/7/2015	6:37:08 P	T06	
9/7/2015	8:57:35 P	T06	
9/7/2015	8:57:36 P	T06	
9/7/2015	8:57:37 P	T06	
9/7/2015	8:57:38 P	T06	
9/7/2015	8:57:39 P	T06	
9/7/2015	11:12:22 P	T06	
9/7/2015	11:12:24 P	T06	

Date	Time	Camera 1	Camera 2
9/7/2015	11:12:25 P	T06	
9/7/2015	11:12:26 P	T06	
9/7/2015	11:12:27 P	T06	
10/7/2015	12:21:31 A	T06	
10/7/2015	12:21:32 A	T06	
10/7/2015	12:21:33 A	T06	
10/7/2015	12:21:34 A	T06	
10/7/2015	12:21:35 A	T06	
10/7/2015	5:17:32 A	T06	
10/7/2015	5:17:34 A	T06	
10/7/2015	5:17:35 A	T06	
10/7/2015	5:17:36 A	T06	
10/7/2015	5:17:37 A	T06	
10/7/2015	5:34:02 A	T06	
10/7/2015	5:34:07 A	T06	
10/7/2015	5:34:09 A	T06	
10/7/2015	5:34:10 A	T06	
10/7/2015	5:34:11 A	T06	
10/7/2015	7:21:23 A	T06	
10/7/2015	7:21:25 A	T06	
10/7/2015	7:21:26 A	T06	
10/7/2015	7:21:27 A	T06	
10/7/2015	7:21:28 A	T06	
10/7/2015	8:09:50 A	T06	
10/7/2015	8:09:52 A	T06	
10/7/2015	8:09:53 A	T06	
10/7/2015	8:09:54 A	T06	
10/7/2015	8:09:55 A	T06	
10/7/2015	8:11:39 A	T06	
10/7/2015	8:11:40 A	T06	
10/7/2015	8:11:41 A	T06	
10/7/2015	8:11:42 A	T06	
10/7/2015	8:11:43 A	T06	
10/7/2015	9:43:20 A	T06	
10/7/2015	9:43:22 A	T06	
10/7/2015	9:43:23 A	T06	
10/7/2015	9:43:24 A	T06	
10/7/2015	9:43:25 A	T06	
10/7/2015	10:25:54 A	T06	

Date	Time	Camera 1	Camera 2
10/7/2015	10:25:55 A	T06	
10/7/2015	10:25:57 A	T06	
10/7/2015	10:25:58 A	T06	
10/7/2015	10:25:59 A	T06	
10/7/2015	11:27:00 A	T06	
10/7/2015	11:27:02 A	T06	
10/7/2015	11:27:03 A	T06	
10/7/2015	11:27:04 A	T06	
10/7/2015	11:27:05 A	T06	
10/7/2015	12:25:52 P	T06	
10/7/2015	12:25:53 P	T06	
10/7/2015	12:25:54 P	T06	
10/7/2015	12:25:55 P	T06	
10/7/2015	12:25:56 P	T06	
10/7/2015	1:47:32 P	T06	
10/7/2015	1:47:33 P	T06	
10/7/2015	1:47:34 P	T06	
10/7/2015	1:47:35 P	T06	
10/7/2015	1:47:36 P	T06	
10/7/2015	2:05:17 P	T07	
10/7/2015	2:05:18 P	T07	
10/7/2015	2:05:19 P	T07	
10/7/2015	2:05:20 P	T07	
10/7/2015	2:05:21 P	T07	
10/7/2015	2:22:23 P	T06	
10/7/2015	2:22:25 P	T06	
10/7/2015	2:22:26 P	T06	
10/7/2015	2:22:27 P	T06	
10/7/2015	2:22:28 P	T06	
10/7/2015	3:23:48 P	T06	
10/7/2015	3:23:49 P	T06	
10/7/2015	3:23:50 P	T06	
10/7/2015	3:23:51 P	T06	
10/7/2015	3:23:52 P	T06	
10/7/2015	3:39:37 P	T06	
10/7/2015	3:39:38 P	T06	
10/7/2015	3:39:39 P	T06	
10/7/2015	3:39:40 P	T06	
10/7/2015	3:39:41 P	T06	

Date	Time	Camera 1	Camera 2
10/7/2015	4:15:10 P	T06	
10/7/2015	4:15:11 P	T06	
10/7/2015	4:15:13 P	T06	
10/7/2015	4:15:14 P	T06	
10/7/2015	4:15:15 P	T06	
10/7/2015	5:48:27 P	T06	
10/7/2015	5:48:28 P	T06	
10/7/2015	5:48:29 P	T06	
10/7/2015	5:48:30 P	T06	
10/7/2015	5:48:31 P	T06	
10/7/2015	5:48:51 P	T06	
10/7/2015	5:48:52 P	T06	
10/7/2015	5:48:53 P	T06	
10/7/2015	5:48:54 P	T06	
10/7/2015	5:48:55 P	T06	
10/7/2015	6:45:32 P	T06	
10/7/2015	6:45:33 P	T06	
10/7/2015	6:45:34 P	T06	
10/7/2015	6:45:35 P	T06	
10/7/2015	6:45:36 P	T06	
10/7/2015	7:02:50 P	T06	
10/7/2015	7:02:51 P	T06	
10/7/2015	7:02:52 P	T06	
10/7/2015	7:02:53 P	T06	
10/7/2015	7:02:54 P	T06	
10/7/2015	7:03:34 P	T06	
10/7/2015	7:03:35 P	T06	
10/7/2015	7:03:36 P	T06	
10/7/2015	7:03:37 P	T06	
10/7/2015	7:03:38 P	T06	
10/7/2015	10:05:08 P	T06	
10/7/2015	10:05:09 P	T06	
10/7/2015	10:05:10 P	T06	
10/7/2015	10:05:12 P	T06	
10/7/2015	10:05:13 P	T06	
11/7/2015	3:42:47 A	T06	
11/7/2015	3:42:48 A	T06	
11/7/2015	3:42:50 A	T06	
11/7/2015	3:42:51 A	T06	

Date	Time	Camera 1	Camera 2
11/7/2015	3:42:52 A	T06	
11/7/2015	5:54:04 A	T06	
11/7/2015	5:54:05 A	T06	
11/7/2015	5:54:06 A	T06	
11/7/2015	5:54:07 A	T06	
11/7/2015	5:54:08 A	T06	
11/7/2015	6:19:49 A	T06	
11/7/2015	6:19:50 A	T06	
11/7/2015	6:19:51 A	T06	
11/7/2015	6:19:52 A	T06	
11/7/2015	6:19:53 A	T06	
11/7/2015	6:58:23 A	T06	
11/7/2015	6:58:25 A	T06	
11/7/2015	6:58:27 A	T06	
11/7/2015	6:58:28 A	T06	
11/7/2015	6:58:29 A	T06	
11/7/2015	8:32:02 A	T06	
11/7/2015	8:32:03 A	T06	
11/7/2015	8:32:05 A	T06	
11/7/2015	8:32:06 A	T06	
11/7/2015	8:32:07 A	T06	
11/7/2015	8:36:09 A	T06	
11/7/2015	8:36:10 A	T06	
11/7/2015	8:36:11 A	T06	
11/7/2015	8:36:12 A	T06	
11/7/2015	8:36:13 A	T06	
11/7/2015	9:42:19 A	T06	
11/7/2015	9:42:21 A	T06	
11/7/2015	9:42:22 A	T06	
11/7/2015	9:42:23 A	T06	
11/7/2015	9:42:24 A	T06	
11/7/2015	11:19:20 A	T06	
11/7/2015	11:19:22 A	T06	
11/7/2015	11:19:23 A	T06	
11/7/2015	11:19:24 A	T06	
11/7/2015	11:19:25 A	T06	
11/7/2015	11:19:41 A	T06	
11/7/2015	11:19:42 A	T06	
11/7/2015	11:19:43 A	T06	

Date	Time	Camera 1	Camera 2
11/7/2015	11:19:44 A	T06	
11/7/2015	11:19:45 A	T06	
11/7/2015	12:01:29 P	T06	
11/7/2015	12:01:30 P	T06	
11/7/2015	12:01:31 P	T06	
11/7/2015	12:01:32 P	T06	
11/7/2015	12:01:33 P	T06	
11/7/2015	12:02:30 P	T06	
11/7/2015	12:02:31 P	T06	
11/7/2015	12:02:32 P	T06	
11/7/2015	12:02:33 P	T06	
11/7/2015	12:02:34 P	T06	
11/7/2015	1:13:23 P	T06	
11/7/2015	1:13:24 P	T06	
11/7/2015	1:13:25 P	T06	
11/7/2015	1:13:26 P	T06	
11/7/2015	1:13:27 P	T06	
11/7/2015	1:24:23 P	T09	
11/7/2015	1:24:24 P	T09	
11/7/2015	1:24:25 P	T09	
11/7/2015	1:24:26 P	T09	
11/7/2015	1:24:27 P	T09	
12/7/2015	1:52:06 A	T06	
12/7/2015	1:52:08 A	T06	
12/7/2015	1:52:09 A	T06	
12/7/2015	1:52:10 A	T06	
12/7/2015	1:52:11 A	T06	
12/7/2015	4:25:06 A	T06	
12/7/2015	4:25:08 A	T06	
12/7/2015	4:25:09 A	T06	
12/7/2015	4:25:10 A	T06	
12/7/2015	4:25:11 A	T06	
12/7/2015	5:07:42 A	T06	
12/7/2015	5:07:43 A	T06	
12/7/2015	5:07:44 A	T06	
12/7/2015	5:07:45 A	T06	
12/7/2015	5:07:46 A	T06	
12/7/2015	6:07:28 A	T06	
12/7/2015	6:07:31 A	T06	

Date	Time	Camera 1	Camera 2
12/7/2015	6:07:32 A	T06	
12/7/2015	6:07:33 A	T06	
12/7/2015	6:07:34 A	T06	
12/7/2015	10:09:01 A	T07	
12/7/2015	10:09:02 A	T07	
12/7/2015	10:09:03 A	T07	
12/7/2015	10:09:04 A	T07	
12/7/2015	10:09:05 A	T07	
12/7/2015	10:32:33 A	T06	
12/7/2015	10:32:34 A	T06	
12/7/2015	10:32:36 A	T06	
12/7/2015	10:32:37 A	T06	
12/7/2015	10:32:38 A	T06	
12/7/2015	1:16:58 P	T06	
12/7/2015	1:16:59 P	T06	
12/7/2015	1:17:00 P	T06	
12/7/2015	1:17:01 P	T06	
12/7/2015	1:17:02 P	T06	
12/7/2015	4:16:46 P	T06	
12/7/2015	4:16:48 P	T06	
12/7/2015	4:16:49 P	T06	
12/7/2015	4:16:50 P	T06	
12/7/2015	4:16:51 P	T06	
12/7/2015	4:33:07 P	T07	
12/7/2015	4:33:09 P	T07	
12/7/2015	4:33:10 P	T07	
12/7/2015	4:33:11 P	T07	
12/7/2015	4:33:12 P	T07	
12/7/2015	4:33:27 P	T07	
12/7/2015	4:33:28 P	T07	
12/7/2015	4:33:29 P	T07	
12/7/2015	4:33:30 P	T07	
12/7/2015	4:33:31 P	T07	
12/7/2015	4:36:33 P	T07	
12/7/2015	4:36:34 P	T07	
12/7/2015	4:36:35 P	T07	
12/7/2015	4:36:36 P	T07	
12/7/2015	4:36:37 P	T07	
12/7/2015	4:39:06 P	T07	

Date	Time	Camera 1	Camera 2
12/7/2015	4:39:07 P	T07	
12/7/2015	4:39:08 P	T07	
12/7/2015	4:39:09 P	T07	
12/7/2015	4:39:10 P	T07	
12/7/2015	4:39:25 P	T07	
12/7/2015	4:39:26 P	T07	
12/7/2015	4:39:28 P	T07	
12/7/2015	4:39:29 P	T07	
12/7/2015	4:39:30 P	T07	
12/7/2015	4:39:46 P	T07	
12/7/2015	4:39:47 P	T07	
12/7/2015	4:39:48 P	T07	
12/7/2015	4:39:49 P	T07	
12/7/2015	4:39:50 P	T07	
12/7/2015	4:50:00 P	T06	
12/7/2015	4:50:01 P	T06	
12/7/2015	4:50:02 P	T06	
12/7/2015	4:50:03 P	T06	
12/7/2015	4:50:04 P	T06	
12/7/2015	4:50:20 P	T06	
12/7/2015	4:50:21 P	T06	
12/7/2015	4:50:22 P	T06	
12/7/2015	4:50:23 P	T06	
12/7/2015	4:50:24 P	T06	
12/7/2015	4:51:08 P	T06	
12/7/2015	4:51:09 P	T06	
12/7/2015	4:51:10 P	T06	
12/7/2015	4:51:11 P	T06	
12/7/2015	4:51:12 P	T06	
12/7/2015	4:51:38 P	T06	
12/7/2015	4:51:39 P	T06	
12/7/2015	4:51:40 P	T06	
12/7/2015	4:51:41 P	T06	
12/7/2015	4:51:42 P	T06	
12/7/2015	4:55:43 P	T06	
12/7/2015	4:55:44 P	T06	
12/7/2015	4:55:45 P	T06	
12/7/2015	4:55:46 P	T06	
12/7/2015	4:55:47 P	T06	

Date	Time	Camera 1	Camera 2
12/7/2015	4:56:15 P	T06	
12/7/2015	4:56:16 P	T06	
12/7/2015	4:56:17 P	T06	
12/7/2015	4:56:18 P	T06	
12/7/2015	4:56:19 P	T06	
12/7/2015	5:56:10 P	T06	
12/7/2015	5:56:11 P	T06	
12/7/2015	5:56:12 P	T06	
12/7/2015	5:56:13 P	T06	
12/7/2015	5:56:14 P	T06	
13/7/2015	6:52:21 A	T06	
13/7/2015	6:52:23 A	T06	
13/7/2015	6:52:25 A	T06	
13/7/2015	6:52:26 A	T06	
13/7/2015	6:52:27 A	T06	
13/7/2015	6:55:24 A	T06	
13/7/2015	6:55:26 A	T06	
13/7/2015	6:55:27 A	T06	
13/7/2015	6:55:28 A	T06	
13/7/2015	6:55:29 A	T06	
13/7/2015	7:46:02 A	T06	
13/7/2015	7:46:04 A	T06	
13/7/2015	7:46:05 A	T06	
13/7/2015	7:46:06 A	T06	
13/7/2015	7:46:07 A	T06	
13/7/2015	2:19:47 P	T06	
13/7/2015	2:19:49 P	T06	
13/7/2015	2:19:50 P	T06	
13/7/2015	2:19:51 P	T06	
13/7/2015	2:19:52 P	T06	
13/7/2015	2:46:45 P	T06	
13/7/2015	2:46:46 P	T06	
13/7/2015	2:46:47 P	T06	
13/7/2015	2:46:48 P	T06	
13/7/2015	2:46:49 P	T06	
13/7/2015	4:05:41 P	T07	
13/7/2015	4:05:42 P	T07	
13/7/2015	4:05:43 P	T07	
13/7/2015	4:05:44 P	T07	

Date	Time	Camera 1	Camera 2
13/7/2015	4:05:45 P	T07	
13/7/2015	4:06:00 P	T07	
13/7/2015	4:06:01 P	T07	
13/7/2015	4:06:02 P	T07	
13/7/2015	4:06:03 P	T07	
13/7/2015	4:06:04 P	T07	
13/7/2015	4:07:06 P	T07	
13/7/2015	4:07:07 P	T07	
13/7/2015	4:07:08 P	T07	
13/7/2015	4:07:09 P	T07	
13/7/2015	4:07:10 P	T07	
13/7/2015	4:31:53 P	T06	
13/7/2015	4:31:55 P	T06	
13/7/2015	4:31:56 P	T06	
13/7/2015	4:31:57 P	T06	
13/7/2015	4:31:58 P	T06	
13/7/2015	4:36:50 P	T06	
13/7/2015	4:36:51 P	T06	
13/7/2015	4:36:52 P	T06	
13/7/2015	4:36:53 P	T06	
13/7/2015	4:36:54 P	T06	
13/7/2015	4:37:52 P	T06	
13/7/2015	4:37:53 P	T06	
13/7/2015	4:37:54 P	T06	
13/7/2015	4:37:55 P	T06	
13/7/2015	4:37:56 P	T06	
14/7/2015	5:14:05 A	T06	
14/7/2015	5:14:06 A	T06	
14/7/2015	5:14:07 A	T06	
14/7/2015	5:14:08 A	T06	
14/7/2015	5:14:10 A	T06	
14/7/2015	5:14:27 A	T06	
14/7/2015	5:14:30 A	T06	
14/7/2015	5:14:31 A	T06	
14/7/2015	5:14:32 A	T06	
14/7/2015	5:14:33 A	T06	
14/7/2015	5:25:07 A	T06	
14/7/2015	5:25:10 A	T06	
14/7/2015	5:25:11 A	T06	

Date	Time	Camera 1	Camera 2
14/7/2015	5:25:12 A	T06	
14/7/2015	5:25:13 A	T06	
14/7/2015	6:18:18 A	T06	
14/7/2015	6:18:19 A	T06	
14/7/2015	6:18:20 A	T06	
14/7/2015	6:18:21 A	T06	
14/7/2015	6:18:22 A	T06	
14/7/2015	6:33:08 A	T06	
14/7/2015	6:33:11 A	T06	
14/7/2015	6:33:12 A	T06	
14/7/2015	6:33:13 A	T06	
14/7/2015	6:33:14 A	T06	
14/7/2015	10:01:02 A	T07	
14/7/2015	10:01:03 A	T07	
14/7/2015	10:01:04 A	T07	
14/7/2015	10:01:05 A	T07	
14/7/2015	10:01:06 A	T07	
14/7/2015	10:01:25 A	T07	
14/7/2015	10:01:26 A	T07	
14/7/2015	10:01:27 A	T07	
14/7/2015	10:01:28 A	T07	
14/7/2015	10:01:30 A	T07	
14/7/2015	10:52:11 A	T06	
14/7/2015	10:52:12 A	T06	
14/7/2015	10:52:13 A	T06	
14/7/2015	10:52:14 A	T06	
14/7/2015	10:52:15 A	T06	
14/7/2015	11:15:34 A	T06	
14/7/2015	11:15:35 A	T06	
14/7/2015	11:15:36 A	T06	
14/7/2015	11:15:37 A	T06	
14/7/2015	11:15:38 A	T06	
14/7/2015	1:31:18 P	T06	
14/7/2015	1:31:19 P	T06	
14/7/2015	1:31:20 P	T06	
14/7/2015	1:31:21 P	T06	
14/7/2015	1:31:22 P	T06	
14/7/2015	4:12:22 P	T06	
14/7/2015	4:12:23 P	T06	

Date	Time	Camera 1	Camera 2
14/7/2015	4:12:24 P	T06	
14/7/2015	4:12:25 P	T06	
14/7/2015	4:12:26 P	T06	
14/7/2015	5:59:36 P	T06	
14/7/2015	5:59:38 P	T06	
14/7/2015	5:59:39 P	T06	
14/7/2015	5:59:40 P	T06	
14/7/2015	5:59:41 P	T06	
14/7/2015	6:45:54 P	T06	
14/7/2015	6:45:55 P	T06	
14/7/2015	6:45:56 P	T06	
14/7/2015	6:45:57 P	T06	
14/7/2015	6:45:58 P	T06	
15/7/2015	1:46:35 A	T06	
15/7/2015	1:46:37 A	T06	
15/7/2015	1:46:38 A	T06	
15/7/2015	1:46:39 A	T06	
15/7/2015	1:46:40 A	T06	
15/7/2015	2:01:21 A	T06	
15/7/2015	2:01:22 A	T06	
15/7/2015	2:01:24 A	T06	
15/7/2015	2:01:25 A	T06	
15/7/2015	2:01:26 A	T06	
15/7/2015	3:09:40 A	T06	
15/7/2015	3:09:43 A	T06	
15/7/2015	3:09:44 A	T06	
15/7/2015	3:09:45 A	T06	
15/7/2015	3:09:46 A	T06	
15/7/2015	5:39:22 A	T06	
15/7/2015	5:39:24 A	T06	
15/7/2015	5:39:25 A	T06	
15/7/2015	5:39:26 A	T06	
15/7/2015	5:39:27 A	T06	
15/7/2015	7:58:53 A	T06	
15/7/2015	7:58:55 A	T06	
15/7/2015	7:58:56 A	T06	
15/7/2015	7:58:57 A	T06	
15/7/2015	7:58:58 A	T06	
15/7/2015	10:42:16 A	T06	

Date	Time	Camera 1	Camera 2
15/7/2015	10:42:17 A	T06	
15/7/2015	10:42:18 A	T06	
15/7/2015	10:42:19 A	T06	
15/7/2015	10:42:20 A	T06	
15/7/2015	3:58:58 P	T06	
15/7/2015	3:58:59 P	T06	
15/7/2015	3:59:00 P	T06	
15/7/2015	3:59:01 P	T06	
15/7/2015	3:59:02 P	T06	
15/7/2015	4:24:59 P	T06	
15/7/2015	4:25:01 P	T06	
15/7/2015	4:25:02 P	T06	
15/7/2015	4:25:03 P	T06	
15/7/2015	4:25:04 P	T06	
15/7/2015	4:25:30 P	T06	
15/7/2015	4:25:31 P	T06	
15/7/2015	4:25:32 P	T06	
15/7/2015	4:25:33 P	T06	
15/7/2015	4:25:34 P	T06	
15/7/2015	4:35:17 P	T06	
15/7/2015	4:35:19 P	T06	
15/7/2015	4:35:20 P	T06	
15/7/2015	4:35:21 P	T06	
15/7/2015	4:35:22 P	T06	
15/7/2015	6:41:03 P	T06	
15/7/2015	6:41:05 P	T06	
15/7/2015	6:41:06 P	T06	
15/7/2015	6:41:07 P	T06	
15/7/2015	6:41:08 P	T06	
15/7/2015	9:39:09 P	T06	
15/7/2015	9:39:12 P	T06	
15/7/2015	9:39:13 P	T06	
15/7/2015	9:39:14 P	T06	
15/7/2015	9:39:15 P	T06	
15/7/2015	9:55:23 P	T06	
15/7/2015	9:55:25 P	T06	
15/7/2015	9:55:26 P	T06	
15/7/2015	9:55:27 P	T06	
15/7/2015	9:55:28 P	T06	

Date	Time	Camera 1	Camera 2
16/7/2015	12:38:08 P	T06	
16/7/2015	12:38:10 P	T06	
16/7/2015	12:38:11 P	T06	
16/7/2015	12:38:12 P	T06	
16/7/2015	12:38:13 P	T06	
16/7/2015	3:33:12 P	T06	
16/7/2015	3:33:13 P	T06	
16/7/2015	3:33:14 P	T06	
16/7/2015	3:33:15 P	T06	
16/7/2015	3:33:16 P	T06	
16/7/2015	3:36:29 P	T06	
16/7/2015	3:36:30 P	T06	
16/7/2015	3:36:31 P	T06	
16/7/2015	3:36:32 P	T06	
16/7/2015	3:36:33 P	T06	
16/7/2015	3:57:41 P	T06	
16/7/2015	3:57:42 P	T06	
16/7/2015	3:57:43 P	T06	
16/7/2015	3:57:44 P	T06	
16/7/2015	3:57:45 P	T06	
16/7/2015	4:16:05 P	T06	
16/7/2015	4:16:06 P	T06	
16/7/2015	4:16:07 P	T06	
16/7/2015	4:16:08 P	T06	
16/7/2015	4:16:09 P	T06	
16/7/2015	4:19:55 P	T06	
16/7/2015	4:19:56 P	T06	
16/7/2015	4:19:58 P	T06	
16/7/2015	4:19:59 P	T06	
16/7/2015	4:20:00 P	T06	
16/7/2015	4:59:03 P	T06	
16/7/2015	4:59:04 P	T06	
16/7/2015	4:59:05 P	T06	
16/7/2015	4:59:06 P	T06	
16/7/2015	4:59:07 P	T06	
16/7/2015	6:23:41 P	T06	
16/7/2015	6:23:43 P	T06	
16/7/2015	6:23:44 P	T06	
16/7/2015	6:23:45 P	T06	

Date	Time	Camera 1	Camera 2
16/7/2015	6:23:46 P	T06	
17/7/2015	6:12:06 A	T06	
17/7/2015	6:12:09 A	T06	
17/7/2015	6:12:10 A	T06	
17/7/2015	6:12:11 A	T06	
17/7/2015	6:12:12 A	T06	
17/7/2015	7:04:42 A	T06	
17/7/2015	7:04:44 A	T06	
17/7/2015	7:04:45 A	T06	
17/7/2015	7:04:46 A	T06	
17/7/2015	7:04:47 A	T06	
17/7/2015	9:21:22 A	T06	
17/7/2015	9:21:24 A	T06	
17/7/2015	9:21:25 A	T06	
17/7/2015	9:21:26 A	T06	
17/7/2015	9:21:27 A	T06	
17/7/2015	10:13:59 A	T06	
17/7/2015	10:14:00 A	T06	
17/7/2015	10:14:01 A	T06	
17/7/2015	10:14:02 A	T06	
17/7/2015	10:14:03 A	T06	
17/7/2015	10:29:17 A	T06	
17/7/2015	10:29:18 A	T06	
17/7/2015	10:29:19 A	T06	
17/7/2015	10:29:20 A	T06	
17/7/2015	10:29:21 A	T06	
17/7/2015	10:41:18 A	T09	
17/7/2015	10:41:20 A	T09	
17/7/2015	10:41:21 A	T09	
17/7/2015	10:41:22 A	T09	
17/7/2015	10:41:23 A	T09	
17/7/2015	1:33:55 P	T06	
17/7/2015	1:33:57 P	T06	
17/7/2015	1:33:58 P	T06	
17/7/2015	1:33:59 P	T06	
17/7/2015	1:34:00 P	T06	
17/7/2015	1:39:29 P	T06	
17/7/2015	1:39:30 P	T06	
17/7/2015	1:39:31 P	T06	

Date	Time	Camera 1	Camera 2
17/7/2015	1:39:32 P	T06	
17/7/2015	1:39:33 P	T06	
17/7/2015	2:02:21 P	T06	
17/7/2015	2:02:23 P	T06	
17/7/2015	2:02:24 P	T06	
17/7/2015	2:02:25 P	T06	
17/7/2015	2:02:26 P	T06	
17/7/2015	2:51:28 P	T06	
17/7/2015	2:51:30 P	T06	
17/7/2015	2:51:31 P	T06	
17/7/2015	2:51:32 P	T06	
17/7/2015	2:51:33 P	T06	
17/7/2015	2:52:53 P	T06	
17/7/2015	2:52:54 P	T06	
17/7/2015	2:52:55 P	T06	
17/7/2015	2:52:56 P	T06	
17/7/2015	2:52:57 P	T06	
17/7/2015	5:27:58 P	T06	
17/7/2015	5:27:59 P	T06	
17/7/2015	5:28:00 P	T06	
17/7/2015	5:28:01 P	T06	
17/7/2015	5:28:02 P	T06	
17/7/2015	6:37:13 P	T06	
17/7/2015	6:37:14 P	T06	
17/7/2015	6:37:15 P	T06	
17/7/2015	6:37:16 P	T06	
17/7/2015	6:37:17 P	T06	
17/7/2015	8:27:04 P	T06	
17/7/2015	8:27:07 P	T06	
17/7/2015	8:27:08 P	T06	
17/7/2015	8:27:09 P	T06	
17/7/2015	8:27:10 P	T06	
18/7/2015	8:53:06 A	T06	
18/7/2015	8:53:08 A	T06	
18/7/2015	8:53:09 A	T06	
18/7/2015	8:53:10 A	T06	
18/7/2015	8:53:11 A	T06	
18/7/2015	9:15:16 A	T06	
18/7/2015	9:15:17 A	T06	

Date	Time	Camera 1	Camera 2
18/7/2015	9:15:18 A	T06	
18/7/2015	9:15:19 A	T06	
18/7/2015	9:15:20 A	T06	
18/7/2015	10:56:48 A	T06	
18/7/2015	10:56:49 A	T06	
18/7/2015	10:56:50 A	T06	
18/7/2015	10:56:51 A	T06	
18/7/2015	10:56:52 A	T06	
18/7/2015	11:33:21 A	T06	
18/7/2015	11:33:22 A	T06	
18/7/2015	11:33:23 A	T06	
18/7/2015	11:33:24 A	T06	
18/7/2015	11:33:25 A	T06	
18/7/2015	1:37:17 P	T06	
18/7/2015	1:37:19 P	T06	
18/7/2015	1:37:20 P	T06	
18/7/2015	1:37:21 P	T06	
18/7/2015	1:37:22 P	T06	
18/7/2015	1:50:38 P	T06	
18/7/2015	1:50:39 P	T06	
18/7/2015	1:50:40 P	T06	
18/7/2015	1:50:41 P	T06	
18/7/2015	1:50:42 P	T06	
18/7/2015	2:27:23 P	T06	
18/7/2015	2:27:24 P	T06	
18/7/2015	2:27:25 P	T06	
18/7/2015	2:27:26 P	T06	
18/7/2015	2:27:27 P	T06	
18/7/2015	2:28:04 P	T06	
18/7/2015	2:28:05 P	T06	
18/7/2015	2:28:06 P	T06	
18/7/2015	2:28:07 P	T06	
18/7/2015	2:28:08 P	T06	
18/7/2015	2:28:44 P	T06	
18/7/2015	2:28:45 P	T06	
18/7/2015	2:28:46 P	T06	
18/7/2015	2:28:47 P	T06	
18/7/2015	2:28:48 P	T06	
18/7/2015	2:58:47 P	T06	

Date	Time	Camera 1	Camera 2
18/7/2015	2:58:48 P	T06	
18/7/2015	2:58:49 P	T06	
18/7/2015	2:58:50 P	T06	
18/7/2015	2:58:51 P	T06	
18/7/2015	3:51:47 P	T06	
18/7/2015	3:51:48 P	T06	
18/7/2015	3:51:49 P	T06	
18/7/2015	3:51:50 P	T06	
18/7/2015	3:51:51 P	T06	
18/7/2015	5:16:37 P	T06	
18/7/2015	5:16:38 P	T06	
18/7/2015	5:16:39 P	T06	
18/7/2015	5:16:40 P	T06	
18/7/2015	5:16:41 P	T06	
18/7/2015	5:17:02 P	T06	
18/7/2015	5:17:04 P	T06	
18/7/2015	5:17:05 P	T06	
18/7/2015	5:17:06 P	T06	
18/7/2015	5:17:07 P	T06	
18/7/2015	5:18:18 P	T06	
18/7/2015	5:18:19 P	T06	
18/7/2015	5:18:20 P	T06	
18/7/2015	5:18:21 P	T06	
18/7/2015	5:18:22 P	T06	
19/7/2015	2:19:42 A	T06	
19/7/2015	2:19:43 A	T06	
19/7/2015	2:19:44 A	T06	
19/7/2015	2:19:45 A	T06	
19/7/2015	2:19:46 A	T06	
19/7/2015	6:29:34 A	T06	
19/7/2015	6:29:36 A	T06	
19/7/2015	6:29:38 A	T06	
19/7/2015	6:29:39 A	T06	
19/7/2015	6:29:40 A	T06	
19/7/2015	6:46:24 A	T06	
19/7/2015	6:46:26 A	T06	
19/7/2015	6:46:27 A	T06	
19/7/2015	6:46:28 A	T06	
19/7/2015	6:46:29 A	T06	

Date	Time	Camera 1	Camera 2
19/7/2015	7:27:47 A	T06	
19/7/2015	7:27:48 A	T06	
19/7/2015	7:27:49 A	T06	
19/7/2015	7:27:50 A	T06	
19/7/2015	7:27:51 A	T06	
19/7/2015	7:58:43 A	T06	
19/7/2015	7:58:45 A	T06	
19/7/2015	7:58:46 A	T06	
19/7/2015	7:58:47 A	T06	
19/7/2015	7:58:48 A	T06	
19/7/2015	8:38:53 A	T06	
19/7/2015	8:38:54 A	T06	
19/7/2015	8:38:56 A	T06	
19/7/2015	8:38:57 A	T06	
19/7/2015	8:38:58 A	T06	
19/7/2015	8:43:12 A	T06	
19/7/2015	8:43:14 A	T06	
19/7/2015	8:43:15 A	T06	
19/7/2015	8:43:16 A	T06	
19/7/2015	8:43:17 A	T06	
19/7/2015	9:43:41 A	T06	
19/7/2015	9:43:42 A	T06	
19/7/2015	9:43:43 A	T06	
19/7/2015	9:43:44 A	T06	
19/7/2015	9:43:45 A	T06	
19/7/2015	10:01:20 A	T07	
19/7/2015	10:01:21 A	T07	
19/7/2015	10:01:22 A	T07	
19/7/2015	10:01:23 A	T07	
19/7/2015	10:01:24 A	T07	
19/7/2015	11:26:43 A	T06	
19/7/2015	11:26:44 A	T06	
19/7/2015	11:26:45 A	T06	
19/7/2015	11:26:46 A	T06	
19/7/2015	11:26:47 A	T06	
19/7/2015	12:12:02 P	T06	
19/7/2015	12:12:03 P	T06	
19/7/2015	12:12:07 P	T06	
19/7/2015	12:12:08 P	T06	

Date	Time	Camera 1	Camera 2
19/7/2015	12:12:09 P	T06	
19/7/2015	1:03:15 P	T06	
19/7/2015	1:03:17 P	T06	
19/7/2015	1:03:18 P	T06	
19/7/2015	1:03:19 P	T06	
19/7/2015	1:03:20 P	T06	
19/7/2015	1:03:37 P	T06	
19/7/2015	1:03:38 P	T06	
19/7/2015	1:03:39 P	T06	
19/7/2015	1:03:40 P	T06	
19/7/2015	1:03:41 P	T06	
19/7/2015	1:09:15 P	T06	
19/7/2015	1:09:17 P	T06	
19/7/2015	1:09:18 P	T06	
19/7/2015	1:09:19 P	T06	
19/7/2015	1:09:20 P	T06	
19/7/2015	1:09:39 P	T06	
19/7/2015	1:09:40 P	T06	
19/7/2015	1:09:41 P	T06	
19/7/2015	1:09:42 P	T06	
19/7/2015	1:09:43 P	T06	
19/7/2015	1:51:37 P	T06	
19/7/2015	1:51:39 P	T06	
19/7/2015	1:51:40 P	T06	
19/7/2015	1:51:41 P	T06	
19/7/2015	1:51:42 P	T06	
19/7/2015	1:59:26 P	T06	
19/7/2015	1:59:27 P	T06	
19/7/2015	1:59:28 P	T06	
19/7/2015	1:59:29 P	T06	
19/7/2015	1:59:30 P	T06	
19/7/2015	2:11:19 P	T06	
19/7/2015	2:11:21 P	T06	
19/7/2015	2:11:22 P	T06	
19/7/2015	2:11:23 P	T06	
19/7/2015	2:11:24 P	T06	
19/7/2015	2:11:40 P	T06	
19/7/2015	2:11:41 P	T06	
19/7/2015	2:11:42 P	T06	

Date	Time	Camera 1	Camera 2
19/7/2015	2:11:43 P	T06	
19/7/2015	2:11:44 P	T06	
19/7/2015	2:20:45 P	T06	
19/7/2015	2:20:46 P	T06	
19/7/2015	2:20:48 P	T06	
19/7/2015	2:20:49 P	T06	
19/7/2015	2:20:50 P	T06	
19/7/2015	4:27:46 P	T06	
19/7/2015	4:27:47 P	T06	
19/7/2015	4:27:48 P	T06	
19/7/2015	4:27:49 P	T06	
19/7/2015	4:27:50 P	T06	
19/7/2015	5:00:20 P	T06	
19/7/2015	5:00:21 P	T06	
19/7/2015	5:00:22 P	T06	
19/7/2015	5:00:23 P	T06	
19/7/2015	5:00:24 P	T06	
19/7/2015	5:06:45 P	T06	
19/7/2015	5:06:46 P	T06	
19/7/2015	5:06:47 P	T06	
19/7/2015	5:06:48 P	T06	
19/7/2015	5:06:49 P	T06	
19/7/2015	5:31:07 P	T06	
19/7/2015	5:31:08 P	T06	
19/7/2015	5:31:09 P	T06	
19/7/2015	5:31:10 P	T06	
19/7/2015	5:31:11 P	T06	
19/7/2015	6:13:24 P	T06	
19/7/2015	6:13:25 P	T06	
19/7/2015	6:13:26 P	T06	
19/7/2015	6:13:27 P	T06	
19/7/2015	6:13:28 P	T06	
20/7/2015	5:51:13 A	T06	
20/7/2015	5:51:15 A	T06	
20/7/2015	5:51:16 A	T06	
20/7/2015	5:51:18 A	T06	
20/7/2015	5:51:19 A	T06	
20/7/2015	5:51:39 A	T06	
20/7/2015	5:51:40 A	T06	

Date	Time	Camera 1	Camera 2
20/7/2015	5:51:42 A	T06	
20/7/2015	5:51:43 A	T06	
20/7/2015	5:51:44 A	T06	
20/7/2015	6:22:01 A	T06	
20/7/2015	6:22:03 A	T06	
20/7/2015	6:22:04 A	T06	
20/7/2015	6:22:05 A	T06	
20/7/2015	6:22:06 A	T06	
20/7/2015	6:22:50 A	T06	
20/7/2015	6:22:52 A	T06	
20/7/2015	6:22:53 A	T06	
20/7/2015	6:22:54 A	T06	
20/7/2015	6:22:55 A	T06	
20/7/2015	6:23:28 A	T06	
20/7/2015	6:23:30 A	T06	
20/7/2015	6:23:31 A	T06	
20/7/2015	6:23:32 A	T06	
20/7/2015	6:23:33 A	T06	
20/7/2015	7:03:38 A	T06	
20/7/2015	7:03:41 A	T06	
20/7/2015	7:03:42 A	T06	
20/7/2015	7:03:43 A	T06	
20/7/2015	7:03:44 A	T06	
20/7/2015	9:17:05 A	T06	
20/7/2015	9:17:07 A	T06	
20/7/2015	9:17:08 A	T06	
20/7/2015	9:17:09 A	T06	
20/7/2015	9:17:10 A	T06	
20/7/2015	12:42:37 P	T06	
20/7/2015	12:42:38 P	T06	
20/7/2015	12:42:39 P	T06	
20/7/2015	12:42:40 P	T06	
20/7/2015	12:42:41 P	T06	
20/7/2015	12:58:01 P	T06	
20/7/2015	12:58:02 P	T06	
20/7/2015	12:58:03 P	T06	
20/7/2015	12:58:04 P	T06	
20/7/2015	12:58:05 P	T06	
20/7/2015	1:08:07 P	T06	

Date	Time	Camera 1	Camera 2
20/7/2015	1:08:08 P	T06	
20/7/2015	1:08:09 P	T06	
20/7/2015	1:08:10 P	T06	
20/7/2015	1:08:11 P	T06	
20/7/2015	4:23:44 P	T06	
20/7/2015	4:23:46 P	T06	
20/7/2015	4:23:47 P	T06	
20/7/2015	4:23:48 P	T06	
20/7/2015	4:23:49 P	T06	
20/7/2015	5:36:05 P	T06	
20/7/2015	5:36:07 P	T06	
20/7/2015	5:36:08 P	T06	
20/7/2015	5:36:09 P	T06	
20/7/2015	5:36:10 P	T06	
20/7/2015	5:36:27 P	T06	
20/7/2015	5:36:28 P	T06	
20/7/2015	5:36:29 P	T06	
20/7/2015	5:36:30 P	T06	
20/7/2015	5:36:31 P	T06	
20/7/2015	6:03:25 P	T06	
20/7/2015	6:03:26 P	T06	
20/7/2015	6:03:27 P	T06	
20/7/2015	6:03:28 P	T06	
20/7/2015	6:03:29 P	T06	
20/7/2015	6:17:13 P	T06	
20/7/2015	6:17:14 P	T06	
20/7/2015	6:17:15 P	T06	
20/7/2015	6:17:16 P	T06	
20/7/2015	6:17:17 P	T06	
20/7/2015	8:18:04 P	T06	
20/7/2015	8:18:06 P	T06	
20/7/2015	8:18:07 P	T06	
20/7/2015	8:18:08 P	T06	
20/7/2015	8:18:09 P	T06	
21/7/2015	6:09:35 A	T06	
21/7/2015	6:09:36 A	T06	
21/7/2015	6:09:37 A	T06	
21/7/2015	6:09:39 A	T06	
21/7/2015	6:09:41 A	T06	

Date	Time	Camera 1	Camera 2
21/7/2015	7:57:00 A	T06	
21/7/2015	7:57:02 A	T06	
21/7/2015	7:57:03 A	T06	
21/7/2015	7:57:04 A	T06	
21/7/2015	7:57:05 A	T06	
21/7/2015	10:18:10 A	T06	
21/7/2015	10:18:12 A	T06	
21/7/2015	10:18:13 A	T06	
21/7/2015	10:18:14 A	T06	
21/7/2015	10:18:15 A	T06	
21/7/2015	1:37:59 P	T06	
21/7/2015	1:38:00 P	T06	
21/7/2015	1:38:01 P	T06	
21/7/2015	1:38:02 P	T06	
21/7/2015	1:38:03 P	T06	
21/7/2015	2:51:39 P	T06	
21/7/2015	2:51:41 P	T06	
21/7/2015	2:51:42 P	T06	
21/7/2015	2:51:43 P	T06	
21/7/2015	2:51:44 P	T06	
22/7/2015	8:06:05 A	T06	
22/7/2015	8:06:08 A	T06	
22/7/2015	8:06:09 A	T06	
22/7/2015	8:06:10 A	T06	
22/7/2015	8:06:11 A	T06	
22/7/2015	10:00:34 A	T06	
22/7/2015	10:00:35 A	T06	
22/7/2015	10:00:36 A	T06	
22/7/2015	10:00:37 A	T06	
22/7/2015	10:00:38 A	T06	
23/7/2015	2:35:35 A	T06	
23/7/2015	2:35:36 A	T06	
23/7/2015	2:35:38 A	T06	
23/7/2015	2:35:39 A	T06	
23/7/2015	2:35:40 A	T06	
23/7/2015	7:09:58 A	T06	
23/7/2015	7:10:00 A	T06	
23/7/2015	7:10:01 A	T06	
23/7/2015	7:10:02 A	T06	

Date	Time	Camera 1	Camera 2
23/7/2015	7:10:03 A	T06	
23/7/2015	11:30:55 A	T06	
23/7/2015	11:30:56 A	T06	
23/7/2015	11:30:57 A	T06	
23/7/2015	11:30:58 A	T06	
23/7/2015	11:30:59 A	T06	
23/7/2015	3:46:56 P	T06	
23/7/2015	3:46:58 P	T06	
23/7/2015	3:46:59 P	T06	
23/7/2015	3:47:00 P	T06	
23/7/2015	3:47:01 P	T06	
24/7/2015	8:03:02 A	T06	
24/7/2015	8:03:04 A	T06	
24/7/2015	8:03:05 A	T06	
24/7/2015	8:03:06 A	T06	
24/7/2015	8:03:07 A	T06	
24/7/2015	8:04:58 A	T06	
24/7/2015	8:04:59 A	T06	
24/7/2015	8:05:00 A	T06	
24/7/2015	8:05:01 A	T06	
24/7/2015	8:05:02 A	T06	
24/7/2015	4:30:10 P	T06	
24/7/2015	4:30:12 P	T06	
24/7/2015	4:30:13 P	T06	
24/7/2015	4:30:14 P	T06	
24/7/2015	4:30:15 P	T06	
24/7/2015	5:48:42 P	T06	
24/7/2015	5:48:44 P	T06	
24/7/2015	5:48:45 P	T06	
24/7/2015	5:48:46 P	T06	
24/7/2015	5:48:47 P	T06	
24/7/2015	8:07:05 P	T06	
24/7/2015	8:07:07 P	T06	
24/7/2015	8:07:08 P	T06	
24/7/2015	8:07:09 P	T06	
24/7/2015	8:07:10 P	T06	
25/7/2015	9:49:11 A	T06	
25/7/2015	9:49:13 A	T06	
25/7/2015	9:49:14 A	T06	

Date	Time	Camera 1	Camera 2
25/7/2015	9:49:15 A	T06	
25/7/2015	9:49:16 A	T06	
25/7/2015	11:26:48 A	T06	
25/7/2015	11:26:50 A	T06	
25/7/2015	11:26:51 A	T06	
25/7/2015	11:26:52 A	T06	
25/7/2015	11:26:53 A	T06	
25/7/2015	3:20:55 P	T06	
25/7/2015	3:20:56 P	T06	
25/7/2015	3:20:57 P	T06	
25/7/2015	3:20:58 P	T06	
25/7/2015	3:20:59 P	T06	
25/7/2015	4:45:23 P	T06	
25/7/2015	4:45:24 P	T06	
25/7/2015	4:45:25 P	T06	
25/7/2015	4:45:26 P	T06	
25/7/2015	4:45:27 P	T06	
26/7/2015	1:17:24 A	T06	
26/7/2015	1:17:26 A	T06	
26/7/2015	1:17:27 A	T06	
26/7/2015	1:17:28 A	T06	
26/7/2015	1:17:29 A	T06	
26/7/2015	5:57:38 A	T06	
26/7/2015	5:57:42 A	T06	
26/7/2015	5:57:43 A	T06	
26/7/2015	5:57:44 A	T06	
26/7/2015	5:57:45 A	T06	
26/7/2015	7:24:45 A	T06	
26/7/2015	7:24:47 A	T06	
26/7/2015	7:24:48 A	T06	
26/7/2015	7:24:49 A	T06	
26/7/2015	7:24:50 A	T06	
26/7/2015	7:25:32 A	T06	
26/7/2015	7:25:33 A	T06	
26/7/2015	7:25:34 A	T06	
26/7/2015	7:25:35 A	T06	
26/7/2015	7:25:36 A	T06	
26/7/2015	8:29:09 A	T07	
26/7/2015	8:29:10 A	T07	

Date	Time	Camera 1	Camera 2
26/7/2015	8:29:11 A	T07	
26/7/2015	8:29:12 A	T07	
26/7/2015	8:29:13 A	T07	
26/7/2015	8:29:28 A	T07	
26/7/2015	8:29:30 A	T07	
26/7/2015	8:29:31 A	T07	
26/7/2015	8:29:32 A	T07	
26/7/2015	8:29:33 A	T07	
26/7/2015	12:22:10 P	T06	
26/7/2015	12:22:12 P	T06	
26/7/2015	12:22:13 P	T06	
26/7/2015	12:22:14 P	T06	
26/7/2015	12:22:15 P	T06	
26/7/2015	12:40:55 P	T06	
26/7/2015	12:40:57 P	T06	
26/7/2015	12:40:58 P	T06	
26/7/2015	12:40:59 P	T06	
26/7/2015	12:41:00 P	T06	
26/7/2015	1:30:16 P	T06	
26/7/2015	1:30:17 P	T06	
26/7/2015	1:30:19 P	T06	
26/7/2015	1:30:20 P	T06	
26/7/2015	1:30:21 P	T06	
26/7/2015	3:26:46 P	T06	
26/7/2015	3:26:48 P	T06	
26/7/2015	3:26:49 P	T06	
26/7/2015	3:26:50 P	T06	
26/7/2015	3:26:51 P	T06	
26/7/2015	4:06:29 P	T06	
26/7/2015	4:06:30 P	T06	
26/7/2015	4:06:31 P	T06	
26/7/2015	4:06:32 P	T06	
26/7/2015	4:06:33 P	T06	
27/7/2015	3:01:26 P	T06	
27/7/2015	3:01:27 P	T06	
27/7/2015	3:01:28 P	T06	
27/7/2015	3:01:29 P	T06	
27/7/2015	3:01:30 P	T06	
27/7/2015	3:02:38 P	T06	

Date	Time	Camera 1	Camera 2
27/7/2015	3:02:39 P	T06	
27/7/2015	3:02:40 P	T06	
27/7/2015	3:02:41 P	T06	
27/7/2015	3:02:42 P	T06	
27/7/2015	3:58:20 P	T06	
27/7/2015	3:58:22 P	T06	
27/7/2015	3:58:23 P	T06	
27/7/2015	3:58:24 P	T06	
27/7/2015	3:58:25 P	T06	
28/7/2015	6:30:54 P	T06	
28/7/2015	6:30:56 P	T06	
28/7/2015	6:30:57 P	T06	
28/7/2015	6:30:58 P	T06	
28/7/2015	6:30:59 P	T06	
29/7/2015	3:02:28 P	T06	
29/7/2015	3:02:29 P	T06	
29/7/2015	3:02:31 P	T06	
29/7/2015	3:02:32 P	T06	
29/7/2015	3:02:33 P	T06	
30/7/2015	9:46:52 A	T06	
30/7/2015	9:46:53 A	T06	
30/7/2015	9:46:55 A	T06	
30/7/2015	9:46:56 A	T06	
30/7/2015	9:46:57 A	T06	
30/7/2015	3:28:41 P	T06	
30/7/2015	3:28:42 P	T06	
30/7/2015	3:28:43 P	T06	
30/7/2015	3:28:44 P	T06	
30/7/2015	3:28:45 P	T06	
31/7/2015	9:01:59 A	T06	
31/7/2015	9:02:00 A	T06	
31/7/2015	9:02:01 A	T06	
31/7/2015	9:02:02 A	T06	
31/7/2015	9:02:03 A	T06	
1/8/2015	3:14:36 P	T06	
1/8/2015	3:14:37 P	T06	
1/8/2015	3:14:38 P	T06	
1/8/2015	3:14:39 P	T06	
1/8/2015	3:14:40 P	T06	

Date	Time	Camera 1	Camera 2
2/8/2015	6:09:15 A	T06	
2/8/2015	6:09:16 A	T06	
2/8/2015	6:09:17 A	T06	
2/8/2015	6:09:18 A	T06	
2/8/2015	6:09:19 A	T06	
2/8/2015	11:00:06 A	T06	
2/8/2015	11:00:08 A	T06	
2/8/2015	11:00:09 A	T06	
2/8/2015	11:00:10 A	T06	
2/8/2015	11:00:11 A	T06	
2/8/2015	3:29:41 P	T06	
2/8/2015	3:29:42 P	T06	
2/8/2015	3:29:43 P	T06	
2/8/2015	3:29:44 P	T06	
2/8/2015	3:29:45 P	T06	
2/8/2015	4:32:19 P	T06	
2/8/2015	4:32:20 P	T06	
2/8/2015	4:32:21 P	T06	
2/8/2015	4:32:22 P	T06	
2/8/2015	4:32:23 P	T06	
2/8/2015	4:55:26 P	T06	
2/8/2015	4:55:27 P	T06	
2/8/2015	4:55:28 P	T06	
2/8/2015	4:55:29 P	T06	
2/8/2015	4:55:30 P	T06	
5/8/2015	2:16:40 P	T01	
5/8/2015	2:16:41 P	T01	
5/8/2015	2:16:42 P	T01	
5/8/2015	2:16:43 P	T01	
5/8/2015	2:16:44 P	T01	
5/8/2015	2:30:19 P	T01	
5/8/2015	2:30:20 P	T01	
5/8/2015	2:30:21 P	T01	
5/8/2015	2:30:22 P	T01	
5/8/2015	2:30:23 P	T01	
6/8/2015	2:55:08 P	T01	
6/8/2015	2:55:09 P	T01	
6/8/2015	2:55:10 P	T01	
6/8/2015	2:55:11 P	T01	

Date	Time	Camera 1	Camera 2
6/8/2015	2:55:12 P	T01	
6/8/2015	3:05:42 P	T01	
6/8/2015	3:05:43 P	T01	
6/8/2015	3:05:44 P	T01	
6/8/2015	3:05:45 P	T01	
6/8/2015	3:05:46 P	T01	
8/8/2015	10:40:24 A	T09	
8/8/2015	10:40:25 A	T09	
8/8/2015	10:40:26 A	T09	
8/8/2015	10:40:27 A	T09	
8/8/2015	10:40:28 A	T09	
8/8/2015	11:23:53 A	T07	
8/8/2015	11:23:55 A	T07	
8/8/2015	11:23:56 A	T07	
8/8/2015	11:23:57 A	T07	
8/8/2015	11:23:58 A	T07	
8/8/2015	11:27:14 A	T07	
8/8/2015	11:27:15 A	T07	
8/8/2015	11:27:16 A	T07	
8/8/2015	11:27:17 A	T07	
8/8/2015	11:27:18 A	T07	
10/8/2015	4:03:51 P	T06	
10/8/2015	4:03:53 P	T06	
10/8/2015	4:03:55 P	T06	
10/8/2015	4:03:56 P	T06	
10/8/2015	4:03:57 P	T06	
18/8/2015	10:27:59 A	T06	
18/8/2015	10:28:00 A	T06	
18/8/2015	10:28:02 A	T06	
18/8/2015	10:28:03 A	T06	
18/8/2015	10:28:04 A	T06	
18/8/2015	1:34:34 P	T06	
18/8/2015	1:34:36 P	T06	
18/8/2015	1:34:37 P	T06	
18/8/2015	1:34:38 P	T06	
18/8/2015	1:34:39 P	T06	
24/8/2015	11:40:24 A	T06	
24/8/2015	11:40:25 A	T06	
24/8/2015	11:40:26 A	T06	

Date	Time	Camera 1	Camera 2
24/8/2015	11:40:27 A	T06	
24/8/2015	11:40:28 A	T06	

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13/6/2015	11:15:46 A	T07	
13/6/2015	11:15:47 A	T07	
13/6/2015	11:15:48 A	T07	
13/6/2015	11:15:49 A	T07	
13/6/2015	11:15:50 A	T07	
19/6/2015	1:09:52 P	T07	
19/6/2015	1:09:53 P	T07	
19/6/2015	1:09:54 P	T07	
19/6/2015	1:09:55 P	T07	
19/6/2015	1:09:56 P	T07	
20/6/2015	9:53:44 A	T09	
20/6/2015	9:53:45 A	T09	
20/6/2015	9:53:47 A	T09	
20/6/2015	9:53:48 A	T09	
20/6/2015	9:53:49 A	T09	
20/6/2015	9:54:08 A	T09	
20/6/2015	9:54:09 A	T09	
20/6/2015	9:54:10 A	T09	
20/6/2015	9:54:11 A	T09	
20/6/2015	9:54:12 A	T09	
20/6/2015	9:54:48 A	T09	
20/6/2015	9:54:49 A	T09	
20/6/2015	9:54:50 A	T09	
20/6/2015	9:54:51 A	T09	
20/6/2015	9:54:52 A	T09	
20/6/2015	1:50:34 P	T07	
20/6/2015	1:50:35 P	T07	
20/6/2015	1:50:36 P	T07	
20/6/2015	1:50:37 P	T07	
20/6/2015	1:50:38 P	T07	
20/6/2015	1:55:41 P	T07	
20/6/2015	1:55:42 P	T07	
20/6/2015	1:55:43 P	T07	
20/6/2015	1:55:44 P	T07	

Date	Time	Camera 1	Camera 2
20/6/2015	1:55:45 P	T07	
20/6/2015	2:00:37 P	T07	
20/6/2015	2:00:38 P	T07	
20/6/2015	2:00:39 P	T07	
20/6/2015	2:00:40 P	T07	
20/6/2015	2:00:41 P	T07	
20/6/2015	2:09:06 P	T07	
20/6/2015	2:09:07 P	T07	
20/6/2015	2:09:08 P	T07	
20/6/2015	2:09:09 P	T07	
20/6/2015	2:09:10 P	T07	
25/6/2015	2:37:08 P	T08	
25/6/2015	2:37:10 P	T08	
25/6/2015	2:37:11 P	T08	
25/6/2015	2:37:12 P	T08	
25/6/2015	2:37:13 P	T08	
25/6/2015	2:51:27 P	T08	
25/6/2015	2:51:28 P	T08	
25/6/2015	2:51:30 P	T08	
25/6/2015	2:51:31 P	T08	
25/6/2015	2:51:32 P	T08	
25/6/2015	3:01:41 P	T08	
25/6/2015	3:01:43 P	T08	
25/6/2015	3:01:44 P	T08	
25/6/2015	3:01:45 P	T08	
25/6/2015	3:01:46 P	T08	
25/6/2015	3:02:16 P	T08	
25/6/2015	3:02:18 P	T08	
25/6/2015	3:02:19 P	T08	
25/6/2015	3:02:20 P	T08	
25/6/2015	3:02:21 P	T08	
25/6/2015	3:02:36 P	T08	
25/6/2015	3:02:38 P	T08	
25/6/2015	3:02:39 P	T08	
25/6/2015	3:02:40 P	T08	
25/6/2015	3:02:41 P	T08	
25/6/2015	3:02:57 P	T08	
25/6/2015	3:02:59 P	T08	
25/6/2015	3:03:00 P	T08	

Date	Time	Camera 1	Camera 2
25/6/2015	3:03:01 P	T08	
25/6/2015	3:03:02 P	T08	
25/6/2015	3:07:37 P	T08	
25/6/2015	3:07:38 P	T08	
25/6/2015	3:07:39 P	T08	
25/6/2015	3:07:40 P	T08	
25/6/2015	3:07:41 P	T08	
25/6/2015	3:13:14 P	T08	
25/6/2015	3:13:15 P	T08	
25/6/2015	3:13:16 P	T08	
25/6/2015	3:13:18 P	T08	
25/6/2015	3:13:19 P	T08	
25/6/2015	3:14:27 P	T08	
25/6/2015	3:14:28 P	T08	
25/6/2015	3:14:29 P	T08	
25/6/2015	3:14:30 P	T08	
25/6/2015	3:14:31 P	T08	
30/6/2015	10:27:08 A	T08	
30/6/2015	10:27:10 A	T08	
30/6/2015	10:27:11 A	T08	
30/6/2015	10:27:12 A	T08	
30/6/2015	10:27:13 A	T08	
30/6/2015	11:07:24 A	T08	
30/6/2015	11:07:25 A	T08	
30/6/2015	11:07:26 A	T08	
30/6/2015	11:07:27 A	T08	
30/6/2015	11:07:28 A	T08	
30/6/2015	11:07:46 A	T08	
30/6/2015	11:07:47 A	T08	
30/6/2015	11:07:48 A	T08	
30/6/2015	11:07:49 A	T08	
30/6/2015	11:07:50 A	T08	
30/6/2015	11:08:18 A	T08	
30/6/2015	11:08:20 A	T08	
30/6/2015	11:08:21 A	T08	
30/6/2015	11:08:22 A	T08	
30/6/2015	11:08:23 A	T08	
30/6/2015	11:09:02 A	T08	
30/6/2015	11:09:03 A	T08	

Date	Time	Camera 1	Camera 2
30/6/2015	11:09:04 A	T08	
30/6/2015	11:09:05 A	T08	
30/6/2015	11:09:06 A	T08	
5/7/2015	12:32:06 P	T09	
5/7/2015	12:32:07 P	T09	
5/7/2015	12:32:08 P	T09	
5/7/2015	12:32:09 P	T09	
5/7/2015	12:32:10 P	T09	
7/7/2015	11:36:11 A	T07	
7/7/2015	11:36:12 A	T07	
7/7/2015	11:36:13 A	T07	
7/7/2015	11:36:14 A	T07	
7/7/2015	11:36:15 A	T07	
7/7/2015	11:36:35 A	T07	
7/7/2015	11:36:36 A	T07	
7/7/2015	11:36:37 A	T07	
7/7/2015	11:36:38 A	T07	
7/7/2015	11:36:39 A	T07	
7/7/2015	11:37:04 A	T07	
7/7/2015	11:37:05 A	T07	
7/7/2015	11:37:06 A	T07	
7/7/2015	11:37:07 A	T07	
7/7/2015	11:37:08 A	T07	
7/7/2015	11:37:53 A	T07	
7/7/2015	11:37:54 A	T07	
7/7/2015	11:37:55 A	T07	
7/7/2015	11:37:56 A	T07	
7/7/2015	11:37:57 A	T07	
7/7/2015	11:38:14 A	T07	
7/7/2015	11:38:15 A	T07	
7/7/2015	11:38:16 A	T07	
7/7/2015	11:38:17 A	T07	
7/7/2015	11:38:18 A	T07	
7/7/2015	11:56:28 A	T07	
7/7/2015	11:56:29 A	T07	
7/7/2015	11:56:30 A	T07	
7/7/2015	11:56:31 A	T07	
7/7/2015	11:56:32 A	T07	
7/7/2015	11:57:00 A	T07	

Date	Time	Camera 1	Camera 2
7/7/2015	11:57:01 A	T07	
7/7/2015	11:57:02 A	T07	
7/7/2015	11:57:03 A	T07	
7/7/2015	11:57:04 A	T07	
7/7/2015	12:00:13 P	T07	
7/7/2015	12:00:14 P	T07	
7/7/2015	12:00:15 P	T07	
7/7/2015	12:00:16 P	T07	
7/7/2015	12:00:17 P	T07	
7/7/2015	12:01:18 P	T07	
7/7/2015	12:01:19 P	T07	
7/7/2015	12:01:20 P	T07	
7/7/2015	12:01:21 P	T07	
7/7/2015	12:01:22 P	T07	
7/7/2015	12:02:23 P	T07	
7/7/2015	12:02:24 P	T07	
7/7/2015	12:02:25 P	T07	
7/7/2015	12:02:26 P	T07	
7/7/2015	12:02:27 P	T07	
7/7/2015	12:29:20 P	T09	
7/7/2015	12:29:21 P	T09	
7/7/2015	12:29:22 P	T09	
7/7/2015	12:29:23 P	T09	
7/7/2015	12:29:24 P	T09	
8/7/2015	1:40:43 P	T08	
8/7/2015	1:40:44 P	T08	
8/7/2015	1:40:45 P	T08	
8/7/2015	1:40:46 P	T08	
8/7/2015	1:40:47 P	T08	
13/7/2015	2:55:27 P	T09	
13/7/2015	2:55:28 P	T09	
13/7/2015	2:55:29 P	T09	
13/7/2015	2:55:30 P	T09	
13/7/2015	2:55:31 P	T09	
13/7/2015	3:17:18 P	T08	
13/7/2015	3:17:19 P	T08	
13/7/2015	3:17:20 P	T08	
13/7/2015	3:17:21 P	T08	
13/7/2015	3:17:22 P	T08	

Date	Time	Camera 1	Camera 2
13/7/2015	3:17:59 P	T08	
13/7/2015	3:18:01 P	T08	
13/7/2015	3:18:02 P	T08	
13/7/2015	3:18:03 P	T08	
13/7/2015	3:18:04 P	T08	
13/7/2015	3:22:40 P	T08	
13/7/2015	3:22:42 P	T08	
13/7/2015	3:22:43 P	T08	
13/7/2015	3:22:44 P	T08	
13/7/2015	3:22:45 P	T08	
13/7/2015	3:26:10 P	T08	
13/7/2015	3:26:11 P	T08	
13/7/2015	3:26:12 P	T08	
13/7/2015	3:26:13 P	T08	
13/7/2015	3:26:14 P	T08	
13/7/2015	3:31:36 P	T08	
13/7/2015	3:31:37 P	T08	
13/7/2015	3:31:38 P	T08	
13/7/2015	3:31:39 P	T08	
13/7/2015	3:31:40 P	T08	
13/7/2015	3:32:43 P	T08	
13/7/2015	3:32:44 P	T08	
13/7/2015	3:32:45 P	T08	
13/7/2015	3:32:46 P	T08	
13/7/2015	3:32:47 P	T08	
16/7/2015	1:31:08 P	T07	
16/7/2015	1:31:10 P	T07	
16/7/2015	1:31:11 P	T07	
16/7/2015	1:31:12 P	T07	
16/7/2015	1:31:13 P	T07	
20/7/2015	12:26:13 P	T08	
20/7/2015	12:26:14 P	T08	
20/7/2015	12:26:15 P	T08	
20/7/2015	12:26:16 P	T08	
20/7/2015	12:26:17 P	T08	
20/7/2015	1:02:54 P	T08	
20/7/2015	1:02:55 P	T08	
20/7/2015	1:02:56 P	T08	
20/7/2015	1:02:57 P	T08	

Date	Time	Camera 1	Camera 2
20/7/2015	1:02:58 P	T08	
20/7/2015	2:10:54 P	T09	
20/7/2015	2:10:55 P	T09	
20/7/2015	2:10:56 P	T09	
20/7/2015	2:10:57 P	T09	
20/7/2015	2:10:58 P	T09	
20/7/2015	2:11:24 P	T09	
20/7/2015	2:11:25 P	T09	
20/7/2015	2:11:26 P	T09	
20/7/2015	2:11:27 P	T09	
20/7/2015	2:11:28 P	T09	
20/7/2015	2:17:03 P	T09	
20/7/2015	2:17:04 P	T09	
20/7/2015	2:17:05 P	T09	
20/7/2015	2:17:06 P	T09	
20/7/2015	2:17:07 P	T09	
20/7/2015	2:31:00 P	T09	
20/7/2015	2:31:01 P	T09	
20/7/2015	2:31:02 P	T09	
20/7/2015	2:31:03 P	T09	
20/7/2015	2:31:04 P	T09	
20/7/2015	2:37:48 P	T09	
20/7/2015	2:37:49 P	T09	
20/7/2015	2:37:50 P	T09	
20/7/2015	2:37:51 P	T09	
20/7/2015	2:37:52 P	T09	
20/7/2015	2:45:31 P	T09	
20/7/2015	2:45:32 P	T09	
20/7/2015	2:45:33 P	T09	
20/7/2015	2:45:34 P	T09	
20/7/2015	2:45:35 P	T09	
20/7/2015	2:46:00 P	T09	
20/7/2015	2:46:01 P	T09	
20/7/2015	2:46:02 P	T09	
20/7/2015	2:46:03 P	T09	
20/7/2015	2:46:04 P	T09	
20/7/2015	2:51:22 P	T09	
20/7/2015	2:51:24 P	T09	
20/7/2015	2:51:25 P	T09	

Date	Time	Camera 1	Camera 2
20/7/2015	2:51:26 P	T09	
20/7/2015	2:51:27 P	T09	
20/7/2015	2:52:07 P	T09	
20/7/2015	2:52:08 P	T09	
20/7/2015	2:52:09 P	T09	
20/7/2015	2:52:10 P	T09	
20/7/2015	2:52:11 P	T09	
20/7/2015	2:54:53 P	T09	
20/7/2015	2:54:54 P	T09	
20/7/2015	2:54:55 P	T09	
20/7/2015	2:54:56 P	T09	
20/7/2015	2:54:57 P	T09	
20/7/2015	2:55:15 P	T09	
20/7/2015	2:55:16 P	T09	
20/7/2015	2:55:17 P	T09	
20/7/2015	2:55:18 P	T09	
20/7/2015	2:55:19 P	T09	
20/7/2015	2:56:03 P	T09	
20/7/2015	2:56:04 P	T09	
20/7/2015	2:56:05 P	T09	
20/7/2015	2:56:06 P	T09	
20/7/2015	2:56:07 P	T09	
20/7/2015	2:56:28 P	T09	
20/7/2015	2:56:29 P	T09	
20/7/2015	2:56:30 P	T09	
20/7/2015	2:56:31 P	T09	
20/7/2015	2:56:32 P	T09	
26/7/2015	11:43:15 A	T09	
26/7/2015	11:43:17 A	T09	
26/7/2015	11:43:18 A	T09	
26/7/2015	11:43:19 A	T09	
26/7/2015	11:43:20 A	T09	
26/7/2015	11:44:41 A	T09	
26/7/2015	11:44:42 A	T09	
26/7/2015	11:44:43 A	T09	
26/7/2015	11:44:44 A	T09	
26/7/2015	11:44:45 A	T09	
26/7/2015	11:48:14 A	T09	
26/7/2015	11:48:15 A	T09	

Date	Time	Camera 1	Camera 2
26/7/2015	11:48:16 A	T09	
26/7/2015	11:48:17 A	T09	
26/7/2015	11:48:18 A	T09	
30/7/2015	1:35:20 P	T07	
30/7/2015	1:35:21 P	T07	
30/7/2015	1:35:22 P	T07	
30/7/2015	1:35:23 P	T07	
30/7/2015	1:35:24 P	T07	
1/8/2015	2:28:54 P	T07	
1/8/2015	2:28:55 P	T07	
1/8/2015	2:28:56 P	T07	
1/8/2015	2:28:57 P	T07	
1/8/2015	2:28:58 P	T07	
1/8/2015	2:30:09 P	T07	
1/8/2015	2:30:10 P	T07	
1/8/2015	2:30:11 P	T07	
1/8/2015	2:30:12 P	T07	
1/8/2015	2:30:13 P	T07	
1/8/2015	3:47:59 P	T02	
1/8/2015	3:48:01 P	T02	
1/8/2015	3:48:02 P	T02	
1/8/2015	3:48:03 P	T02	
1/8/2015	3:48:04 P	T02	
6/8/2015	11:25:52 A	T07	
6/8/2015	11:25:53 A	T07	
6/8/2015	11:25:54 A	T07	
6/8/2015	11:25:55 A	T07	
6/8/2015	11:25:56 A	T07	
10/8/2015	5:11:29 P	T02	
10/8/2015	5:11:31 P	T02	
10/8/2015	5:11:32 P	T02	
10/8/2015	5:11:33 P	T02	
10/8/2015	5:11:34 P	T02	
10/8/2015	5:11:51 P	T02	
10/8/2015	5:11:52 P	T02	
10/8/2015	5:11:54 P	T02	
10/8/2015	5:11:55 P	T02	
10/8/2015	5:11:56 P	T02	
10/8/2015	5:19:27 P	T02	

Date	Time	Camera 1	Camera 2
10/8/2015	5:19:28 P	T02	
10/8/2015	5:19:29 P	T02	
10/8/2015	5:19:30 P	T02	
10/8/2015	5:19:31 P	T02	
10/8/2015	5:19:46 P	T02	
10/8/2015	5:19:47 P	T02	
10/8/2015	5:19:48 P	T02	
10/8/2015	5:19:49 P	T02	
10/8/2015	5:19:50 P	T02	
11/8/2015	3:19:49 P	T07	
11/8/2015	3:19:50 P	T07	
11/8/2015	3:19:51 P	T07	
11/8/2015	3:19:52 P	T07	
11/8/2015	3:19:53 P	T07	
13/8/2015	1:19:25 P	T07	
13/8/2015	1:19:26 P	T07	
13/8/2015	1:19:27 P	T07	
13/8/2015	1:19:28 P	T07	
13/8/2015	1:19:29 P	T07	
13/8/2015	1:47:38 P	T07	
13/8/2015	1:47:39 P	T07	
13/8/2015	1:47:40 P	T07	
13/8/2015	1:47:41 P	T07	
13/8/2015	1:47:42 P	T07	
13/8/2015	1:48:12 P	T07	
13/8/2015	1:48:13 P	T07	
13/8/2015	1:48:14 P	T07	
13/8/2015	1:48:15 P	T07	
13/8/2015	1:48:16 P	T07	
13/8/2015	1:50:11 P	T07	
13/8/2015	1:50:12 P	T07	
13/8/2015	1:50:13 P	T07	
13/8/2015	1:50:14 P	T07	
13/8/2015	1:50:15 P	T07	
13/8/2015	1:58:14 P	T07	
13/8/2015	1:58:15 P	T07	
13/8/2015	1:58:16 P	T07	
13/8/2015	1:58:17 P	T07	
13/8/2015	1:58:18 P	T07	

Date	Time	Camera 1	Camera 2
13/8/2015	2:01:24 P	T07	
13/8/2015	2:01:25 P	T07	
13/8/2015	2:01:26 P	T07	
13/8/2015	2:01:27 P	T07	
13/8/2015	2:01:28 P	T07	
13/8/2015	2:03:40 P	T07	
13/8/2015	2:03:41 P	T07	
13/8/2015	2:03:42 P	T07	
13/8/2015	2:03:43 P	T07	
13/8/2015	2:03:44 P	T07	
13/8/2015	2:06:05 P	T07	
13/8/2015	2:06:06 P	T07	
13/8/2015	2:06:07 P	T07	
13/8/2015	2:06:08 P	T07	
13/8/2015	2:06:09 P	T07	
13/8/2015	2:06:24 P	T07	
13/8/2015	2:06:26 P	T07	
13/8/2015	2:06:27 P	T07	
13/8/2015	2:06:28 P	T07	
13/8/2015	2:06:29 P	T07	
13/8/2015	3:38:29 P	T06	
13/8/2015	3:38:31 P	T06	
13/8/2015	3:38:32 P	T06	
13/8/2015	3:38:33 P	T06	
13/8/2015	3:38:34 P	T06	
13/8/2015	4:10:47 P	T07	
13/8/2015	4:10:48 P	T07	
13/8/2015	4:10:49 P	T07	
13/8/2015	4:10:50 P	T07	
13/8/2015	4:10:51 P	T07	
13/8/2015	4:13:31 P	T07	
13/8/2015	4:13:32 P	T07	
13/8/2015	4:13:33 P	T07	
13/8/2015	4:13:34 P	T07	
13/8/2015	4:13:35 P	T07	
15/8/2015	4:28:05 P	T07	
15/8/2015	4:28:06 P	T07	
15/8/2015	4:28:07 P	T07	
15/8/2015	4:28:08 P	T07	

Date	Time	Camera 1	Camera 2
15/8/2015	4:28:09 P	T07	
15/8/2015	4:28:56 P	T07	
15/8/2015	4:28:57 P	T07	
15/8/2015	4:28:58 P	T07	
15/8/2015	4:28:59 P	T07	
15/8/2015	4:29:00 P	T07	
16/8/2015	2:48:07 P	T08	
16/8/2015	2:48:08 P	T08	
16/8/2015	2:48:09 P	T08	
16/8/2015	2:48:10 P	T08	
16/8/2015	2:48:11 P	T08	
16/8/2015	2:56:45 P	T08	
16/8/2015	2:56:46 P	T08	
16/8/2015	2:56:47 P	T08	
16/8/2015	2:56:48 P	T08	
16/8/2015	2:56:49 P	T08	
16/8/2015	2:57:08 P	T08	
16/8/2015	2:57:09 P	T08	
16/8/2015	2:57:10 P	T08	
16/8/2015	2:57:11 P	T08	
16/8/2015	2:57:12 P	T08	
16/8/2015	3:44:18 P	T07	
16/8/2015	3:44:19 P	T07	
16/8/2015	3:44:20 P	T07	
16/8/2015	3:44:21 P	T07	
16/8/2015	3:44:22 P	T07	
16/8/2015	3:46:17 P	T07	
16/8/2015	3:46:18 P	T07	
16/8/2015	3:46:19 P	T07	
16/8/2015	3:46:20 P	T07	
16/8/2015	3:46:21 P	T07	
16/8/2015	3:49:31 P	T07	
16/8/2015	3:49:32 P	T07	
16/8/2015	3:49:33 P	T07	
16/8/2015	3:49:34 P	T07	
16/8/2015	3:49:35 P	T07	
16/8/2015	4:51:40 P	T07	
16/8/2015	4:51:43 P	T07	
16/8/2015	4:51:44 P	T07	

Date	Time	Camera 1	Camera 2
16/8/2015	4:51:45 P	T07	
16/8/2015	4:51:46 P	T07	
16/8/2015	4:55:25 P	T07	
16/8/2015	4:55:26 P	T07	
16/8/2015	4:55:27 P	T07	
16/8/2015	4:55:28 P	T07	
16/8/2015	4:55:29 P	T07	
19/8/2015	12:35:53 P	T03	
19/8/2015	12:35:54 P	T03	
19/8/2015	12:35:55 P	T03	
19/8/2015	12:35:56 P	T03	
19/8/2015	12:35:57 P	T03	
19/8/2015	12:36:14 P	T03	
19/8/2015	12:36:16 P	T03	
19/8/2015	12:36:18 P	T03	
19/8/2015	12:36:19 P	T03	
19/8/2015	12:36:20 P	T03	
19/8/2015	12:37:03 P	T03	
19/8/2015	12:37:05 P	T03	
19/8/2015	12:37:06 P	T03	
19/8/2015	12:37:07 P	T03	
19/8/2015	12:37:08 P	T03	
25/8/2015	9:40:22 A	T06	
25/8/2015	9:40:23 A	T06	
25/8/2015	9:40:24 A	T06	
25/8/2015	9:40:25 A	T06	
25/8/2015	9:40:26 A	T06	
25/8/2015	9:40:46 A	T06	
25/8/2015	9:40:47 A	T06	
25/8/2015	9:40:48 A	T06	
25/8/2015	9:40:49 A	T06	
25/8/2015	9:40:50 A	T06	
25/8/2015	9:41:05 A	T06	
25/8/2015	9:41:06 A	T06	
25/8/2015	9:41:07 A	T06	
25/8/2015	9:41:08 A	T06	
25/8/2015	9:41:09 A	T06	
25/8/2015	9:42:47 A	T06	
25/8/2015	9:42:48 A	T06	

Date	Time	Camera 1	Camera 2
25/8/2015	9:42:49 A	T06	
25/8/2015	9:42:50 A	T06	
25/8/2015	9:42:51 A	T06	
25/8/2015	9:43:14 A	T06	
25/8/2015	9:43:15 A	T06	
25/8/2015	9:43:16 A	T06	
25/8/2015	9:43:17 A	T06	
25/8/2015	9:43:18 A	T06	
25/8/2015	9:46:23 A	T06	
25/8/2015	9:46:25 A	T06	
25/8/2015	9:46:26 A	T06	
25/8/2015	9:46:27 A	T06	
25/8/2015	9:46:28 A	T06	
25/8/2015	9:47:26 A	T06	
25/8/2015	9:47:27 A	T06	
25/8/2015	9:47:28 A	T06	
25/8/2015	9:47:29 A	T06	
25/8/2015	9:47:30 A	T06	
25/8/2015	9:48:47 A	T06	
25/8/2015	9:48:48 A	T06	
25/8/2015	9:48:49 A	T06	
25/8/2015	9:48:50 A	T06	
25/8/2015	9:48:51 A	T06	
25/8/2015	9:49:10 A	T06	
25/8/2015	9:49:13 A	T06	
25/8/2015	9:49:14 A	T06	
25/8/2015	9:49:16 A	T06	
25/8/2015	9:49:17 A	T06	
25/8/2015	9:51:14 A	T06	
25/8/2015	9:51:15 A	T06	
25/8/2015	9:51:16 A	T06	
25/8/2015	9:51:17 A	T06	
25/8/2015	9:51:18 A	T06	
25/8/2015	9:51:42 A	T06	
25/8/2015	9:51:43 A	T06	
25/8/2015	9:51:44 A	T06	
25/8/2015	9:51:45 A	T06	
25/8/2015	9:51:46 A	T06	
25/8/2015	9:53:36 A	T06	

Date	Time	Camera 1	Camera 2
25/8/2015	9:53:37 A	T06	
25/8/2015	9:53:38 A	T06	
25/8/2015	9:53:39 A	T06	
25/8/2015	9:53:40 A	T06	
25/8/2015	9:54:05 A	T06	
25/8/2015	9:54:07 A	T06	
25/8/2015	9:54:08 A	T06	
25/8/2015	9:54:09 A	T06	
25/8/2015	9:54:10 A	T06	
25/8/2015	9:54:30 A	T06	
25/8/2015	9:54:31 A	T06	
25/8/2015	9:54:32 A	T06	
25/8/2015	9:54:33 A	T06	
25/8/2015	9:54:34 A	T06	
25/8/2015	9:55:28 A	T06	
25/8/2015	9:55:29 A	T06	
25/8/2015	9:55:30 A	T06	
25/8/2015	9:55:31 A	T06	
25/8/2015	9:55:32 A	T06	
25/8/2015	9:55:58 A	T06	
25/8/2015	9:56:00 A	T06	
25/8/2015	9:56:01 A	T06	
25/8/2015	9:56:02 A	T06	
25/8/2015	9:56:03 A	T06	
25/8/2015	9:56:19 A	T06	
25/8/2015	9:56:21 A	T06	
25/8/2015	9:56:22 A	T06	
25/8/2015	9:56:23 A	T06	
25/8/2015	9:56:24 A	T06	
25/8/2015	9:57:31 A	T06	
25/8/2015	9:57:32 A	T06	
25/8/2015	9:57:33 A	T06	
25/8/2015	9:57:34 A	T06	
25/8/2015	9:57:35 A	T06	
25/8/2015	9:58:47 A	T06	
25/8/2015	9:58:48 A	T06	
25/8/2015	9:58:49 A	T06	
25/8/2015	9:58:50 A	T06	
25/8/2015	9:58:51 A	T06	

Date	Time	Camera 1	Camera 2
25/8/2015	9:59:30 A	T06	
25/8/2015	9:59:31 A	T06	
25/8/2015	9:59:32 A	T06	
25/8/2015	9:59:33 A	T06	
25/8/2015	9:59:34 A	T06	
25/8/2015	10:00:03 A	T06	
25/8/2015	10:00:04 A	T06	
25/8/2015	10:00:05 A	T06	
25/8/2015	10:00:06 A	T06	
25/8/2015	10:00:07 A	T06	
25/8/2015	10:00:22 A	T06	
25/8/2015	10:00:23 A	T06	
25/8/2015	10:00:25 A	T06	
25/8/2015	10:00:26 A	T06	
25/8/2015	10:00:27 A	T06	
25/8/2015	10:02:42 A	T06	
25/8/2015	10:02:43 A	T06	
25/8/2015	10:02:44 A	T06	
25/8/2015	10:02:45 A	T06	
25/8/2015	10:02:46 A	T06	
25/8/2015	10:03:06 A	T06	
25/8/2015	10:03:07 A	T06	
25/8/2015	10:03:08 A	T06	
25/8/2015	10:03:09 A	T06	
25/8/2015	10:03:10 A	T06	
25/8/2015	10:03:29 A	T06	
25/8/2015	10:03:30 A	T06	
25/8/2015	10:03:31 A	T06	
25/8/2015	10:03:32 A	T06	
25/8/2015	10:03:33 A	T06	
25/8/2015	10:03:50 A	T06	
25/8/2015	10:03:51 A	T06	
25/8/2015	10:03:53 A	T06	
25/8/2015	10:03:54 A	T06	
25/8/2015	10:03:55 A	T06	
25/8/2015	10:14:53 A	T06	
25/8/2015	10:14:54 A	T06	
25/8/2015	10:14:55 A	T06	
25/8/2015	10:14:56 A	T06	

Date	Time	Camera 1	Camera 2
25/8/2015	10:14:57 A	T06	
25/8/2015	10:15:37 A	T06	
25/8/2015	10:15:38 A	T06	
25/8/2015	10:15:39 A	T06	
25/8/2015	10:15:40 A	T06	
25/8/2015	10:15:41 A	T06	
25/8/2015	10:23:16 A	T06	
25/8/2015	10:23:17 A	T06	
25/8/2015	10:23:18 A	T06	
25/8/2015	10:23:19 A	T06	
25/8/2015	10:23:20 A	T06	
25/8/2015	10:23:40 A	T06	
25/8/2015	10:23:41 A	T06	
25/8/2015	10:23:42 A	T06	
25/8/2015	10:23:43 A	T06	
25/8/2015	10:23:44 A	T06	
25/8/2015	10:24:05 A	T06	
25/8/2015	10:24:06 A	T06	
25/8/2015	10:24:07 A	T06	
25/8/2015	10:24:08 A	T06	
25/8/2015	10:24:09 A	T06	
25/8/2015	10:24:24 A	T06	
25/8/2015	10:24:26 A	T06	
25/8/2015	10:24:27 A	T06	
25/8/2015	10:24:28 A	T06	
25/8/2015	10:24:29 A	T06	
25/8/2015	10:48:10 A	T06	
25/8/2015	10:48:11 A	T06	
25/8/2015	10:48:12 A	T06	
25/8/2015	10:48:13 A	T06	
25/8/2015	10:48:14 A	T06	
25/8/2015	10:54:15 A	T06	
25/8/2015	10:54:16 A	T06	
25/8/2015	10:54:18 A	T06	
25/8/2015	10:54:19 A	T06	
25/8/2015	10:54:20 A	T06	
25/8/2015	11:32:48 A	T06	
25/8/2015	11:32:50 A	T06	
25/8/2015	11:32:51 A	T06	

Date	Time	Camera 1	Camera 2
25/8/2015	11:32:52 A	T06	
25/8/2015	11:32:53 A	T06	
25/8/2015	11:33:58 A	T06	
25/8/2015	11:33:59 A	T06	
25/8/2015	11:34:00 A	T06	
25/8/2015	11:34:02 A	T06	
25/8/2015	11:34:03 A	T06	
25/8/2015	11:34:18 A	T06	
25/8/2015	11:34:19 A	T06	
25/8/2015	11:34:20 A	T06	
25/8/2015	11:34:21 A	T06	
25/8/2015	11:34:22 A	T06	
25/8/2015	11:34:40 A	T06	
25/8/2015	11:34:41 A	T06	
25/8/2015	11:34:42 A	T06	
25/8/2015	11:34:43 A	T06	
25/8/2015	11:34:44 A	T06	
25/8/2015	11:35:09 A	T06	
25/8/2015	11:35:10 A	T06	
25/8/2015	11:35:11 A	T06	
25/8/2015	11:35:12 A	T06	
25/8/2015	11:35:13 A	T06	
25/8/2015	11:35:28 A	T06	
25/8/2015	11:35:29 A	T06	
25/8/2015	11:35:30 A	T06	
25/8/2015	11:35:31 A	T06	
25/8/2015	11:35:32 A	T06	
25/8/2015	11:51:40 A	T06	
25/8/2015	11:51:42 A	T06	
25/8/2015	11:51:43 A	T06	
25/8/2015	11:51:44 A	T06	
25/8/2015	11:51:45 A	T06	
25/8/2015	11:53:14 A	T06	
25/8/2015	11:53:15 A	T06	
25/8/2015	11:53:16 A	T06	
25/8/2015	11:53:17 A	T06	
25/8/2015	11:53:18 A	T06	
25/8/2015	11:56:15 A	T06	
25/8/2015	11:56:16 A	T06	

Date	Time	Camera 1	Camera 2
25/8/2015	11:56:17 A	T06	
25/8/2015	11:56:18 A	T06	
25/8/2015	11:56:19 A	T06	
25/8/2015	11:56:41 A	T06	
25/8/2015	11:56:42 A	T06	
25/8/2015	11:56:43 A	T06	
25/8/2015	11:56:44 A	T06	
25/8/2015	11:56:45 A	T06	
25/8/2015	11:59:04 A	T06	
25/8/2015	11:59:05 A	T06	
25/8/2015	11:59:06 A	T06	
25/8/2015	11:59:07 A	T06	
25/8/2015	11:59:08 A	T06	
25/8/2015	11:59:34 A	T06	
25/8/2015	11:59:35 A	T06	
25/8/2015	11:59:36 A	T06	
25/8/2015	11:59:37 A	T06	
25/8/2015	11:59:38 A	T06	
25/8/2015	11:59:56 A	T06	
25/8/2015	11:59:58 A	T06	
25/8/2015	11:59:59 A	T06	
25/8/2015	12:00:00 P	T06	
25/8/2015	12:00:01 P	T06	
28/8/2015	10:43:06 A	T03	
28/8/2015	10:43:08 A	T03	
28/8/2015	10:43:09 A	T03	
28/8/2015	10:43:10 A	T03	
28/8/2015	10:43:11 A	T03	
28/8/2015	10:43:28 A	T03	
28/8/2015	10:43:29 A	T03	
28/8/2015	10:43:30 A	T03	
28/8/2015	10:43:31 A	T03	
28/8/2015	10:43:32 A	T03	
28/8/2015	10:43:52 A	T03	
28/8/2015	10:43:53 A	T03	
28/8/2015	10:43:54 A	T03	
28/8/2015	10:43:55 A	T03	
28/8/2015	10:43:56 A	T03	
28/8/2015	11:15:32 A	T03	

Date	Time	Camera 1	Camera 2
28/8/2015	11:15:34 A	T03	
28/8/2015	11:15:35 A	T03	
28/8/2015	11:15:36 A	T03	
28/8/2015	11:15:37 A	T03	
28/8/2015	11:15:53 A	T03	
28/8/2015	11:15:55 A	T03	
28/8/2015	11:15:56 A	T03	
28/8/2015	11:15:57 A	T03	
28/8/2015	11:15:58 A	T03	
28/8/2015	11:16:16 A	T03	
28/8/2015	11:16:19 A	T03	
28/8/2015	11:16:20 A	T03	
28/8/2015	11:16:21 A	T03	
28/8/2015	11:16:22 A	T03	
28/8/2015	11:16:44 A	T03	
28/8/2015	11:16:45 A	T03	
28/8/2015	11:16:46 A	T03	
28/8/2015	11:16:47 A	T03	
28/8/2015	11:16:48 A	T03	
28/8/2015	11:17:07 A	T03	
28/8/2015	11:17:10 A	T03	
28/8/2015	11:17:11 A	T03	
28/8/2015	11:17:12 A	T03	
28/8/2015	11:17:13 A	T03	
28/8/2015	11:17:41 A	T03	
28/8/2015	11:17:42 A	T03	
28/8/2015	11:17:43 A	T03	
28/8/2015	11:17:44 A	T03	
28/8/2015	11:17:45 A	T03	
28/8/2015	11:18:06 A	T03	
28/8/2015	11:18:07 A	T03	
28/8/2015	11:18:08 A	T03	
28/8/2015	11:18:09 A	T03	
28/8/2015	11:18:10 A	T03	
28/8/2015	11:18:45 A	T03	
28/8/2015	11:18:48 A	T03	
28/8/2015	11:18:49 A	T03	
28/8/2015	11:18:50 A	T03	
28/8/2015	11:18:51 A	T03	

Date	Time	Camera 1	Camera 2
28/8/2015	11:19:07 A	T03	
28/8/2015	11:19:09 A	T03	
28/8/2015	11:19:10 A	T03	
28/8/2015	11:19:11 A	T03	
28/8/2015	11:19:12 A	T03	
28/8/2015	11:19:28 A	T03	
28/8/2015	11:19:29 A	T03	
28/8/2015	11:19:30 A	T03	
28/8/2015	11:19:31 A	T03	
28/8/2015	11:19:32 A	T03	
28/8/2015	11:19:55 A	T03	
28/8/2015	11:19:56 A	T03	
28/8/2015	11:19:57 A	T03	
28/8/2015	11:19:58 A	T03	
28/8/2015	11:19:59 A	T03	
28/8/2015	11:20:15 A	T03	
28/8/2015	11:20:16 A	T03	
28/8/2015	11:20:17 A	T03	
28/8/2015	11:20:18 A	T03	
28/8/2015	11:20:19 A	T03	
28/8/2015	11:20:35 A	T03	
28/8/2015	11:20:36 A	T03	
28/8/2015	11:20:37 A	T03	
28/8/2015	11:20:38 A	T03	
28/8/2015	11:20:39 A	T03	
28/8/2015	11:20:58 A	T03	
28/8/2015	11:21:00 A	T03	
28/8/2015	11:21:01 A	T03	
28/8/2015	11:21:02 A	T03	
28/8/2015	11:21:03 A	T03	
28/8/2015	11:22:05 A	T03	
28/8/2015	11:22:06 A	T03	
28/8/2015	11:22:07 A	T03	
28/8/2015	11:22:08 A	T03	
28/8/2015	11:22:09 A	T03	
28/8/2015	11:22:26 A	T03	
28/8/2015	11:22:27 A	T03	
28/8/2015	11:22:28 A	T03	
28/8/2015	11:22:29 A	T03	

Date	Time	Camera 1	Camera 2
28/8/2015	11:22:30 A	T03	
28/8/2015	11:22:45 A	T03	
28/8/2015	11:22:47 A	T03	
28/8/2015	11:22:48 A	T03	
28/8/2015	11:22:49 A	T03	
28/8/2015	11:22:50 A	T03	
28/8/2015	11:23:10 A	T03	
28/8/2015	11:23:11 A	T03	
28/8/2015	11:23:12 A	T03	
28/8/2015	11:23:13 A	T03	
28/8/2015	11:23:14 A	T03	
28/8/2015	11:23:29 A	T03	
28/8/2015	11:23:31 A	T03	
28/8/2015	11:23:32 A	T03	
28/8/2015	11:23:33 A	T03	
28/8/2015	11:23:34 A	T03	
28/8/2015	11:23:52 A	T03	
28/8/2015	11:23:54 A	T03	
28/8/2015	11:23:55 A	T03	
28/8/2015	11:23:56 A	T03	
28/8/2015	11:23:57 A	T03	
28/8/2015	11:24:14 A	T03	
28/8/2015	11:24:17 A	T03	
28/8/2015	11:24:18 A	T03	
28/8/2015	11:24:19 A	T03	
28/8/2015	11:24:21 A	T03	
28/8/2015	11:24:46 A	T03	
28/8/2015	11:24:47 A	T03	
28/8/2015	11:24:49 A	T03	
28/8/2015	11:24:50 A	T03	
28/8/2015	11:24:51 A	T03	
28/8/2015	11:26:09 A	T03	
28/8/2015	11:26:11 A	T03	
28/8/2015	11:26:12 A	T03	
28/8/2015	11:26:13 A	T03	
28/8/2015	11:26:14 A	T03	
28/8/2015	11:26:44 A	T03	
28/8/2015	11:26:46 A	T03	
28/8/2015	11:26:47 A	T03	

Date	Time	Camera 1	Camera 2
28/8/2015	11:26:48 A	T03	
28/8/2015	11:26:49 A	T03	
28/8/2015	11:27:05 A	T03	
28/8/2015	11:27:07 A	T03	
28/8/2015	11:27:09 A	T03	
28/8/2015	11:27:10 A	T03	
28/8/2015	11:27:11 A	T03	
28/8/2015	11:27:30 A	T03	
28/8/2015	11:27:33 A	T03	
28/8/2015	11:27:34 A	T03	
28/8/2015	11:27:35 A	T03	
28/8/2015	11:27:36 A	T03	
28/8/2015	11:27:52 A	T03	
28/8/2015	11:27:53 A	T03	
28/8/2015	11:27:54 A	T03	
28/8/2015	11:27:56 A	T03	
28/8/2015	11:27:57 A	T03	
28/8/2015	11:28:31 A	T03	
28/8/2015	11:28:32 A	T03	
28/8/2015	11:28:33 A	T03	
28/8/2015	11:28:34 A	T03	
28/8/2015	11:28:35 A	T03	
28/8/2015	11:28:53 A	T03	
28/8/2015	11:28:54 A	T03	
28/8/2015	11:28:55 A	T03	
28/8/2015	11:28:57 A	T03	
28/8/2015	11:28:58 A	T03	
28/8/2015	11:29:14 A	T03	
28/8/2015	11:29:16 A	T03	
28/8/2015	11:29:18 A	T03	
28/8/2015	11:29:19 A	T03	
28/8/2015	11:29:20 A	T03	
28/8/2015	11:29:37 A	T03	
28/8/2015	11:29:38 A	T03	
28/8/2015	11:29:39 A	T03	
28/8/2015	11:29:40 A	T03	
28/8/2015	11:29:41 A	T03	
28/8/2015	11:30:45 A	T03	
28/8/2015	11:30:46 A	T03	

Date	Time	Camera 1	Camera 2
28/8/2015	11:30:48 A	T03	
28/8/2015	11:30:49 A	T03	
28/8/2015	11:30:50 A	T03	
28/8/2015	11:31:05 A	T03	
28/8/2015	11:31:07 A	T03	
28/8/2015	11:31:08 A	T03	
28/8/2015	11:31:09 A	T03	
28/8/2015	11:31:10 A	T03	
28/8/2015	11:31:28 A	T03	
28/8/2015	11:31:29 A	T03	
28/8/2015	11:31:30 A	T03	
28/8/2015	11:31:31 A	T03	
28/8/2015	11:31:32 A	T03	
28/8/2015	11:32:02 A	T03	
28/8/2015	11:32:03 A	T03	
28/8/2015	11:32:04 A	T03	
28/8/2015	11:32:05 A	T03	
28/8/2015	11:32:06 A	T03	
28/8/2015	11:33:56 A	T03	
28/8/2015	11:33:57 A	T03	
28/8/2015	11:33:58 A	T03	
28/8/2015	11:33:59 A	T03	
28/8/2015	11:34:00 A	T03	
28/8/2015	11:35:50 A	T03	
28/8/2015	11:35:52 A	T03	
28/8/2015	11:35:53 A	T03	
28/8/2015	11:35:54 A	T03	
28/8/2015	11:35:55 A	T03	
28/8/2015	11:36:11 A	T03	
28/8/2015	11:36:12 A	T03	
28/8/2015	11:36:14 A	T03	
28/8/2015	11:36:15 A	T03	
28/8/2015	11:36:16 A	T03	
28/8/2015	11:36:32 A	T03	
28/8/2015	11:36:33 A	T03	
28/8/2015	11:36:34 A	T03	
28/8/2015	11:36:35 A	T03	
28/8/2015	11:36:36 A	T03	
28/8/2015	11:37:09 A	T03	

Date	Time	Camera 1	Camera 2
28/8/2015	11:37:10 A	T03	
28/8/2015	11:37:11 A	T03	
28/8/2015	11:37:12 A	T03	
28/8/2015	11:37:13 A	T03	
28/8/2015	11:38:19 A	T03	
28/8/2015	11:38:20 A	T03	
28/8/2015	11:38:21 A	T03	
28/8/2015	11:38:22 A	T03	
28/8/2015	11:38:23 A	T03	
28/8/2015	11:38:40 A	T03	
28/8/2015	11:38:41 A	T03	
28/8/2015	11:38:42 A	T03	
28/8/2015	11:38:43 A	T03	
28/8/2015	11:38:44 A	T03	
28/8/2015	11:53:31 A	T03	
28/8/2015	11:53:32 A	T03	
28/8/2015	11:53:33 A	T03	
28/8/2015	11:53:34 A	T03	
28/8/2015	11:53:35 A	T03	
28/8/2015	3:18:25 P	T04	
28/8/2015	3:18:27 P	T04	
28/8/2015	3:18:28 P	T04	
28/8/2015	3:18:29 P	T04	
28/8/2015	3:18:30 P	T04	

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3/7/2015	3:14:42 A	T05	
3/7/2015	3:14:43 A	T05	
3/7/2015	3:14:44 A	T05	
3/7/2015	3:14:45 A	T05	
3/7/2015	3:14:46 A	T05	
8/7/2015	3:07:38 A	T09	
8/7/2015	3:07:39 A	T09	
8/7/2015	3:07:40 A	T09	
8/7/2015	3:07:41 A	T09	
8/7/2015	3:07:42 A	T09	
19/7/2015	4:23:17 A	T07	
19/7/2015	4:23:18 A	T07	

Date	Time	Camera 1	Camera 2
19/7/2015	4:23:19 A	T07	
19/7/2015	4:23:21 A	T07	
19/7/2015	4:23:22 A	T07	
2/8/2015	1:35:01 A	T07	
2/8/2015	1:35:02 A	T07	
2/8/2015	1:35:03 A	T07	
2/8/2015	1:35:04 A	T07	
2/8/2015	1:35:05 A	T07	
18/8/2015	4:18:13 A	T07	
18/8/2015	4:18:14 A	T07	
18/8/2015	4:18:15 A	T07	
18/8/2015	4:18:16 A	T07	
18/8/2015	4:18:17 A	T07	

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15/8/2015	1:09:24 P	T05	
15/8/2015	1:09:26 P	T05	
15/8/2015	1:09:27 P	T05	
15/8/2015	1:09:28 P	T05	
15/8/2015	1:09:29 P	T05	

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13/6/2015	4:57:51 A	T06	
13/6/2015	4:57:52 A	T06	
13/6/2015	4:57:53 A	T06	
13/6/2015	4:57:54 A	T06	
13/6/2015	4:57:55 A	T06	
13/6/2015	8:07:09 A	T06	
13/6/2015	8:07:11 A	T06	
13/6/2015	8:07:12 A	T06	
13/6/2015	8:07:13 A	T06	
13/6/2015	8:07:14 A	T06	
14/6/2015	7:59:13 A	T06	
14/6/2015	7:59:15 A	T06	
14/6/2015	7:59:16 A	T06	
14/6/2015	7:59:17 A	T06	
14/6/2015	7:59:18 A	T06	

Date	Time	Camera 1	Camera 2
15/6/2015	9:53:05 P	T07	
15/6/2015	9:53:06 P	T07	
15/6/2015	9:53:07 P	T07	
15/6/2015	9:53:08 P	T07	
15/6/2015	9:53:09 P	T07	
2/7/2015	1:48:33 A	T07	
2/7/2015	1:48:34 A	T07	
2/7/2015	1:48:35 A	T07	
2/7/2015	1:48:36 A	T07	
2/7/2015	1:48:37 A	T07	
11/7/2015	8:17:40 P	T09	
11/7/2015	8:17:41 P	T09	
11/7/2015	8:17:42 P	T09	
11/7/2015	8:17:43 P	T09	
11/7/2015	8:17:44 P	T09	
16/7/2015	3:04:22 P	T07	
16/7/2015	3:04:24 P	T07	
16/7/2015	3:04:25 P	T07	
16/7/2015	3:04:26 P	T07	
16/7/2015	3:04:27 P	T07	
1/8/2015	7:22:08 A	T07	
1/8/2015	7:22:09 A	T07	
1/8/2015	7:22:10 A	T07	
1/8/2015	7:22:11 A	T07	
1/8/2015	7:22:12 A	T07	
2/8/2015	7:11:05 P	T07	
2/8/2015	7:11:06 P	T07	
2/8/2015	7:11:07 P	T07	
2/8/2015	7:11:08 P	T07	
2/8/2015	7:11:09 P	T07	
11/8/2015	6:08:26 A	T07	
11/8/2015	6:08:27 A	T07	
11/8/2015	6:08:28 A	T07	
11/8/2015	6:08:29 A	T07	
11/8/2015	6:08:30 A	T07	
12/8/2015	7:23:30 A	T07	
12/8/2015	7:23:31 A	T07	
12/8/2015	7:23:32 A	T07	
12/8/2015	7:23:33 A	T07	

Date	Time	Camera 1	Camera 2
12/8/2015	7:23:34 A	T07	
13/8/2015	10:02:07 A	T02	
13/8/2015	10:02:09 A	T02	
13/8/2015	10:02:10 A	T02	
13/8/2015	10:02:11 A	T02	
13/8/2015	10:02:12 A	T02	
13/8/2015	4:36:47 P	T02	
13/8/2015	4:36:48 P	T02	
13/8/2015	4:36:49 P	T02	
13/8/2015	4:36:50 P	T02	
13/8/2015	4:36:51 P	T02	
15/8/2015	6:22:28 P	T07	
15/8/2015	6:22:30 P	T07	
15/8/2015	6:22:31 P	T07	
15/8/2015	6:22:32 P	T07	
15/8/2015	6:22:33 P	T07	
17/8/2015	5:48:42 A	T07	
17/8/2015	5:48:43 A	T07	
17/8/2015	5:48:44 A	T07	
17/8/2015	5:48:45 A	T07	
17/8/2015	5:48:46 A	T07	
18/8/2015	12:11:07 A	T07	
18/8/2015	12:11:08 A	T07	
18/8/2015	12:11:09 A	T07	
18/8/2015	12:11:10 A	T07	
18/8/2015	12:11:11 A	T07	
18/8/2015	5:11:13 P	T02	
18/8/2015	5:11:15 P	T02	
18/8/2015	5:11:16 P	T02	
18/8/2015	5:11:17 P	T02	
18/8/2015	5:11:18 P	T02	
19/8/2015	9:33:41 A	T07	
19/8/2015	9:33:43 A	T07	
19/8/2015	9:33:44 A	T07	
19/8/2015	9:33:45 A	T07	
19/8/2015	9:33:46 A	T07	
19/8/2015	8:48:32 P	T07	
19/8/2015	8:48:33 P	T07	
19/8/2015	8:48:34 P	T07	

Date	Time	Camera 1	Camera 2
19/8/2015	8:48:35 P	T07	
19/8/2015	8:48:36 P	T07	
22/8/2015	7:21:03 A	T02	
22/8/2015	7:21:05 A	T02	
22/8/2015	7:21:06 A	T02	
22/8/2015	7:21:07 A	T02	
22/8/2015	7:21:08 A	T02	
22/8/2015	8:21:09 A	T04	
24/8/2015	6:34:11 A	T06	
24/8/2015	6:34:12 A	T06	
24/8/2015	6:34:13 A	T06	
24/8/2015	6:34:14 A	T06	
24/8/2015	6:34:15 A	T06	
26/8/2015	10:49:47 A	T02	
26/8/2015	10:49:49 A	T02	
26/8/2015	10:49:50 A	T02	
26/8/2015	10:49:51 A	T02	
26/8/2015	10:49:52 A	T02	
24/9/2015	3:00:29 P	T04	

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14/7/2015	9:00:33 P	T02	
14/7/2015	9:00:34 P	T02	
14/7/2015	9:00:35 P	T02	
14/7/2015	9:00:36 P	T02	
14/7/2015	9:00:37 P	T02	
21/7/2015	8:14:46 P	T07	
21/7/2015	8:14:47 P	T07	
21/7/2015	8:14:48 P	T07	
21/7/2015	8:14:49 P	T07	
21/7/2015	8:14:50 P	T07	
27/7/2015	8:16:56 P	T09	
27/7/2015	8:16:57 P	T09	
27/7/2015	8:16:58 P	T09	
27/7/2015	8:16:59 P	T09	
27/7/2015	8:17:00 P	T09	
29/7/2015	9:38:00 P	T02	
29/7/2015	9:38:01 P	T02	

Date	Time	Camera 1	Camera 2
29/7/2015	9:38:02 P	T02	
29/7/2015	9:38:03 P	T02	
29/7/2015	9:38:04 P	T02	
29/7/2015	9:38:19 P	T02	
29/7/2015	9:38:20 P	T02	
29/7/2015	9:38:21 P	T02	
29/7/2015	9:38:22 P	T02	
29/7/2015	9:38:23 P	T02	
6/8/2015	11:03:38 P	T09	
6/8/2015	11:03:39 P	T09	
6/8/2015	11:03:40 P	T09	
6/8/2015	11:03:41 P	T09	
6/8/2015	11:03:42 P	T09	

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14/6/2015	10:56:38 P	T06	
14/6/2015	10:56:39 P	T06	
14/6/2015	10:56:40 P	T06	
14/6/2015	10:56:41 P	T06	
14/6/2015	10:56:42 P	T06	
18/6/2015	4:33:14 A	T09	
18/6/2015	4:33:15 A	T09	
18/6/2015	4:33:16 A	T09	
18/6/2015	4:33:17 A	T09	
18/6/2015	4:33:18 A	T09	
18/6/2015	9:52:25 P	T07	
18/6/2015	9:52:26 P	T07	
18/6/2015	9:52:27 P	T07	
18/6/2015	9:52:28 P	T07	
18/6/2015	9:52:29 P	T07	
24/6/2015	3:16:01 A	T09	
24/6/2015	3:16:02 A	T09	
24/6/2015	3:16:03 A	T09	
24/6/2015	3:16:04 A	T09	
24/6/2015	3:16:05 A	T09	
25/6/2015	1:07:06 A	T09	
25/6/2015	1:07:07 A	T09	
25/6/2015	1:07:08 A	T09	

Date	Time	Camera 1	Camera 2
25/6/2015	1:07:09 A	T09	
25/6/2015	1:07:10 A	T09	
1/7/2015	12:47:45 A	T06	
1/7/2015	12:47:47 A	T06	
1/7/2015	12:47:48 A	T06	
1/7/2015	12:47:49 A	T06	
1/7/2015	12:47:50 A	T06	
2/7/2015	1:46:38 A	T07	
2/7/2015	1:46:39 A	T07	
2/7/2015	1:46:40 A	T07	
2/7/2015	1:46:41 A	T07	
2/7/2015	1:46:42 A	T07	
2/7/2015	5:14:16 A	T09	
2/7/2015	5:14:17 A	T09	
2/7/2015	5:14:18 A	T09	
2/7/2015	5:14:19 A	T09	
2/7/2015	5:14:20 A	T09	
3/7/2015	10:18:10 P	T07	
3/7/2015	10:18:11 P	T07	
3/7/2015	10:18:12 P	T07	
3/7/2015	10:18:13 P	T07	
3/7/2015	10:18:14 P	T07	
5/7/2015	10:39:20 P	T07	
5/7/2015	10:39:21 P	T07	
5/7/2015	10:39:22 P	T07	
5/7/2015	10:39:23 P	T07	
5/7/2015	10:39:24 P	T07	
7/7/2015	1:14:21 A	T01	
7/7/2015	1:14:22 A	T01	
7/7/2015	1:14:23 A	T01	
7/7/2015	1:14:24 A	T01	
7/7/2015	1:14:25 A	T01	
8/7/2015	2:03:47 A	T01	
8/7/2015	2:03:48 A	T01	
8/7/2015	2:03:49 A	T01	
8/7/2015	2:03:50 A	T01	
8/7/2015	2:03:51 A	T01	
9/7/2015	2:59:12 A	T07	
9/7/2015	2:59:13 A	T07	

Date	Time	Camera 1	Camera 2
9/7/2015	2:59:14 A	T07	
9/7/2015	2:59:15 A	T07	
9/7/2015	2:59:16 A	T07	
9/7/2015	3:37:08 A	T07	
9/7/2015	3:37:09 A	T07	
9/7/2015	3:37:10 A	T07	
9/7/2015	3:37:11 A	T07	
9/7/2015	3:37:12 A	T07	
9/7/2015	6:17:52 A	T06	
9/7/2015	6:17:54 A	T06	
9/7/2015	6:17:55 A	T06	
9/7/2015	6:17:56 A	T06	
9/7/2015	6:17:57 A	T06	
9/7/2015	7:46:07 P	T07	
9/7/2015	7:46:08 P	T07	
9/7/2015	7:46:09 P	T07	
9/7/2015	7:46:10 P	T07	
9/7/2015	7:46:11 P	T07	
10/7/2015	8:31:27 P	T07	
10/7/2015	8:31:28 P	T07	
10/7/2015	8:31:29 P	T07	
10/7/2015	8:31:30 P	T07	
10/7/2015	8:31:31 P	T07	
11/7/2015	12:44:04 A	T09	
11/7/2015	12:44:05 A	T09	
11/7/2015	12:44:06 A	T09	
11/7/2015	12:44:07 A	T09	
11/7/2015	12:44:08 A	T09	
11/7/2015	3:18:57 A	T07	
11/7/2015	3:18:58 A	T07	
11/7/2015	3:18:59 A	T07	
11/7/2015	3:19:00 A	T07	
11/7/2015	3:19:01 A	T07	
11/7/2015	8:59:23 P	T07	
11/7/2015	8:59:24 P	T07	
11/7/2015	8:59:25 P	T07	
11/7/2015	8:59:26 P	T07	
11/7/2015	8:59:27 P	T07	
11/7/2015	10:41:38 P	T07	

Date	Time	Camera 1	Camera 2
11/7/2015	10:41:39 P	T07	
11/7/2015	10:41:40 P	T07	
11/7/2015	10:41:41 P	T07	
11/7/2015	10:41:42 P	T07	
15/7/2015	11:48:45 P	T07	
15/7/2015	11:48:46 P	T07	
15/7/2015	11:48:47 P	T07	
15/7/2015	11:48:48 P	T07	
15/7/2015	11:48:49 P	T07	
16/7/2015	11:07:10 P	T09	
16/7/2015	11:07:11 P	T09	
16/7/2015	11:07:12 P	T09	
16/7/2015	11:07:13 P	T09	
16/7/2015	11:07:14 P	T09	
19/7/2015	11:28:41 P	T09	
19/7/2015	11:28:42 P	T09	
19/7/2015	11:28:43 P	T09	
19/7/2015	11:28:44 P	T09	
19/7/2015	11:28:45 P	T09	
20/7/2015	8:51:26 P	T07	
20/7/2015	8:51:27 P	T07	
20/7/2015	8:51:28 P	T07	
20/7/2015	8:51:29 P	T07	
20/7/2015	8:51:30 P	T07	
20/7/2015	8:54:22 P	T07	
20/7/2015	8:54:23 P	T07	
20/7/2015	8:54:24 P	T07	
20/7/2015	8:54:25 P	T07	
20/7/2015	8:54:26 P	T07	
20/7/2015	10:15:30 P	T09	
20/7/2015	10:15:31 P	T09	
20/7/2015	10:15:32 P	T09	
20/7/2015	10:15:33 P	T09	
20/7/2015	10:15:34 P	T09	
21/7/2015	9:20:53 P	T07	
21/7/2015	9:20:54 P	T07	
21/7/2015	9:20:55 P	T07	
21/7/2015	9:20:56 P	T07	
21/7/2015	9:20:57 P	T07	

Date	Time	Camera 1	Camera 2
23/7/2015	6:18:03 A	T09	
23/7/2015	6:18:04 A	T09	
23/7/2015	6:18:05 A	T09	
23/7/2015	6:18:06 A	T09	
23/7/2015	6:18:07 A	T09	
23/7/2015	6:18:48 A	T09	
23/7/2015	6:18:49 A	T09	
23/7/2015	6:18:50 A	T09	
23/7/2015	6:18:51 A	T09	
23/7/2015	6:18:52 A	T09	
23/7/2015	10:12:40 P	T07	
23/7/2015	10:12:41 P	T07	
23/7/2015	10:12:42 P	T07	
23/7/2015	10:12:43 P	T07	
23/7/2015	10:12:44 P	T07	
24/7/2015	10:32:11 P	T06	
24/7/2015	10:32:12 P	T06	
24/7/2015	10:32:13 P	T06	
24/7/2015	10:32:14 P	T06	
24/7/2015	10:32:15 P	T06	
25/7/2015	6:30:17 A	T09	
25/7/2015	6:30:18 A	T09	
25/7/2015	6:30:19 A	T09	
25/7/2015	6:30:20 A	T09	
25/7/2015	6:30:21 A	T09	
25/7/2015	6:30:57 A	T09	
25/7/2015	6:30:58 A	T09	
25/7/2015	6:30:59 A	T09	
25/7/2015	6:31:00 A	T09	
25/7/2015	6:31:01 A	T09	
26/7/2015	12:53:19 A	T06	
26/7/2015	12:53:20 A	T06	
26/7/2015	12:53:21 A	T06	
26/7/2015	12:53:22 A	T06	
26/7/2015	12:53:23 A	T06	
27/7/2015	6:06:06 A	T06	
27/7/2015	6:06:07 A	T06	
27/7/2015	6:06:09 A	T06	
27/7/2015	6:06:10 A	T06	

Date	Time	Camera 1	Camera 2
27/7/2015	6:06:11 A	T06	
29/7/2015	1:52:46 A	T09	
29/7/2015	1:52:48 A	T09	
29/7/2015	1:52:49 A	T09	
29/7/2015	1:52:50 A	T09	
29/7/2015	1:52:51 A	T09	
29/7/2015	3:21:41 A	T07	
29/7/2015	3:21:42 A	T07	
29/7/2015	3:21:43 A	T07	
29/7/2015	3:21:44 A	T07	
29/7/2015	3:21:45 A	T07	
29/7/2015	7:39:53 P	T09	
29/7/2015	7:39:54 P	T09	
29/7/2015	7:39:55 P	T09	
29/7/2015	7:39:56 P	T09	
29/7/2015	7:39:57 P	T09	
31/7/2015	5:47:08 A	T09	
31/7/2015	5:47:09 A	T09	
31/7/2015	5:47:10 A	T09	
31/7/2015	5:47:11 A	T09	
31/7/2015	5:47:12 A	T09	
2/8/2015	10:43:19 P	T09	
2/8/2015	10:43:20 P	T09	
2/8/2015	10:43:21 P	T09	
2/8/2015	10:43:22 P	T09	
2/8/2015	10:43:23 P	T09	
3/8/2015	1:16:51 A	T07	
3/8/2015	1:16:52 A	T07	
3/8/2015	1:16:53 A	T07	
3/8/2015	1:16:54 A	T07	
3/8/2015	1:16:55 A	T07	
4/8/2015	12:22:50 A	T07	
4/8/2015	12:22:51 A	T07	
4/8/2015	12:22:52 A	T07	
4/8/2015	12:22:53 A	T07	
4/8/2015	12:22:54 A	T07	
4/8/2015	12:48:16 A	T09	
4/8/2015	12:48:17 A	T09	
4/8/2015	12:48:18 A	T09	

Date	Time	Camera 1	Camera 2
4/8/2015	12:48:19 A	T09	
4/8/2015	12:48:20 A	T09	
4/8/2015	12:58:36 A	T07	
4/8/2015	12:58:37 A	T07	
4/8/2015	12:58:38 A	T07	
4/8/2015	12:58:39 A	T07	
4/8/2015	12:58:40 A	T07	
4/8/2015	8:00:46 P	T07	
4/8/2015	8:00:47 P	T07	
4/8/2015	8:00:48 P	T07	
4/8/2015	8:00:49 P	T07	
4/8/2015	8:00:50 P	T07	
4/8/2015	10:14:58 P	T09	
4/8/2015	10:14:59 P	T09	
4/8/2015	10:15:00 P	T09	
4/8/2015	10:15:01 P	T09	
4/8/2015	10:15:02 P	T09	
5/8/2015	7:43:53 A	T07	
5/8/2015	7:43:55 A	T07	
5/8/2015	7:43:56 A	T07	
5/8/2015	7:43:57 A	T07	
5/8/2015	7:43:58 A	T07	
6/8/2015	4:02:01 A	T07	
6/8/2015	4:02:02 A	T07	
6/8/2015	4:02:03 A	T07	
6/8/2015	4:02:04 A	T07	
6/8/2015	4:02:05 A	T07	
7/8/2015	6:22:53 A	T09	
7/8/2015	6:22:54 A	T09	
7/8/2015	6:22:55 A	T09	
7/8/2015	6:22:56 A	T09	
7/8/2015	6:22:57 A	T09	
7/8/2015	8:22:20 P	T09	
7/8/2015	8:22:21 P	T09	
7/8/2015	8:22:22 P	T09	
7/8/2015	8:22:23 P	T09	
7/8/2015	8:22:24 P	T09	
9/8/2015	10:18:00 P	T06	
9/8/2015	10:18:01 P	T06	

Date	Time	Camera 1	Camera 2
9/8/2015	10:18:02 P	T06	
9/8/2015	10:18:03 P	T06	
9/8/2015	10:18:04 P	T06	
11/8/2015	7:58:57 P	T07	
11/8/2015	7:58:58 P	T07	
11/8/2015	7:58:59 P	T07	
11/8/2015	7:59:00 P	T07	
11/8/2015	7:59:01 P	T07	
12/8/2015	5:04:35 A	T07	
12/8/2015	5:04:36 A	T07	
12/8/2015	5:04:37 A	T07	
12/8/2015	5:04:38 A	T07	
12/8/2015	5:04:39 A	T07	
12/8/2015	5:21:09 A	T07	
12/8/2015	5:21:10 A	T07	
12/8/2015	5:21:11 A	T07	
12/8/2015	5:21:12 A	T07	
12/8/2015	5:21:13 A	T07	
12/8/2015	8:25:08 P	T07	
12/8/2015	8:25:09 P	T07	
12/8/2015	8:25:10 P	T07	
12/8/2015	8:25:11 P	T07	
12/8/2015	8:25:12 P	T07	
12/8/2015	9:06:33 P	T07	
12/8/2015	9:06:34 P	T07	
12/8/2015	9:06:35 P	T07	
12/8/2015	9:06:36 P	T07	
12/8/2015	9:06:37 P	T07	
12/8/2015	9:08:57 P	T07	
12/8/2015	9:08:58 P	T07	
12/8/2015	9:08:59 P	T07	
12/8/2015	9:09:00 P	T07	
12/8/2015	9:09:01 P	T07	
12/8/2015	10:43:55 P	T07	
12/8/2015	10:43:56 P	T07	
12/8/2015	10:43:57 P	T07	
12/8/2015	10:43:58 P	T07	
12/8/2015	10:43:59 P	T07	
13/8/2015	3:24:00 A	T02	

Date	Time	Camera 1	Camera 2
13/8/2015	3:24:01 A	T02	
13/8/2015	3:24:02 A	T02	
13/8/2015	3:24:03 A	T02	
13/8/2015	3:24:04 A	T02	
13/8/2015	4:33:43 A	T07	
13/8/2015	4:33:44 A	T07	
13/8/2015	4:33:45 A	T07	
13/8/2015	4:33:46 A	T07	
13/8/2015	4:33:47 A	T07	
13/8/2015	8:23:56 P	T07	
13/8/2015	8:23:57 P	T07	
13/8/2015	8:23:58 P	T07	
13/8/2015	8:23:59 P	T07	
13/8/2015	8:24:00 P	T07	
13/8/2015	11:23:38 P	T06	
13/8/2015	11:23:39 P	T06	
13/8/2015	11:23:40 P	T06	
13/8/2015	11:23:41 P	T06	
13/8/2015	11:23:42 P	T06	
14/8/2015	8:37:06 P	T07	
14/8/2015	8:37:07 P	T07	
14/8/2015	8:37:08 P	T07	
14/8/2015	8:37:09 P	T07	
14/8/2015	8:37:10 P	T07	
14/8/2015	8:39:42 P	T07	
14/8/2015	8:39:43 P	T07	
14/8/2015	8:39:44 P	T07	
14/8/2015	8:39:45 P	T07	
14/8/2015	8:39:46 P	T07	
14/8/2015	8:44:11 P	T07	
14/8/2015	8:44:12 P	T07	
14/8/2015	8:44:13 P	T07	
14/8/2015	8:44:14 P	T07	
14/8/2015	8:44:15 P	T07	
14/8/2015	10:44:39 P	T07	
14/8/2015	10:44:40 P	T07	
14/8/2015	10:44:41 P	T07	
14/8/2015	10:44:42 P	T07	
14/8/2015	10:44:43 P	T07	

Date	Time	Camera 1	Camera 2
15/8/2015	1:40:52 A	T06	
15/8/2015	1:40:53 A	T06	
15/8/2015	1:40:54 A	T06	
15/8/2015	1:40:55 A	T06	
15/8/2015	1:40:56 A	T06	
15/8/2015	3:45:30 A	T07	
15/8/2015	3:45:31 A	T07	
15/8/2015	3:45:32 A	T07	
15/8/2015	3:45:33 A	T07	
15/8/2015	3:45:34 A	T07	
15/8/2015	8:22:47 P	T07	
15/8/2015	8:22:48 P	T07	
15/8/2015	8:22:49 P	T07	
15/8/2015	8:22:50 P	T07	
15/8/2015	8:22:51 P	T07	
15/8/2015	8:38:45 P	T07	
15/8/2015	8:38:46 P	T07	
15/8/2015	8:38:47 P	T07	
15/8/2015	8:38:48 P	T07	
15/8/2015	8:38:49 P	T07	
15/8/2015	11:55:46 P	T07	
15/8/2015	11:55:47 P	T07	
15/8/2015	11:55:48 P	T07	
15/8/2015	11:55:49 P	T07	
15/8/2015	11:55:50 P	T07	
15/8/2015	11:56:13 P	T07	
15/8/2015	11:56:14 P	T07	
15/8/2015	11:56:15 P	T07	
15/8/2015	11:56:16 P	T07	
15/8/2015	11:56:17 P	T07	
16/8/2015	12:30:12 A	T06	
16/8/2015	12:30:13 A	T06	
16/8/2015	12:30:14 A	T06	
16/8/2015	12:30:15 A	T06	
16/8/2015	12:30:16 A	T06	
16/8/2015	4:06:33 A	T07	
16/8/2015	4:06:34 A	T07	
16/8/2015	4:06:35 A	T07	
16/8/2015	4:06:36 A	T07	

Date	Time	Camera 1	Camera 2
16/8/2015	4:06:37 A	T07	
16/8/2015	6:10:29 A	T06	
16/8/2015	6:10:30 A	T06	
16/8/2015	6:10:31 A	T06	
16/8/2015	6:10:32 A	T06	
16/8/2015	6:10:33 A	T06	
16/8/2015	9:28:01 P	T06	
16/8/2015	9:28:02 P	T06	
16/8/2015	9:28:03 P	T06	
16/8/2015	9:28:04 P	T06	
16/8/2015	9:28:05 P	T06	
17/8/2015	4:00:10 A	T07	
17/8/2015	4:00:11 A	T07	
17/8/2015	4:00:12 A	T07	
17/8/2015	4:00:13 A	T07	
17/8/2015	4:00:14 A	T07	
17/8/2015	5:54:01 A	T07	
17/8/2015	5:54:02 A	T07	
17/8/2015	5:54:03 A	T07	
17/8/2015	5:54:04 A	T07	
17/8/2015	5:54:05 A	T07	
17/8/2015	6:23:27 A	T06	
17/8/2015	6:23:28 A	T06	
17/8/2015	6:23:29 A	T06	
17/8/2015	6:23:30 A	T06	
17/8/2015	6:23:31 A	T06	
17/8/2015	9:36:08 P	T06	
17/8/2015	9:36:09 P	T06	
17/8/2015	9:36:10 P	T06	
17/8/2015	9:36:11 P	T06	
17/8/2015	9:36:12 P	T06	
17/8/2015	9:40:55 P	T06	
17/8/2015	9:40:56 P	T06	
17/8/2015	9:40:57 P	T06	
17/8/2015	9:40:58 P	T06	
17/8/2015	9:40:59 P	T06	
18/8/2015	4:00:02 A	T02	
18/8/2015	4:00:03 A	T02	
18/8/2015	4:00:04 A	T02	

Date	Time	Camera 1	Camera 2
18/8/2015	4:00:05 A	T02	
18/8/2015	4:00:06 A	T02	
18/8/2015	9:52:03 P	T07	
18/8/2015	9:52:04 P	T07	
18/8/2015	9:52:05 P	T07	
18/8/2015	9:52:06 P	T07	
18/8/2015	9:52:07 P	T07	
18/8/2015	9:56:50 P	T07	
18/8/2015	9:56:51 P	T07	
18/8/2015	9:56:52 P	T07	
18/8/2015	9:56:53 P	T07	
18/8/2015	9:56:54 P	T07	
18/8/2015	10:02:51 P	T07	
18/8/2015	10:02:52 P	T07	
18/8/2015	10:02:53 P	T07	
18/8/2015	10:02:54 P	T07	
18/8/2015	10:02:55 P	T07	
20/8/2015	12:21:31 A	T03	
20/8/2015	12:21:32 A	T03	
20/8/2015	12:21:33 A	T03	
20/8/2015	12:21:34 A	T03	
20/8/2015	12:21:35 A	T03	
20/8/2015	9:06:16 P	T07	
20/8/2015	9:06:17 P	T07	
20/8/2015	9:06:18 P	T07	
20/8/2015	9:06:19 P	T07	
20/8/2015	9:06:20 P	T07	
20/8/2015	9:18:52 P	T07	
20/8/2015	9:18:54 P	T07	
20/8/2015	9:18:55 P	T07	
20/8/2015	9:18:56 P	T07	
20/8/2015	9:18:57 P	T07	
20/8/2015	9:27:22 P	T07	
20/8/2015	9:27:23 P	T07	
20/8/2015	9:27:24 P	T07	
20/8/2015	9:27:25 P	T07	
20/8/2015	9:27:26 P	T07	
20/8/2015	9:51:33 P	T07	
20/8/2015	9:51:35 P	T07	

Date	Time	Camera 1	Camera 2
20/8/2015	9:51:36 P	T07	
20/8/2015	9:51:37 P	T07	
20/8/2015	9:51:38 P	T07	
20/8/2015	9:52:31 P	T07	
20/8/2015	9:52:32 P	T07	
20/8/2015	9:52:33 P	T07	
20/8/2015	9:52:34 P	T07	
20/8/2015	9:52:35 P	T07	
20/8/2015	9:54:10 P	T07	
20/8/2015	9:54:11 P	T07	
20/8/2015	9:54:12 P	T07	
20/8/2015	9:54:13 P	T07	
20/8/2015	9:54:14 P	T07	
20/8/2015	10:14:19 P	T07	
20/8/2015	10:14:20 P	T07	
20/8/2015	10:14:21 P	T07	
20/8/2015	10:14:22 P	T07	
20/8/2015	10:14:23 P	T07	
20/8/2015	10:17:57 P	T07	
20/8/2015	10:17:58 P	T07	
20/8/2015	10:17:59 P	T07	
20/8/2015	10:18:00 P	T07	
20/8/2015	10:18:01 P	T07	
20/8/2015	10:37:28 P	T07	
20/8/2015	10:37:29 P	T07	
20/8/2015	10:37:30 P	T07	
20/8/2015	10:37:31 P	T07	
20/8/2015	10:37:32 P	T07	
20/8/2015	10:37:53 P	T07	
20/8/2015	10:37:54 P	T07	
20/8/2015	10:37:55 P	T07	
20/8/2015	10:37:56 P	T07	
20/8/2015	10:37:57 P	T07	
22/8/2015	3:45:58 A	T06	
22/8/2015	3:45:59 A	T06	
22/8/2015	3:46:00 A	T06	
22/8/2015	3:46:01 A	T06	
22/8/2015	3:46:02 A	T06	
24/8/2015	2:39:51 A	T02	

Date	Time	Camera 1	Camera 2
24/8/2015	2:39:52 A	T02	
24/8/2015	2:39:53 A	T02	
24/8/2015	2:39:54 A	T02	
24/8/2015	2:39:55 A	T02	
24/8/2015	5:30:04 A	T06	
24/8/2015	5:30:05 A	T06	
24/8/2015	5:30:06 A	T06	
24/8/2015	5:30:07 A	T06	
24/8/2015	5:30:08 A	T06	
26/8/2015	7:57:46 P	T02	
26/8/2015	7:57:47 P	T02	
26/8/2015	7:57:48 P	T02	
26/8/2015	7:57:49 P	T02	
26/8/2015	7:57:50 P	T02	
26/8/2015	10:10:21 P	T02	
26/8/2015	10:10:22 P	T02	
26/8/2015	10:10:23 P	T02	
26/8/2015	10:10:24 P	T02	
26/8/2015	10:10:25 P	T02	
1/9/2015	6:01:27 A	T06	
1/9/2015	6:01:28 A	T06	
1/9/2015	6:01:29 A	T06	
1/9/2015	6:01:30 A	T06	
1/9/2015	6:01:31 A	T06	
7/9/2015	8:12:19 P	T06	
7/9/2015	8:12:20 P	T06	
7/9/2015	8:12:21 P	T06	
7/9/2015	8:12:22 P	T06	
7/9/2015	8:12:23 P	T06	
8/9/2015	8:21:43 P	T06	
8/9/2015	8:21:44 P	T06	
8/9/2015	8:21:45 P	T06	
8/9/2015	8:21:46 P	T06	
8/9/2015	8:21:47 P	T06	
9/9/2015	5:57:26 A	T06	
9/9/2015	5:57:27 A	T06	
9/9/2015	5:57:28 A	T06	
9/9/2015	5:57:29 A	T06	
9/9/2015	5:57:30 A	T06	

Date	Time	Camera 1	Camera 2
10/9/2015	5:51:02 A	T06	
10/9/2015	5:51:03 A	T06	
10/9/2015	5:51:04 A	T06	
10/9/2015	5:51:05 A	T06	
10/9/2015	5:51:06 A	T06	
12/9/2015	8:39:43 P	T06	
12/9/2015	8:39:44 P	T06	
12/9/2015	8:39:45 P	T06	
12/9/2015	8:39:46 P	T06	
12/9/2015	8:39:47 P	T06	
12/9/2015	8:40:30 P	T06	
12/9/2015	8:40:31 P	T06	
12/9/2015	8:40:32 P	T06	
12/9/2015	8:40:33 P	T06	
12/9/2015	8:40:34 P	T06	
12/9/2015	9:15:48 P	T06	
12/9/2015	9:15:49 P	T06	
12/9/2015	9:15:50 P	T06	
12/9/2015	9:15:51 P	T06	
12/9/2015	9:15:52 P	T06	
12/9/2015	9:17:29 P	T06	
12/9/2015	9:17:30 P	T06	
12/9/2015	9:17:31 P	T06	
12/9/2015	9:17:32 P	T06	
12/9/2015	9:17:33 P	T06	
12/9/2015	9:19:29 P	T06	
12/9/2015	9:19:30 P	T06	
12/9/2015	9:19:31 P	T06	
12/9/2015	9:19:32 P	T06	
12/9/2015	9:19:33 P	T06	
12/9/2015	9:21:53 P	T06	
12/9/2015	9:21:54 P	T06	
12/9/2015	9:21:55 P	T06	
12/9/2015	9:21:56 P	T06	
12/9/2015	9:21:57 P	T06	
12/9/2015	9:22:35 P	T06	
12/9/2015	9:22:36 P	T06	
12/9/2015	9:22:37 P	T06	
12/9/2015	9:22:38 P	T06	

Date	Time	Camera 1	Camera 2
12/9/2015	9:22:39 P	T06	
12/9/2015	9:32:30 P	T06	
12/9/2015	9:32:31 P	T06	
12/9/2015	9:32:32 P	T06	
12/9/2015	9:32:33 P	T06	
12/9/2015	9:32:34 P	T06	
13/9/2015	12:31:54 A	T06	
13/9/2015	12:31:55 A	T06	
13/9/2015	12:31:56 A	T06	
13/9/2015	12:31:57 A	T06	
13/9/2015	12:31:58 A	T06	
13/9/2015	12:33:37 A	T06	
13/9/2015	12:33:38 A	T06	
13/9/2015	12:33:39 A	T06	
13/9/2015	12:33:40 A	T06	
13/9/2015	12:33:41 A	T06	

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11/6/2015	9:24:57 P	T07	
11/6/2015	9:24:58 P	T07	
11/6/2015	9:24:59 P	T07	
11/6/2015	9:25:00 P	T07	
11/6/2015	9:25:01 P	T07	
11/6/2015	9:25:17 P	T07	
11/6/2015	9:25:18 P	T07	
11/6/2015	9:25:19 P	T07	
11/6/2015	9:25:20 P	T07	
11/6/2015	9:25:21 P	T07	
11/6/2015	9:25:40 P	T07	
11/6/2015	9:25:41 P	T07	
11/6/2015	9:25:42 P	T07	
11/6/2015	9:25:43 P	T07	
11/6/2015	9:25:44 P	T07	
11/6/2015	9:27:01 P	T07	
11/6/2015	9:27:02 P	T07	
11/6/2015	9:27:03 P	T07	
11/6/2015	9:27:04 P	T07	
11/6/2015	9:27:05 P	T07	

Date	Time	Camera 1	Camera 2
11/6/2015	9:27:38 P	T07	
11/6/2015	9:27:39 P	T07	
11/6/2015	9:27:40 P	T07	
11/6/2015	9:27:41 P	T07	
11/6/2015	9:27:42 P	T07	
11/6/2015	9:28:26 P	T07	
11/6/2015	9:28:27 P	T07	
11/6/2015	9:28:28 P	T07	
11/6/2015	9:28:29 P	T07	
11/6/2015	9:28:30 P	T07	
13/6/2015	11:57:00 P	T07	
13/6/2015	11:57:01 P	T07	
13/6/2015	11:57:02 P	T07	
13/6/2015	11:57:03 P	T07	
13/6/2015	11:57:04 P	T07	
13/6/2015	11:57:20 P	T07	
13/6/2015	11:57:21 P	T07	
13/6/2015	11:57:22 P	T07	
13/6/2015	11:57:23 P	T07	
13/6/2015	11:57:24 P	T07	
13/6/2015	11:57:40 P	T07	
13/6/2015	11:57:41 P	T07	
13/6/2015	11:57:42 P	T07	
13/6/2015	11:57:43 P	T07	
13/6/2015	11:57:44 P	T07	
13/6/2015	11:58:13 P	T07	
13/6/2015	11:58:14 P	T07	
13/6/2015	11:58:15 P	T07	
13/6/2015	11:58:16 P	T07	
13/6/2015	11:58:17 P	T07	
19/6/2015	4:42:20 A	T09	
19/6/2015	4:42:21 A	T09	
19/6/2015	4:42:22 A	T09	
19/6/2015	4:42:23 A	T09	
19/6/2015	4:42:24 A	T09	
19/6/2015	4:42:41 A	T09	
19/6/2015	4:42:42 A	T09	
19/6/2015	4:42:43 A	T09	
19/6/2015	4:42:44 A	T09	

Date	Time	Camera 1	Camera 2
19/6/2015	4:42:45 A	T09	
19/6/2015	4:43:05 A	T09	
19/6/2015	4:43:06 A	T09	
19/6/2015	4:43:07 A	T09	
19/6/2015	4:43:08 A	T09	
19/6/2015	4:43:09 A	T09	
20/6/2015	9:35:01 P	T09	
20/6/2015	9:35:03 P	T09	
20/6/2015	9:35:04 P	T09	
20/6/2015	9:35:05 P	T09	
20/6/2015	9:35:06 P	T09	
20/6/2015	11:35:45 P	T09	
20/6/2015	11:35:46 P	T09	
20/6/2015	11:35:47 P	T09	
20/6/2015	11:35:48 P	T09	
20/6/2015	11:35:49 P	T09	
20/6/2015	11:36:09 P	T09	
20/6/2015	11:36:11 P	T09	
20/6/2015	11:36:12 P	T09	
20/6/2015	11:36:13 P	T09	
20/6/2015	11:36:14 P	T09	
23/6/2015	8:25:31 P	T09	
23/6/2015	8:25:32 P	T09	
23/6/2015	8:25:33 P	T09	
23/6/2015	8:25:34 P	T09	
23/6/2015	8:25:35 P	T09	
23/6/2015	8:25:54 P	T09	
23/6/2015	8:25:55 P	T09	
23/6/2015	8:25:56 P	T09	
23/6/2015	8:25:57 P	T09	
23/6/2015	8:25:58 P	T09	
23/6/2015	8:27:22 P	T09	
23/6/2015	8:27:23 P	T09	
23/6/2015	8:27:24 P	T09	
23/6/2015	8:27:25 P	T09	
23/6/2015	8:27:26 P	T09	
23/6/2015	8:28:03 P	T09	
23/6/2015	8:28:04 P	T09	
23/6/2015	8:28:05 P	T09	

Date	Time	Camera 1	Camera 2
23/6/2015	8:28:06 P	T09	
23/6/2015	8:28:07 P	T09	
26/6/2015	3:39:54 A	T09	
26/6/2015	3:39:55 A	T09	
26/6/2015	3:39:56 A	T09	
26/6/2015	3:39:57 A	T09	
26/6/2015	3:39:58 A	T09	
26/6/2015	6:38:57 P	T09	
26/6/2015	6:38:59 P	T09	
26/6/2015	6:39:00 P	T09	
26/6/2015	6:39:01 P	T09	
26/6/2015	6:39:02 P	T09	
26/6/2015	8:50:00 P	T09	
26/6/2015	8:50:01 P	T09	
26/6/2015	8:50:02 P	T09	
26/6/2015	8:50:03 P	T09	
26/6/2015	8:50:04 P	T09	
26/6/2015	8:50:30 P	T09	
26/6/2015	8:50:31 P	T09	
26/6/2015	8:50:32 P	T09	
26/6/2015	8:50:33 P	T09	
26/6/2015	8:50:34 P	T09	
26/6/2015	10:17:24 P	T07	
26/6/2015	10:17:25 P	T07	
26/6/2015	10:17:26 P	T07	
26/6/2015	10:17:27 P	T07	
26/6/2015	10:17:28 P	T07	
26/6/2015	10:17:59 P	T07	
26/6/2015	10:18:00 P	T07	
26/6/2015	10:18:01 P	T07	
26/6/2015	10:18:02 P	T07	
26/6/2015	10:18:03 P	T07	
26/6/2015	10:18:29 P	T07	
26/6/2015	10:18:30 P	T07	
26/6/2015	10:18:31 P	T07	
26/6/2015	10:18:32 P	T07	
26/6/2015	10:18:33 P	T07	
26/6/2015	10:19:23 P	T07	
26/6/2015	10:19:24 P	T07	

Date	Time	Camera 1	Camera 2
26/6/2015	10:19:25 P	T07	
26/6/2015	10:19:26 P	T07	
26/6/2015	10:19:27 P	T07	
26/6/2015	10:20:22 P	T07	
26/6/2015	10:20:23 P	T07	
26/6/2015	10:20:24 P	T07	
26/6/2015	10:20:25 P	T07	
26/6/2015	10:20:26 P	T07	
26/6/2015	10:20:45 P	T07	
26/6/2015	10:20:46 P	T07	
26/6/2015	10:20:47 P	T07	
26/6/2015	10:20:48 P	T07	
26/6/2015	10:20:49 P	T07	
26/6/2015	10:23:17 P	T07	
26/6/2015	10:23:18 P	T07	
26/6/2015	10:23:19 P	T07	
26/6/2015	10:23:20 P	T07	
26/6/2015	10:23:21 P	T07	
30/6/2015	12:43:01 A	T08	
30/6/2015	12:43:02 A	T08	
30/6/2015	12:43:03 A	T08	
30/6/2015	12:43:05 A	T08	
30/6/2015	12:43:06 A	T08	
1/7/2015	9:17:15 P	T08	
1/7/2015	9:17:16 P	T08	
1/7/2015	9:17:19 P	T08	
1/7/2015	9:17:20 P	T08	
1/7/2015	9:17:21 P	T08	
3/7/2015	10:04:35 P	T07	
3/7/2015	10:04:36 P	T07	
3/7/2015	10:04:37 P	T07	
3/7/2015	10:04:38 P	T07	
3/7/2015	10:04:39 P	T07	
22/7/2015	1:16:39 A	T08	
22/7/2015	1:16:40 A	T08	
22/7/2015	1:16:41 A	T08	
22/7/2015	1:16:42 A	T08	
22/7/2015	1:16:43 A	T08	
22/7/2015	1:17:02 A	T08	

Date	Time	Camera 1	Camera 2
22/7/2015	1:17:04 A	T08	
22/7/2015	1:17:05 A	T08	
22/7/2015	1:17:06 A	T08	
22/7/2015	1:17:07 A	T08	
22/7/2015	7:38:00 P	T09	
22/7/2015	7:38:01 P	T09	
22/7/2015	7:38:02 P	T09	
22/7/2015	7:38:03 P	T09	
22/7/2015	7:38:04 P	T09	
22/7/2015	7:40:06 P	T09	
22/7/2015	7:40:07 P	T09	
22/7/2015	7:40:08 P	T09	
22/7/2015	7:40:09 P	T09	
22/7/2015	7:40:10 P	T09	
22/7/2015	7:41:20 P	T09	
22/7/2015	7:41:21 P	T09	
22/7/2015	7:41:22 P	T09	
22/7/2015	7:41:23 P	T09	
22/7/2015	7:41:24 P	T09	
22/7/2015	7:42:26 P	T09	
22/7/2015	7:42:27 P	T09	
22/7/2015	7:42:28 P	T09	
22/7/2015	7:42:29 P	T09	
22/7/2015	7:42:30 P	T09	
22/7/2015	7:43:12 P	T09	
22/7/2015	7:43:13 P	T09	
22/7/2015	7:43:14 P	T09	
22/7/2015	7:43:15 P	T09	
22/7/2015	7:43:16 P	T09	
22/7/2015	7:43:42 P	T09	
22/7/2015	7:43:43 P	T09	
22/7/2015	7:43:44 P	T09	
22/7/2015	7:43:45 P	T09	
22/7/2015	7:43:46 P	T09	
22/7/2015	7:45:16 P	T09	
22/7/2015	7:45:17 P	T09	
22/7/2015	7:45:18 P	T09	
22/7/2015	7:45:19 P	T09	
22/7/2015	7:45:20 P	T09	

Date	Time	Camera 1	Camera 2
23/7/2015	3:32:24 A	T08	
23/7/2015	3:32:25 A	T08	
23/7/2015	3:32:26 A	T08	
23/7/2015	3:32:27 A	T08	
23/7/2015	3:32:28 A	T08	
23/7/2015	6:34:59 A	T08	
23/7/2015	6:35:00 A	T08	
23/7/2015	6:35:01 A	T08	
23/7/2015	6:35:02 A	T08	
23/7/2015	6:35:03 A	T08	
23/7/2015	5:17:50 P	T08	
23/7/2015	5:17:52 P	T08	
23/7/2015	5:17:53 P	T08	
23/7/2015	5:17:54 P	T08	
23/7/2015	5:17:55 P	T08	
25/7/2015	6:48:01 A	T08	
25/7/2015	6:48:02 A	T08	
25/7/2015	6:48:04 A	T08	
25/7/2015	6:48:05 A	T08	
25/7/2015	6:48:06 A	T08	
27/7/2015	3:44:17 P	T08	
27/7/2015	3:44:19 P	T08	
27/7/2015	3:44:20 P	T08	
27/7/2015	3:44:21 P	T08	
27/7/2015	3:44:22 P	T08	
27/7/2015	7:47:54 P	T08	
27/7/2015	7:47:56 P	T08	
27/7/2015	7:47:58 P	T08	
27/7/2015	7:47:59 P	T08	
27/7/2015	7:48:00 P	T08	
28/7/2015	1:22:15 A	T09	
28/7/2015	1:22:16 A	T09	
28/7/2015	1:22:17 A	T09	
28/7/2015	1:22:18 A	T09	
28/7/2015	1:22:19 A	T09	
28/7/2015	1:23:26 A	T09	
28/7/2015	1:23:27 A	T09	
28/7/2015	1:23:28 A	T09	
28/7/2015	1:23:29 A	T09	

Date	Time	Camera 1	Camera 2
28/7/2015	1:23:30 A	T09	
28/7/2015	5:39:12 A	T08	
28/7/2015	5:39:13 A	T08	
28/7/2015	5:39:14 A	T08	
28/7/2015	5:39:15 A	T08	
28/7/2015	5:39:16 A	T08	
28/7/2015	5:39:32 A	T08	
28/7/2015	5:39:34 A	T08	
28/7/2015	5:39:35 A	T08	
28/7/2015	5:39:36 A	T08	
28/7/2015	5:39:37 A	T08	
29/7/2015	8:54:04 P	T09	
29/7/2015	8:54:05 P	T09	
29/7/2015	8:54:06 P	T09	
29/7/2015	8:54:07 P	T09	
29/7/2015	8:54:08 P	T09	
2/8/2015	2:22:22 A	T06	
2/8/2015	2:22:24 A	T06	
2/8/2015	2:22:25 A	T06	
2/8/2015	2:22:26 A	T06	
2/8/2015	2:22:27 A	T06	
2/8/2015	2:22:53 A	T06	
2/8/2015	2:22:55 A	T06	
2/8/2015	2:22:56 A	T06	
2/8/2015	2:22:57 A	T06	
2/8/2015	2:22:58 A	T06	
2/8/2015	2:26:21 A	T06	
2/8/2015	2:26:22 A	T06	
2/8/2015	2:26:23 A	T06	
2/8/2015	2:26:24 A	T06	
2/8/2015	2:26:25 A	T06	
2/8/2015	2:26:44 A	T06	
2/8/2015	2:26:45 A	T06	
2/8/2015	2:26:46 A	T06	
2/8/2015	2:26:47 A	T06	
2/8/2015	2:26:48 A	T06	
3/8/2015	1:35:36 A	T06	
3/8/2015	1:35:37 A	T06	
3/8/2015	1:35:38 A	T06	

Date	Time	Camera 1	Camera 2
3/8/2015	1:35:39 A	T06	
3/8/2015	1:35:40 A	T06	
6/8/2015	8:46:47 P	T08	
6/8/2015	8:46:48 P	T08	
6/8/2015	8:46:49 P	T08	
6/8/2015	8:46:50 P	T08	
6/8/2015	8:46:51 P	T08	
8/8/2015	5:48:16 A	T07	
8/8/2015	5:48:17 A	T07	
8/8/2015	5:48:18 A	T07	
8/8/2015	5:48:19 A	T07	
8/8/2015	5:48:20 A	T07	
8/8/2015	5:49:26 A	T07	
8/8/2015	5:49:27 A	T07	
8/8/2015	5:49:28 A	T07	
8/8/2015	5:49:29 A	T07	
8/8/2015	5:49:30 A	T07	
10/8/2015	8:25:20 P	T06	
10/8/2015	8:25:21 P	T06	
10/8/2015	8:25:22 P	T06	
10/8/2015	8:25:23 P	T06	
10/8/2015	8:25:24 P	T06	
13/8/2015	8:57:48 A	T05	
13/8/2015	8:57:50 A	T05	
13/8/2015	8:57:51 A	T05	
13/8/2015	8:57:52 A	T05	
13/8/2015	8:57:53 A	T05	
16/8/2015	6:47:53 A	T07	
16/8/2015	6:47:54 A	T07	
16/8/2015	6:47:55 A	T07	
16/8/2015	6:47:56 A	T07	
16/8/2015	6:47:57 A	T07	
16/8/2015	8:36:32 P	T07	
16/8/2015	8:36:33 P	T07	
16/8/2015	8:36:34 P	T07	
16/8/2015	8:36:35 P	T07	
16/8/2015	8:36:36 P	T07	
18/8/2015	6:17:39 A	T07	
18/8/2015	6:17:40 A	T07	

Date	Time	Camera 1	Camera 2
18/8/2015	6:17:41 A	T07	
18/8/2015	6:17:42 A	T07	
18/8/2015	6:17:43 A	T07	
18/8/2015	6:18:04 A	T07	
18/8/2015	6:18:05 A	T07	
18/8/2015	6:18:06 A	T07	
18/8/2015	6:18:07 A	T07	
18/8/2015	6:18:08 A	T07	
18/8/2015	4:33:01 P	T02	
18/8/2015	4:33:02 P	T02	
18/8/2015	4:33:03 P	T02	
18/8/2015	4:33:04 P	T02	
18/8/2015	4:33:05 P	T02	
18/8/2015	4:33:38 P	T02	
18/8/2015	4:33:40 P	T02	
18/8/2015	4:33:41 P	T02	
18/8/2015	4:33:42 P	T02	
18/8/2015	4:33:43 P	T02	
18/8/2015	4:34:04 P	T02	
18/8/2015	4:34:05 P	T02	
18/8/2015	4:34:07 P	T02	
18/8/2015	4:34:08 P	T02	
18/8/2015	4:34:09 P	T02	
18/8/2015	4:34:38 P	T02	
18/8/2015	4:34:39 P	T02	
18/8/2015	4:34:40 P	T02	
18/8/2015	4:34:41 P	T02	
18/8/2015	4:34:42 P	T02	
18/8/2015	8:10:23 P	T07	
18/8/2015	8:10:24 P	T07	
18/8/2015	8:10:25 P	T07	
18/8/2015	8:10:26 P	T07	
18/8/2015	8:10:27 P	T07	
18/8/2015	9:43:10 P	T07	
18/8/2015	9:43:12 P	T07	
18/8/2015	9:43:13 P	T07	
18/8/2015	9:43:14 P	T07	
18/8/2015	9:43:15 P	T07	
19/8/2015	7:46:24 P	T07	

Date	Time	Camera 1	Camera 2
19/8/2015	7:46:25 P	T07	
19/8/2015	7:46:26 P	T07	
19/8/2015	7:46:27 P	T07	
19/8/2015	7:46:28 P	T07	
26/8/2015	5:44:16 P	T04	
26/8/2015	5:44:17 P	T04	
26/8/2015	5:44:19 P	T04	
26/8/2015	5:44:20 P	T04	
26/8/2015	5:44:21 P	T04	
27/9/2015	10:55:39 P	T04	
27/9/2015	10:55:40 P	T04	
27/9/2015	10:55:41 P	T04	
27/9/2015	10:55:42 P	T04	
27/9/2015	10:55:43 P	T04	
27/9/2015	10:56:17 P	T04	
27/9/2015	10:56:18 P	T04	
27/9/2015	10:56:19 P	T04	
27/9/2015	10:56:20 P	T04	
27/9/2015	10:56:21 P	T04	

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12/8/2015	3:07:48 P	T07	
12/8/2015	3:07:49 P	T07	
12/8/2015	3:07:50 P	T07	
12/8/2015	3:07:51 P	T07	
12/8/2015	3:07:52 P	T07	
15/8/2015	4:05:17 P	T07	
15/8/2015	4:05:18 P	T07	
15/8/2015	4:05:19 P	T07	
15/8/2015	4:05:20 P	T07	
15/8/2015	4:05:21 P	T07	
17/8/2015	11:14:28 A	T07	
17/8/2015	11:14:29 A	T07	
17/8/2015	11:14:30 A	T07	
17/8/2015	11:14:31 A	T07	
17/8/2015	11:14:32 A	T07	
17/8/2015	11:14:50 A	T07	
17/8/2015	11:14:51 A	T07	

Date	Time	Camera 1	Camera 2
17/8/2015	11:14:52 A	T07	
17/8/2015	11:14:53 A	T07	
17/8/2015	11:14:54 A	T07	
18/8/2015	4:44:04 P	T07	
18/8/2015	4:44:05 P	T07	
18/8/2015	4:44:06 P	T07	
18/8/2015	4:44:07 P	T07	
18/8/2015	4:44:08 P	T07	
19/8/2015	1:56:02 P	T07	
19/8/2015	1:56:03 P	T07	
19/8/2015	1:56:04 P	T07	
19/8/2015	1:56:05 P	T07	
19/8/2015	1:56:06 P	T07	

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21/7/2015	9:32:37 A	T07	
21/7/2015	9:32:38 A	T07	
21/7/2015	9:32:39 A	T07	
21/7/2015	9:32:40 A	T07	
21/7/2015	9:32:41 A	T07	
10/8/2015	6:55:32 P	T02	
10/8/2015	6:55:34 P	T02	
10/8/2015	6:55:35 P	T02	
10/8/2015	6:55:36 P	T02	
10/8/2015	6:55:37 P	T02	
16/8/2015	3:22:13 P	T08	
16/8/2015	3:22:15 P	T08	
16/8/2015	3:22:16 P	T08	
16/8/2015	3:22:17 P	T08	
16/8/2015	3:22:18 P	T08	
17/8/2015	4:29:37 P	T07	
17/8/2015	4:29:38 P	T07	
17/8/2015	4:29:39 P	T07	
17/8/2015	4:29:40 P	T07	
17/8/2015	4:29:41 P	T07	

Sus scrofa

Date	Time	Camera 1	Camera 2
11/6/2015	11:42:27 P	T07	
11/6/2015	11:42:28 P	T07	
11/6/2015	11:42:29 P	T07	
11/6/2015	11:42:30 P	T07	
11/6/2015	11:42:31 P	T07	
13/6/2015	9:05:43 A	T07	
13/6/2015	9:05:44 A	T07	
13/6/2015	9:05:45 A	T07	
13/6/2015	9:05:46 A	T07	
13/6/2015	9:05:47 A	T07	
13/6/2015	6:58:49 P	T07	
13/6/2015	6:58:51 P	T07	
13/6/2015	6:58:52 P	T07	
13/6/2015	6:58:53 P	T07	
13/6/2015	6:58:54 P	T07	
13/6/2015	6:59:15 P	T07	
13/6/2015	6:59:16 P	T07	
13/6/2015	6:59:17 P	T07	
13/6/2015	6:59:18 P	T07	
13/6/2015	6:59:19 P	T07	
13/6/2015	7:00:13 P	T07	
13/6/2015	7:00:14 P	T07	
13/6/2015	7:00:15 P	T07	
13/6/2015	7:00:16 P	T07	
13/6/2015	7:00:17 P	T07	
13/6/2015	8:35:57 P	T07	
13/6/2015	8:35:58 P	T07	
13/6/2015	8:35:59 P	T07	
13/6/2015	8:36:00 P	T07	
13/6/2015	8:36:01 P	T07	
14/6/2015	6:28:51 A	T07	
14/6/2015	6:28:52 A	T07	
14/6/2015	6:28:53 A	T07	
14/6/2015	6:28:54 A	T07	
14/6/2015	6:28:55 A	T07	
14/6/2015	8:34:29 A	T07	
14/6/2015	8:34:31 A	T07	
14/6/2015	8:34:32 A	T07	
14/6/2015	8:34:33 A	T07	

Date	Time	Camera 1	Camera 2
14/6/2015	8:34:34 A	T07	
15/6/2015	4:40:15 A	T06	
15/6/2015	4:40:16 A	T06	
15/6/2015	4:40:17 A	T06	
15/6/2015	4:40:18 A	T06	
15/6/2015	4:40:19 A	T06	
16/6/2015	5:52:25 A	T07	
16/6/2015	5:52:26 A	T07	
16/6/2015	5:52:27 A	T07	
16/6/2015	5:52:28 A	T07	
16/6/2015	5:52:29 A	T07	
16/6/2015	5:52:44 A	T07	
16/6/2015	5:52:45 A	T07	
16/6/2015	5:52:46 A	T07	
16/6/2015	5:52:47 A	T07	
16/6/2015	5:52:48 A	T07	
17/6/2015	10:09:07 P	T07	
17/6/2015	10:09:08 P	T07	
17/6/2015	10:09:09 P	T07	
17/6/2015	10:09:10 P	T07	
17/6/2015	10:09:11 P	T07	
17/6/2015	11:18:35 P	T07	
17/6/2015	11:18:36 P	T07	
17/6/2015	11:18:37 P	T07	
17/6/2015	11:18:38 P	T07	
17/6/2015	11:18:39 P	T07	
17/6/2015	11:20:47 P	T07	
17/6/2015	11:20:48 P	T07	
17/6/2015	11:20:49 P	T07	
17/6/2015	11:20:50 P	T07	
17/6/2015	11:20:51 P	T07	
17/6/2015	11:21:34 P	T07	
17/6/2015	11:21:35 P	T07	
17/6/2015	11:21:36 P	T07	
17/6/2015	11:21:37 P	T07	
17/6/2015	11:21:38 P	T07	
17/6/2015	11:21:53 P	T07	
17/6/2015	11:21:54 P	T07	
17/6/2015	11:21:55 P	T07	

Date	Time	Camera 1	Camera 2
17/6/2015	11:21:56 P	T07	
17/6/2015	11:21:57 P	T07	
17/6/2015	11:23:16 P	T07	
17/6/2015	11:23:17 P	T07	
17/6/2015	11:23:18 P	T07	
17/6/2015	11:23:19 P	T07	
17/6/2015	11:23:20 P	T07	
17/6/2015	11:23:35 P	T07	
17/6/2015	11:23:36 P	T07	
17/6/2015	11:23:37 P	T07	
17/6/2015	11:23:38 P	T07	
17/6/2015	11:23:39 P	T07	
17/6/2015	11:23:54 P	T07	
17/6/2015	11:23:55 P	T07	
17/6/2015	11:23:56 P	T07	
17/6/2015	11:23:57 P	T07	
17/6/2015	11:23:58 P	T07	
19/6/2015	3:32:15 P	T09	
19/6/2015	3:32:16 P	T09	
19/6/2015	3:32:17 P	T09	
19/6/2015	3:32:18 P	T09	
19/6/2015	3:32:19 P	T09	
20/6/2015	4:50:54 A	T07	
20/6/2015	4:50:55 A	T07	
20/6/2015	4:50:56 A	T07	
20/6/2015	4:50:57 A	T07	
20/6/2015	4:50:58 A	T07	
20/6/2015	4:51:14 A	T07	
20/6/2015	4:51:15 A	T07	
20/6/2015	4:51:16 A	T07	
20/6/2015	4:51:17 A	T07	
20/6/2015	4:51:18 A	T07	
22/6/2015	8:35:00 A	T07	
22/6/2015	8:35:02 A	T07	
22/6/2015	8:35:03 A	T07	
22/6/2015	8:35:04 A	T07	
22/6/2015	8:35:05 A	T07	
23/6/2015	12:35:08 A	T07	
23/6/2015	12:35:09 A	T07	

Date	Time	Camera 1	Camera 2
23/6/2015	12:35:10 A	T07	
23/6/2015	12:35:11 A	T07	
23/6/2015	12:35:12 A	T07	
23/6/2015	8:28:59 P	T07	
23/6/2015	8:29:00 P	T07	
23/6/2015	8:29:01 P	T07	
23/6/2015	8:29:02 P	T07	
23/6/2015	8:29:03 P	T07	
25/6/2015	10:50:29 A	T09	
25/6/2015	10:50:30 A	T09	
25/6/2015	10:50:31 A	T09	
25/6/2015	10:50:32 A	T09	
25/6/2015	10:50:33 A	T09	
25/6/2015	4:34:54 P	T05	
25/6/2015	4:34:55 P	T05	
25/6/2015	4:34:56 P	T05	
25/6/2015	4:34:57 P	T05	
25/6/2015	4:34:58 P	T05	
26/6/2015	1:05:28 A	T09	
26/6/2015	1:05:29 A	T09	
26/6/2015	1:05:30 A	T09	
26/6/2015	1:05:31 A	T09	
26/6/2015	1:05:32 A	T09	
26/6/2015	1:05:49 A	T07	
26/6/2015	1:05:50 A	T07	
26/6/2015	1:05:51 A	T07	
26/6/2015	1:05:52 A	T07	
26/6/2015	1:05:53 A	T07	
26/6/2015	1:06:08 A	T07	
26/6/2015	1:06:09 A	T07	
26/6/2015	1:06:10 A	T07	
26/6/2015	1:06:11 A	T07	
26/6/2015	1:06:12 A	T07	
26/6/2015	5:53:48 A	T07	
26/6/2015	5:53:49 A	T07	
26/6/2015	5:53:50 A	T07	
26/6/2015	5:53:51 A	T07	
26/6/2015	5:53:52 A	T07	
26/6/2015	5:54:21 A	T07	

Date	Time	Camera 1	Camera 2
26/6/2015	5:54:22 A	T07	
26/6/2015	5:54:23 A	T07	
26/6/2015	5:54:24 A	T07	
26/6/2015	5:54:25 A	T07	
26/6/2015	7:35:10 P	T07	
26/6/2015	7:35:11 P	T07	
26/6/2015	7:35:12 P	T07	
26/6/2015	7:35:13 P	T07	
26/6/2015	7:35:14 P	T07	
26/6/2015	7:41:32 P	T09	
26/6/2015	7:41:33 P	T09	
26/6/2015	7:41:34 P	T09	
26/6/2015	7:41:35 P	T09	
26/6/2015	7:41:36 P	T09	
27/6/2015	7:15:23 P	T07	
27/6/2015	7:15:25 P	T07	
27/6/2015	7:15:26 P	T07	
27/6/2015	7:15:27 P	T07	
27/6/2015	7:15:28 P	T07	
27/6/2015	8:08:29 P	T06	
27/6/2015	8:08:30 P	T06	
27/6/2015	8:08:32 P	T06	
27/6/2015	8:08:33 P	T06	
27/6/2015	8:08:34 P	T06	
27/6/2015	10:52:05 P	T07	
27/6/2015	10:52:06 P	T07	
27/6/2015	10:52:07 P	T07	
27/6/2015	10:52:08 P	T07	
27/6/2015	10:52:09 P	T07	
27/6/2015	10:52:26 P	T07	
27/6/2015	10:52:27 P	T07	
27/6/2015	10:52:28 P	T07	
27/6/2015	10:52:29 P	T07	
27/6/2015	10:52:30 P	T07	
27/6/2015	10:52:45 P	T07	
27/6/2015	10:52:46 P	T07	
27/6/2015	10:52:47 P	T07	
27/6/2015	10:52:48 P	T07	
27/6/2015	10:52:49 P	T07	

Date	Time	Camera 1	Camera 2
27/6/2015	10:53:04 P	T07	
27/6/2015	10:53:05 P	T07	
27/6/2015	10:53:06 P	T07	
27/6/2015	10:53:07 P	T07	
27/6/2015	10:53:08 P	T07	
27/6/2015	10:55:16 P	T07	
27/6/2015	10:55:17 P	T07	
27/6/2015	10:55:18 P	T07	
27/6/2015	10:55:19 P	T07	
27/6/2015	10:55:20 P	T07	
27/6/2015	10:56:37 P	T07	
27/6/2015	10:56:38 P	T07	
27/6/2015	10:56:39 P	T07	
27/6/2015	10:56:40 P	T07	
27/6/2015	10:56:41 P	T07	
27/6/2015	10:56:56 P	T07	
27/6/2015	10:56:57 P	T07	
27/6/2015	10:56:58 P	T07	
27/6/2015	10:56:59 P	T07	
27/6/2015	10:57:00 P	T07	
28/6/2015	5:12:24 A	T07	
28/6/2015	5:12:25 A	T07	
28/6/2015	5:12:26 A	T07	
28/6/2015	5:12:27 A	T07	
28/6/2015	5:12:28 A	T07	
28/6/2015	5:12:43 A	T07	
28/6/2015	5:12:45 A	T07	
28/6/2015	5:12:46 A	T07	
28/6/2015	5:12:47 A	T07	
28/6/2015	5:12:48 A	T07	
28/6/2015	5:13:05 A	T07	
28/6/2015	5:13:06 A	T07	
28/6/2015	5:13:07 A	T07	
28/6/2015	5:13:08 A	T07	
28/6/2015	5:13:09 A	T07	
28/6/2015	10:11:38 P	T07	
28/6/2015	10:11:39 P	T07	
28/6/2015	10:11:40 P	T07	
28/6/2015	10:11:41 P	T07	

Date	Time	Camera 1	Camera 2
28/6/2015	10:11:42 P	T07	
28/6/2015	10:11:57 P	T07	
28/6/2015	10:11:58 P	T07	
28/6/2015	10:11:59 P	T07	
28/6/2015	10:12:00 P	T07	
28/6/2015	10:12:01 P	T07	
30/6/2015	1:51:11 A	T08	
30/6/2015	1:51:12 A	T08	
30/6/2015	1:51:13 A	T08	
30/6/2015	1:51:14 A	T08	
30/6/2015	1:51:15 A	T08	
30/6/2015	9:22:56 A	T08	
30/6/2015	9:22:58 A	T08	
30/6/2015	9:22:59 A	T08	
30/6/2015	9:23:00 A	T08	
30/6/2015	9:23:01 A	T08	
1/7/2015	5:30:05 P	T02	
1/7/2015	5:30:07 P	T02	
1/7/2015	5:30:08 P	T02	
1/7/2015	5:30:09 P	T02	
1/7/2015	5:30:10 P	T02	
2/7/2015	2:43:56 A	T07	
2/7/2015	2:43:57 A	T07	
2/7/2015	2:43:58 A	T07	
2/7/2015	2:43:59 A	T07	
2/7/2015	2:44:00 A	T07	
2/7/2015	2:44:17 A	T07	
2/7/2015	2:44:18 A	T07	
2/7/2015	2:44:19 A	T07	
2/7/2015	2:44:20 A	T07	
2/7/2015	2:44:21 A	T07	
2/7/2015	10:11:15 P	T07	
2/7/2015	10:11:16 P	T07	
2/7/2015	10:11:17 P	T07	
2/7/2015	10:11:18 P	T07	
2/7/2015	10:11:19 P	T07	
3/7/2015	8:15:26 A	T09	
3/7/2015	8:15:28 A	T09	
3/7/2015	8:15:29 A	T09	

Date	Time	Camera 1	Camera 2
3/7/2015	8:15:30 A	T09	
3/7/2015	8:15:31 A	T09	
3/7/2015	5:45:58 P	T07	
3/7/2015	5:45:59 P	T07	
3/7/2015	5:46:00 P	T07	
3/7/2015	5:46:01 P	T07	
3/7/2015	5:46:02 P	T07	
3/7/2015	5:46:29 P	T07	
3/7/2015	5:46:30 P	T07	
3/7/2015	5:46:31 P	T07	
3/7/2015	5:46:32 P	T07	
3/7/2015	5:46:33 P	T07	
3/7/2015	5:46:53 P	T07	
3/7/2015	5:46:54 P	T07	
3/7/2015	5:46:55 P	T07	
3/7/2015	5:46:56 P	T07	
3/7/2015	5:46:57 P	T07	
3/7/2015	5:47:13 P	T07	
3/7/2015	5:47:14 P	T07	
3/7/2015	5:47:15 P	T07	
3/7/2015	5:47:16 P	T07	
3/7/2015	5:47:17 P	T07	
3/7/2015	7:52:09 P	T07	
3/7/2015	7:52:10 P	T07	
3/7/2015	7:52:11 P	T07	
3/7/2015	7:52:12 P	T07	
3/7/2015	7:52:13 P	T07	
3/7/2015	7:52:28 P	T07	
3/7/2015	7:52:30 P	T07	
3/7/2015	7:52:31 P	T07	
3/7/2015	7:52:32 P	T07	
3/7/2015	7:52:33 P	T07	
3/7/2015	7:52:49 P	T07	
3/7/2015	7:52:50 P	T07	
3/7/2015	7:52:51 P	T07	
3/7/2015	7:52:52 P	T07	
3/7/2015	7:52:53 P	T07	
3/7/2015	7:53:09 P	T07	
3/7/2015	7:53:10 P	T07	

Date	Time	Camera 1	Camera 2
3/7/2015	7:53:11 P	T07	
3/7/2015	7:53:12 P	T07	
3/7/2015	7:53:13 P	T07	
3/7/2015	7:53:29 P	T07	
3/7/2015	7:53:31 P	T07	
3/7/2015	7:53:32 P	T07	
3/7/2015	7:53:33 P	T07	
3/7/2015	7:53:34 P	T07	
3/7/2015	7:53:49 P	T07	
3/7/2015	7:53:51 P	T07	
3/7/2015	7:53:52 P	T07	
3/7/2015	7:53:53 P	T07	
3/7/2015	7:53:54 P	T07	
3/7/2015	7:54:09 P	T07	
3/7/2015	7:54:10 P	T07	
3/7/2015	7:54:11 P	T07	
3/7/2015	7:54:12 P	T07	
3/7/2015	7:54:13 P	T07	
3/7/2015	7:54:28 P	T07	
3/7/2015	7:54:29 P	T07	
3/7/2015	7:54:30 P	T07	
3/7/2015	7:54:31 P	T07	
3/7/2015	7:54:32 P	T07	
3/7/2015	7:54:49 P	T07	
3/7/2015	7:54:50 P	T07	
3/7/2015	7:54:51 P	T07	
3/7/2015	7:54:52 P	T07	
3/7/2015	7:54:53 P	T07	
3/7/2015	7:55:09 P	T07	
3/7/2015	7:55:10 P	T07	
3/7/2015	7:55:11 P	T07	
3/7/2015	7:55:12 P	T07	
3/7/2015	7:55:13 P	T07	
3/7/2015	8:31:41 P	T07	
3/7/2015	8:31:42 P	T07	
3/7/2015	8:31:43 P	T07	
3/7/2015	8:31:44 P	T07	
3/7/2015	8:31:45 P	T07	
3/7/2015	8:35:39 P	T07	

Date	Time	Camera 1	Camera 2
3/7/2015	8:35:40 P	T07	
3/7/2015	8:35:41 P	T07	
3/7/2015	8:35:42 P	T07	
3/7/2015	8:35:43 P	T07	
3/7/2015	8:35:58 P	T07	
3/7/2015	8:36:00 P	T07	
3/7/2015	8:36:01 P	T07	
3/7/2015	8:36:02 P	T07	
3/7/2015	8:36:03 P	T07	
3/7/2015	9:45:26 P	T07	
3/7/2015	9:45:27 P	T07	
3/7/2015	9:45:28 P	T07	
3/7/2015	9:45:29 P	T07	
3/7/2015	9:45:30 P	T07	
3/7/2015	9:45:46 P	T07	
3/7/2015	9:45:47 P	T07	
3/7/2015	9:45:48 P	T07	
3/7/2015	9:45:49 P	T07	
3/7/2015	9:45:50 P	T07	
4/7/2015	7:34:45 A	T09	
4/7/2015	7:34:46 A	T09	
4/7/2015	7:34:47 A	T09	
4/7/2015	7:34:48 A	T09	
4/7/2015	7:34:49 A	T09	
4/7/2015	2:02:37 P	T08	
4/7/2015	2:02:39 P	T08	
4/7/2015	2:02:40 P	T08	
4/7/2015	2:02:41 P	T08	
4/7/2015	2:02:42 P	T08	
4/7/2015	8:43:23 P	T01	
4/7/2015	8:43:24 P	T01	
4/7/2015	8:43:25 P	T01	
4/7/2015	8:43:26 P	T01	
4/7/2015	8:43:27 P	T01	
5/7/2015	12:24:09 A	T07	
5/7/2015	12:24:10 A	T07	
5/7/2015	12:24:11 A	T07	
5/7/2015	12:24:12 A	T07	
5/7/2015	12:24:13 A	T07	

Date	Time	Camera 1	Camera 2
5/7/2015	12:24:28 A	T07	
5/7/2015	12:24:29 A	T07	
5/7/2015	12:24:30 A	T07	
5/7/2015	12:24:31 A	T07	
5/7/2015	12:24:32 A	T07	
5/7/2015	12:24:48 A	T07	
5/7/2015	12:24:49 A	T07	
5/7/2015	12:24:50 A	T07	
5/7/2015	12:24:52 A	T07	
5/7/2015	12:24:53 A	T07	
5/7/2015	2:18:04 A	T07	
5/7/2015	2:18:06 A	T07	
5/7/2015	2:18:07 A	T07	
5/7/2015	2:18:08 A	T07	
5/7/2015	2:18:09 A	T07	
5/7/2015	2:18:26 A	T07	
5/7/2015	2:18:27 A	T07	
5/7/2015	2:18:28 A	T07	
5/7/2015	2:18:29 A	T07	
5/7/2015	2:18:30 A	T07	
5/7/2015	9:53:30 A	T09	
5/7/2015	9:53:32 A	T09	
5/7/2015	9:53:33 A	T09	
5/7/2015	9:53:34 A	T09	
5/7/2015	9:53:35 A	T09	
5/7/2015	1:19:51 P	T07	
5/7/2015	1:19:52 P	T07	
5/7/2015	1:19:53 P	T07	
5/7/2015	1:19:54 P	T07	
5/7/2015	1:19:55 P	T07	
5/7/2015	1:20:11 P	T07	
5/7/2015	1:20:12 P	T07	
5/7/2015	1:20:13 P	T07	
5/7/2015	1:20:14 P	T07	
5/7/2015	1:20:15 P	T07	
5/7/2015	1:20:30 P	T07	
5/7/2015	1:20:31 P	T07	
5/7/2015	1:20:32 P	T07	
5/7/2015	1:20:33 P	T07	

Date	Time	Camera 1	Camera 2
5/7/2015	1:20:34 P	T07	
5/7/2015	8:43:34 P	T06	
5/7/2015	8:43:36 P	T06	
5/7/2015	8:43:37 P	T06	
5/7/2015	8:43:38 P	T06	
5/7/2015	8:43:39 P	T06	
6/7/2015	8:00:30 A	T07	
6/7/2015	8:00:31 A	T07	
6/7/2015	8:00:32 A	T07	
6/7/2015	8:00:33 A	T07	
6/7/2015	8:00:34 A	T07	
6/7/2015	8:00:49 A	T07	
6/7/2015	8:00:50 A	T07	
6/7/2015	8:00:51 A	T07	
6/7/2015	8:00:52 A	T07	
6/7/2015	8:00:53 A	T07	
6/7/2015	5:26:45 P	T07	
6/7/2015	5:26:46 P	T07	
6/7/2015	5:26:47 P	T07	
6/7/2015	5:26:48 P	T07	
6/7/2015	5:26:49 P	T07	
6/7/2015	6:52:00 P	T07	
6/7/2015	6:52:01 P	T07	
6/7/2015	6:52:02 P	T07	
6/7/2015	6:52:03 P	T07	
6/7/2015	6:52:04 P	T07	
6/7/2015	6:52:21 P	T07	
6/7/2015	6:52:22 P	T07	
6/7/2015	6:52:23 P	T07	
6/7/2015	6:52:24 P	T07	
6/7/2015	6:52:25 P	T07	
6/7/2015	6:52:41 P	T07	
6/7/2015	6:52:42 P	T07	
6/7/2015	6:52:43 P	T07	
6/7/2015	6:52:44 P	T07	
6/7/2015	6:52:45 P	T07	
6/7/2015	6:53:14 P	T07	
6/7/2015	6:53:15 P	T07	
6/7/2015	6:53:16 P	T07	

Date	Time	Camera 1	Camera 2
6/7/2015	6:53:17 P	T07	
6/7/2015	6:53:18 P	T07	
6/7/2015	7:01:14 P	T07	
6/7/2015	7:01:15 P	T07	
6/7/2015	7:01:16 P	T07	
6/7/2015	7:01:17 P	T07	
6/7/2015	7:01:18 P	T07	
6/7/2015	7:01:34 P	T07	
6/7/2015	7:01:35 P	T07	
6/7/2015	7:01:36 P	T07	
6/7/2015	7:01:37 P	T07	
6/7/2015	7:01:38 P	T07	
6/7/2015	7:01:54 P	T07	
6/7/2015	7:01:55 P	T07	
6/7/2015	7:01:56 P	T07	
6/7/2015	7:01:57 P	T07	
6/7/2015	7:01:58 P	T07	
6/7/2015	7:03:27 P	T07	
6/7/2015	7:03:28 P	T07	
6/7/2015	7:03:29 P	T07	
6/7/2015	7:03:30 P	T07	
6/7/2015	7:03:31 P	T07	
6/7/2015	7:03:53 P	T07	
6/7/2015	7:03:54 P	T07	
6/7/2015	7:03:55 P	T07	
6/7/2015	7:03:56 P	T07	
6/7/2015	7:03:57 P	T07	
6/7/2015	7:25:28 P	T07	
6/7/2015	7:25:29 P	T07	
6/7/2015	7:25:30 P	T07	
6/7/2015	7:25:31 P	T07	
6/7/2015	7:25:32 P	T07	
7/7/2015	8:45:49 P	T07	
7/7/2015	8:45:51 P	T07	
7/7/2015	8:45:52 P	T07	
7/7/2015	8:45:53 P	T07	
7/7/2015	8:45:54 P	T07	
7/7/2015	8:46:09 P	T07	
7/7/2015	8:46:10 P	T07	

Date	Time	Camera 1	Camera 2
7/7/2015	8:46:11 P	T07	
7/7/2015	8:46:12 P	T07	
7/7/2015	8:46:14 P	T07	
7/7/2015	8:47:14 P	T07	
7/7/2015	8:47:15 P	T07	
7/7/2015	8:47:16 P	T07	
7/7/2015	8:47:17 P	T07	
7/7/2015	8:47:18 P	T07	
8/7/2015	2:35:07 A	T09	
8/7/2015	2:35:08 A	T09	
8/7/2015	2:35:09 A	T09	
8/7/2015	2:35:10 A	T09	
8/7/2015	2:35:11 A	T09	
8/7/2015	1:54:11 P	T07	
8/7/2015	1:54:12 P	T07	
8/7/2015	1:54:13 P	T07	
8/7/2015	1:54:14 P	T07	
8/7/2015	1:54:15 P	T07	
8/7/2015	1:54:31 P	T07	
8/7/2015	1:54:32 P	T07	
8/7/2015	1:54:33 P	T07	
8/7/2015	1:54:34 P	T07	
8/7/2015	1:54:35 P	T07	
8/7/2015	4:27:50 P	T07	
8/7/2015	4:27:51 P	T07	
8/7/2015	4:27:52 P	T07	
8/7/2015	4:27:53 P	T07	
8/7/2015	4:27:54 P	T07	
9/7/2015	7:17:32 A	T09	
9/7/2015	7:17:33 A	T09	
9/7/2015	7:17:34 A	T09	
9/7/2015	7:17:35 A	T09	
9/7/2015	7:17:36 A	T09	
9/7/2015	10:01:37 A	T07	
9/7/2015	10:01:38 A	T07	
9/7/2015	10:01:39 A	T07	
9/7/2015	10:01:40 A	T07	
9/7/2015	10:01:41 A	T07	
9/7/2015	7:19:55 P	T07	

Date	Time	Camera 1	Camera 2
9/7/2015	7:19:56 P	T07	
9/7/2015	7:19:57 P	T07	
9/7/2015	7:19:58 P	T07	
9/7/2015	7:19:59 P	T07	
10/7/2015	2:54:10 A	T05	
10/7/2015	2:54:12 A	T05	
10/7/2015	2:54:13 A	T05	
10/7/2015	2:54:14 A	T05	
10/7/2015	2:54:15 A	T05	
10/7/2015	6:39:36 A	T07	
10/7/2015	6:39:37 A	T07	
10/7/2015	6:39:38 A	T07	
10/7/2015	6:39:39 A	T07	
10/7/2015	6:39:40 A	T07	
10/7/2015	6:39:56 A	T07	
10/7/2015	6:39:57 A	T07	
10/7/2015	6:39:58 A	T07	
10/7/2015	6:39:59 A	T07	
10/7/2015	6:40:00 A	T07	
10/7/2015	6:42:51 A	T07	
10/7/2015	6:42:52 A	T07	
10/7/2015	6:42:53 A	T07	
10/7/2015	6:42:54 A	T07	
10/7/2015	6:42:55 A	T07	
10/7/2015	6:43:36 A	T07	
10/7/2015	6:43:37 A	T07	
10/7/2015	6:43:38 A	T07	
10/7/2015	6:43:39 A	T07	
10/7/2015	6:43:40 A	T07	
12/7/2015	8:11:34 P	T07	
12/7/2015	8:11:35 P	T07	
12/7/2015	8:11:36 P	T07	
12/7/2015	8:11:37 P	T07	
12/7/2015	8:11:38 P	T07	
12/7/2015	8:12:27 P	T07	
12/7/2015	8:12:28 P	T07	
12/7/2015	8:12:29 P	T07	
12/7/2015	8:12:30 P	T07	
12/7/2015	8:12:31 P	T07	

Date	Time	Camera 1	Camera 2
12/7/2015	8:12:47 P	T07	
12/7/2015	8:12:48 P	T07	
12/7/2015	8:12:49 P	T07	
12/7/2015	8:12:50 P	T07	
12/7/2015	8:12:51 P	T07	
12/7/2015	8:13:11 P	T07	
12/7/2015	8:13:12 P	T07	
12/7/2015	8:13:13 P	T07	
12/7/2015	8:13:14 P	T07	
12/7/2015	8:13:15 P	T07	
12/7/2015	8:13:31 P	T07	
12/7/2015	8:13:32 P	T07	
12/7/2015	8:13:33 P	T07	
12/7/2015	8:13:34 P	T07	
12/7/2015	8:13:35 P	T07	
16/7/2015	4:40:32 A	T09	
16/7/2015	4:40:34 A	T09	
16/7/2015	4:40:35 A	T09	
16/7/2015	4:40:36 A	T09	
16/7/2015	4:40:37 A	T09	
18/7/2015	7:55:00 A	T09	
18/7/2015	7:55:03 A	T09	
18/7/2015	7:55:04 A	T09	
18/7/2015	7:55:05 A	T09	
18/7/2015	7:55:06 A	T09	
18/7/2015	10:55:18 P	T08	
18/7/2015	10:55:19 P	T08	
18/7/2015	10:55:20 P	T08	
18/7/2015	10:55:21 P	T08	
18/7/2015	10:55:22 P	T08	
19/7/2015	6:27:39 P	T07	
19/7/2015	6:27:40 P	T07	
19/7/2015	6:27:41 P	T07	
19/7/2015	6:27:42 P	T07	
19/7/2015	6:27:43 P	T07	
19/7/2015	6:28:21 P	T07	
19/7/2015	6:28:22 P	T07	
19/7/2015	6:28:23 P	T07	
19/7/2015	6:28:24 P	T07	

Date	Time	Camera 1	Camera 2
19/7/2015	6:28:25 P	T07	
19/7/2015	6:28:42 P	T07	
19/7/2015	6:28:44 P	T07	
19/7/2015	6:28:45 P	T07	
19/7/2015	6:28:46 P	T07	
19/7/2015	6:28:47 P	T07	
19/7/2015	10:54:45 P	T06	
19/7/2015	10:54:46 P	T06	
19/7/2015	10:54:47 P	T06	
19/7/2015	10:54:48 P	T06	
19/7/2015	10:54:49 P	T06	
20/7/2015	5:51:30 P	T07	
20/7/2015	5:51:31 P	T07	
20/7/2015	5:51:32 P	T07	
20/7/2015	5:51:33 P	T07	
20/7/2015	5:51:34 P	T07	
20/7/2015	7:14:14 P	T07	
20/7/2015	7:14:15 P	T07	
20/7/2015	7:14:16 P	T07	
20/7/2015	7:14:17 P	T07	
20/7/2015	7:14:18 P	T07	
20/7/2015	7:14:34 P	T07	
20/7/2015	7:14:35 P	T07	
20/7/2015	7:14:36 P	T07	
20/7/2015	7:14:37 P	T07	
20/7/2015	7:14:38 P	T07	
21/7/2015	3:44:13 A	T07	
21/7/2015	3:44:14 A	T07	
21/7/2015	3:44:15 A	T07	
21/7/2015	3:44:16 A	T07	
21/7/2015	3:44:17 A	T07	
21/7/2015	2:28:17 P	T07	
21/7/2015	2:28:18 P	T07	
21/7/2015	2:28:19 P	T07	
21/7/2015	2:28:20 P	T07	
21/7/2015	2:28:21 P	T07	
21/7/2015	2:28:36 P	T07	
21/7/2015	2:28:37 P	T07	
21/7/2015	2:28:38 P	T07	

Date	Time	Camera 1	Camera 2
21/7/2015	2:28:39 P	T07	
21/7/2015	2:28:40 P	T07	
21/7/2015	2:28:55 P	T07	
21/7/2015	2:28:56 P	T07	
21/7/2015	2:28:57 P	T07	
21/7/2015	2:28:58 P	T07	
21/7/2015	2:28:59 P	T07	
23/7/2015	7:12:10 P	T06	
23/7/2015	7:12:11 P	T06	
23/7/2015	7:12:12 P	T06	
23/7/2015	7:12:13 P	T06	
23/7/2015	7:12:14 P	T06	
24/7/2015	5:05:36 P	T07	
24/7/2015	5:05:37 P	T07	
24/7/2015	5:05:38 P	T07	
24/7/2015	5:05:39 P	T07	
24/7/2015	5:05:40 P	T07	
24/7/2015	8:45:31 P	T06	
24/7/2015	8:45:32 P	T06	
24/7/2015	8:45:34 P	T06	
24/7/2015	8:45:35 P	T06	
24/7/2015	8:45:36 P	T06	
25/7/2015	6:27:35 A	T08	
25/7/2015	6:27:36 A	T08	
25/7/2015	6:27:37 A	T08	
25/7/2015	6:27:39 A	T08	
25/7/2015	6:27:40 A	T08	
26/7/2015	5:19:36 A	T06	
26/7/2015	5:19:37 A	T06	
26/7/2015	5:19:38 A	T06	
26/7/2015	5:19:39 A	T06	
26/7/2015	5:19:40 A	T06	
26/7/2015	5:19:55 A	T06	
26/7/2015	5:19:57 A	T06	
26/7/2015	5:19:58 A	T06	
26/7/2015	5:19:59 A	T06	
26/7/2015	5:20:00 A	T06	
27/7/2015	3:33:11 A	T06	
27/7/2015	3:33:12 A	T06	

Date	Time	Camera 1	Camera 2
27/7/2015	3:33:14 A	T06	
27/7/2015	3:33:15 A	T06	
27/7/2015	3:33:16 A	T06	
27/7/2015	8:42:51 A	T08	
27/7/2015	8:42:53 A	T08	
27/7/2015	8:42:54 A	T08	
27/7/2015	8:42:55 A	T08	
27/7/2015	8:42:56 A	T08	
27/7/2015	7:00:39 P	T07	
27/7/2015	7:00:41 P	T07	
27/7/2015	7:00:42 P	T07	
27/7/2015	7:00:43 P	T07	
27/7/2015	7:00:44 P	T07	
27/7/2015	7:01:06 P	T07	
27/7/2015	7:01:07 P	T07	
27/7/2015	7:01:08 P	T07	
27/7/2015	7:01:09 P	T07	
27/7/2015	7:01:10 P	T07	
27/7/2015	7:01:29 P	T07	
27/7/2015	7:01:30 P	T07	
27/7/2015	7:01:31 P	T07	
27/7/2015	7:01:32 P	T07	
27/7/2015	7:01:33 P	T07	
27/7/2015	10:51:11 P	T02	
27/7/2015	10:51:12 P	T02	
27/7/2015	10:51:13 P	T02	
27/7/2015	10:51:14 P	T02	
27/7/2015	10:51:15 P	T02	
28/7/2015	1:55:59 A	T06	
28/7/2015	1:56:00 A	T06	
28/7/2015	1:56:01 A	T06	
28/7/2015	1:56:02 A	T06	
28/7/2015	1:56:03 A	T06	
28/7/2015	6:31:46 A	T06	
28/7/2015	6:31:47 A	T06	
28/7/2015	6:31:49 A	T06	
28/7/2015	6:31:50 A	T06	
28/7/2015	6:31:51 A	T06	
28/7/2015	7:56:22 P	T07	

Date	Time	Camera 1	Camera 2
28/7/2015	7:56:23 P	T07	
28/7/2015	7:56:24 P	T07	
28/7/2015	7:56:25 P	T07	
28/7/2015	7:56:26 P	T07	
28/7/2015	8:16:48 P	T07	
28/7/2015	8:16:49 P	T07	
28/7/2015	8:16:50 P	T07	
28/7/2015	8:16:51 P	T07	
28/7/2015	8:16:52 P	T07	
29/7/2015	1:16:02 A	T07	
29/7/2015	1:16:03 A	T07	
29/7/2015	1:16:04 A	T07	
29/7/2015	1:16:05 A	T07	
29/7/2015	1:16:06 A	T07	
29/7/2015	2:10:36 P	T09	
29/7/2015	2:10:37 P	T09	
29/7/2015	2:10:38 P	T09	
29/7/2015	2:10:39 P	T09	
29/7/2015	2:10:40 P	T09	
29/7/2015	5:47:59 P	T07	
29/7/2015	5:48:01 P	T07	
29/7/2015	5:48:02 P	T07	
29/7/2015	5:48:03 P	T07	
29/7/2015	5:48:04 P	T07	
29/7/2015	5:49:58 P	T07	
29/7/2015	5:50:00 P	T07	
29/7/2015	5:50:01 P	T07	
29/7/2015	5:50:02 P	T07	
29/7/2015	5:50:03 P	T07	
29/7/2015	6:45:51 P	T09	
29/7/2015	6:45:53 P	T09	
29/7/2015	6:45:54 P	T09	
29/7/2015	6:45:55 P	T09	
29/7/2015	6:45:56 P	T09	
29/7/2015	8:26:43 P	T06	
29/7/2015	8:26:44 P	T06	
29/7/2015	8:26:45 P	T06	
29/7/2015	8:26:46 P	T06	
29/7/2015	8:26:47 P	T06	

Date	Time	Camera 1	Camera 2
30/7/2015	8:15:04 P	T06	
30/7/2015	8:15:05 P	T06	
30/7/2015	8:15:06 P	T06	
30/7/2015	8:15:07 P	T06	
30/7/2015	8:15:08 P	T06	
30/7/2015	8:15:23 P	T06	
30/7/2015	8:15:25 P	T06	
30/7/2015	8:15:26 P	T06	
30/7/2015	8:15:27 P	T06	
30/7/2015	8:15:28 P	T06	
31/7/2015	8:19:37 A	T07	
31/7/2015	8:19:38 A	T07	
31/7/2015	8:19:39 A	T07	
31/7/2015	8:19:40 A	T07	
31/7/2015	8:19:41 A	T07	
31/7/2015	8:19:56 A	T07	
31/7/2015	8:19:57 A	T07	
31/7/2015	8:19:58 A	T07	
31/7/2015	8:19:59 A	T07	
31/7/2015	8:20:00 A	T07	
31/7/2015	8:21:28 A	T07	
31/7/2015	8:21:30 A	T07	
31/7/2015	8:21:31 A	T07	
31/7/2015	8:21:32 A	T07	
31/7/2015	8:21:33 A	T07	
31/7/2015	10:16:36 A	T07	
31/7/2015	10:16:37 A	T07	
31/7/2015	10:16:39 A	T07	
31/7/2015	10:16:40 A	T07	
31/7/2015	10:16:41 A	T07	
31/7/2015	2:11:42 P	T08	
31/7/2015	2:11:43 P	T08	
31/7/2015	2:11:44 P	T08	
31/7/2015	2:11:45 P	T08	
31/7/2015	2:11:46 P	T08	
31/7/2015	2:18:26 P	T08	
31/7/2015	2:18:27 P	T08	
31/7/2015	2:18:28 P	T08	
31/7/2015	2:18:29 P	T08	

Date	Time	Camera 1	Camera 2
31/7/2015	2:18:30 P	T08	
1/8/2015	1:22:01 A	T06	
1/8/2015	1:22:02 A	T06	
1/8/2015	1:22:03 A	T06	
1/8/2015	1:22:04 A	T06	
1/8/2015	1:22:05 A	T06	
1/8/2015	2:58:51 A	T06	
1/8/2015	2:58:52 A	T06	
1/8/2015	2:58:53 A	T06	
1/8/2015	2:58:54 A	T06	
1/8/2015	2:58:55 A	T06	
1/8/2015	3:00:31 A	T06	
1/8/2015	3:00:32 A	T06	
1/8/2015	3:00:33 A	T06	
1/8/2015	3:00:34 A	T06	
1/8/2015	3:00:35 A	T06	
1/8/2015	5:44:22 P	T07	
1/8/2015	5:44:23 P	T07	
1/8/2015	5:44:24 P	T07	
1/8/2015	5:44:25 P	T07	
1/8/2015	5:44:27 P	T07	
1/8/2015	5:44:43 P	T07	
1/8/2015	5:44:45 P	T07	
1/8/2015	5:44:46 P	T07	
1/8/2015	5:44:47 P	T07	
1/8/2015	5:44:48 P	T07	
1/8/2015	5:45:04 P	T07	
1/8/2015	5:45:05 P	T07	
1/8/2015	5:45:06 P	T07	
1/8/2015	5:45:07 P	T07	
1/8/2015	5:45:08 P	T07	
1/8/2015	5:45:43 P	T07	
1/8/2015	5:45:44 P	T07	
1/8/2015	5:45:45 P	T07	
1/8/2015	5:45:46 P	T07	
1/8/2015	5:45:47 P	T07	
1/8/2015	5:48:18 P	T07	
1/8/2015	5:48:20 P	T07	
1/8/2015	5:48:21 P	T07	

Date	Time	Camera 1	Camera 2
1/8/2015	5:48:22 P	T07	
1/8/2015	5:48:23 P	T07	
1/8/2015	5:49:08 P	T07	
1/8/2015	5:49:09 P	T07	
1/8/2015	5:49:10 P	T07	
1/8/2015	5:49:11 P	T07	
1/8/2015	5:49:12 P	T07	
1/8/2015	7:07:57 P	T02	
1/8/2015	7:07:59 P	T02	
1/8/2015	7:08:01 P	T02	
1/8/2015	7:08:02 P	T02	
1/8/2015	7:08:03 P	T02	
1/8/2015	8:02:34 P	T07	
1/8/2015	8:02:35 P	T07	
1/8/2015	8:02:36 P	T07	
1/8/2015	8:02:37 P	T07	
1/8/2015	8:02:38 P	T07	
1/8/2015	8:02:53 P	T07	
1/8/2015	8:02:54 P	T07	
1/8/2015	8:02:55 P	T07	
1/8/2015	8:02:56 P	T07	
1/8/2015	8:02:57 P	T07	
2/8/2015	5:24:57 A	T07	
2/8/2015	5:24:58 A	T07	
2/8/2015	5:24:59 A	T07	
2/8/2015	5:25:00 A	T07	
2/8/2015	5:25:01 A	T07	
2/8/2015	5:25:16 A	T07	
2/8/2015	5:25:17 A	T07	
2/8/2015	5:25:18 A	T07	
2/8/2015	5:25:19 A	T07	
2/8/2015	5:25:20 A	T07	
2/8/2015	5:25:37 A	T07	
2/8/2015	5:25:38 A	T07	
2/8/2015	5:25:39 A	T07	
2/8/2015	5:25:40 A	T07	
2/8/2015	5:25:41 A	T07	
2/8/2015	7:16:59 A	T07	
2/8/2015	7:17:00 A	T07	

Date	Time	Camera 1	Camera 2
2/8/2015	7:17:01 A	T07	
2/8/2015	7:17:02 A	T07	
2/8/2015	7:17:03 A	T07	
3/8/2015	1:35:56 A	T06	
3/8/2015	1:35:57 A	T06	
3/8/2015	8:44:31 A	T08	
3/8/2015	8:44:32 A	T08	
3/8/2015	8:44:33 A	T08	
3/8/2015	8:44:34 A	T08	
3/8/2015	8:44:35 A	T08	
3/8/2015	8:47:20 A	T07	
3/8/2015	8:47:22 A	T07	
3/8/2015	8:47:23 A	T07	
3/8/2015	8:47:24 A	T07	
3/8/2015	8:47:25 A	T07	
3/8/2015	11:29:01 A	T07	
3/8/2015	11:29:02 A	T07	
3/8/2015	11:29:03 A	T07	
3/8/2015	11:29:04 A	T07	
3/8/2015	11:29:05 A	T07	
3/8/2015	1:35:43 P	T09	
3/8/2015	1:35:44 P	T09	
3/8/2015	1:35:45 P	T09	
3/8/2015	1:35:46 P	T09	
3/8/2015	1:35:47 P	T09	
3/8/2015	7:06:39 P	T07	
3/8/2015	7:06:40 P	T07	
3/8/2015	7:06:41 P	T07	
3/8/2015	7:06:42 P	T07	
3/8/2015	7:06:43 P	T07	
4/8/2015	3:19:32 A	T07	
4/8/2015	3:19:33 A	T07	
4/8/2015	3:19:34 A	T07	
4/8/2015	3:19:35 A	T07	
4/8/2015	3:19:36 A	T07	
4/8/2015	5:10:12 A	T07	
4/8/2015	5:10:13 A	T07	
4/8/2015	5:10:14 A	T07	
4/8/2015	5:10:15 A	T07	

Date	Time	Camera 1	Camera 2
4/8/2015	5:10:16 A	T07	
4/8/2015	7:34:03 A	T07	
4/8/2015	7:34:05 A	T07	
4/8/2015	7:34:06 A	T07	
4/8/2015	7:34:07 A	T07	
4/8/2015	7:34:08 A	T07	
4/8/2015	7:35:52 A	T07	
4/8/2015	7:35:53 A	T07	
4/8/2015	7:35:54 A	T07	
4/8/2015	7:35:55 A	T07	
4/8/2015	7:35:56 A	T07	
4/8/2015	7:36:13 A	T07	
4/8/2015	7:36:14 A	T07	
4/8/2015	7:36:15 A	T07	
4/8/2015	7:36:16 A	T07	
4/8/2015	7:36:17 A	T07	
4/8/2015	8:28:50 A	T09	
4/8/2015	8:28:51 A	T09	
4/8/2015	8:28:52 A	T09	
4/8/2015	8:28:53 A	T09	
4/8/2015	8:28:54 A	T09	
4/8/2015	7:50:55 P	T01	
4/8/2015	7:50:56 P	T01	
4/8/2015	7:50:57 P	T01	
4/8/2015	7:50:58 P	T01	
4/8/2015	7:50:59 P	T01	
4/8/2015	7:51:14 P	T01	
4/8/2015	7:51:15 P	T01	
4/8/2015	7:51:17 P	T01	
4/8/2015	7:51:18 P	T01	
4/8/2015	7:51:19 P	T01	
4/8/2015	7:58:02 P	T01	
4/8/2015	7:58:03 P	T01	
4/8/2015	7:58:04 P	T01	
4/8/2015	7:58:05 P	T01	
4/8/2015	7:58:06 P	T01	
4/8/2015	8:51:41 P	T01	
4/8/2015	8:51:42 P	T01	
4/8/2015	8:51:43 P	T01	

Date	Time	Camera 1	Camera 2
4/8/2015	8:51:44 P	T01	
4/8/2015	8:51:45 P	T01	
4/8/2015	10:22:42 P	T01	
4/8/2015	10:22:43 P	T01	
4/8/2015	10:22:44 P	T01	
4/8/2015	10:22:45 P	T01	
4/8/2015	10:22:46 P	T01	
5/8/2015	12:23:41 A	T01	
5/8/2015	12:23:42 A	T01	
5/8/2015	12:23:43 A	T01	
5/8/2015	12:23:44 A	T01	
5/8/2015	12:23:45 A	T01	
5/8/2015	12:24:00 A	T01	
5/8/2015	12:24:01 A	T01	
5/8/2015	12:24:02 A	T01	
5/8/2015	12:24:03 A	T01	
5/8/2015	12:24:04 A	T01	
5/8/2015	3:06:40 A	T06	
5/8/2015	3:06:41 A	T06	
5/8/2015	3:06:43 A	T06	
5/8/2015	3:06:44 A	T06	
5/8/2015	3:06:45 A	T06	
5/8/2015	3:22:12 A	T07	
5/8/2015	3:22:13 A	T07	
5/8/2015	3:22:14 A	T07	
5/8/2015	3:22:15 A	T07	
5/8/2015	3:22:16 A	T07	
5/8/2015	3:40:26 A	T06	
5/8/2015	3:40:29 A	T06	
5/8/2015	3:40:30 A	T06	
5/8/2015	3:40:31 A	T06	
5/8/2015	3:40:32 A	T06	
5/8/2015	3:41:07 A	T06	
5/8/2015	3:41:08 A	T06	
5/8/2015	3:41:09 A	T06	
5/8/2015	3:41:10 A	T06	
5/8/2015	3:41:11 A	T06	
5/8/2015	5:00:19 A	T06	
5/8/2015	5:00:20 A	T06	

Date	Time	Camera 1	Camera 2
5/8/2015	5:00:22 A	T06	
5/8/2015	5:00:23 A	T06	
5/8/2015	5:00:24 A	T06	
5/8/2015	6:38:14 A	T06	
5/8/2015	6:38:15 A	T06	
5/8/2015	6:38:16 A	T06	
5/8/2015	6:38:17 A	T06	
5/8/2015	6:38:18 A	T06	
5/8/2015	6:57:28 A	T07	
5/8/2015	6:57:30 A	T07	
5/8/2015	6:57:31 A	T07	
5/8/2015	6:57:32 A	T07	
5/8/2015	6:57:33 A	T07	
5/8/2015	6:57:49 A	T07	
5/8/2015	6:57:50 A	T07	
5/8/2015	6:57:51 A	T07	
5/8/2015	6:57:52 A	T07	
5/8/2015	6:57:53 A	T07	
5/8/2015	9:35:46 A	T07	
5/8/2015	9:35:47 A	T07	
5/8/2015	9:35:48 A	T07	
5/8/2015	9:35:49 A	T07	
5/8/2015	9:35:50 A	T07	
5/8/2015	4:40:10 P	T07	
5/8/2015	4:40:11 P	T07	
5/8/2015	4:40:12 P	T07	
5/8/2015	4:40:13 P	T07	
5/8/2015	4:40:14 P	T07	
5/8/2015	4:40:47 P	T07	
5/8/2015	4:40:48 P	T07	
5/8/2015	4:40:49 P	T07	
5/8/2015	4:40:50 P	T07	
5/8/2015	4:40:51 P	T07	
5/8/2015	5:11:14 P	T08	
5/8/2015	5:11:15 P	T08	
5/8/2015	5:11:16 P	T08	
5/8/2015	5:11:17 P	T08	
5/8/2015	5:11:18 P	T08	
5/8/2015	5:12:16 P	T08	

Date	Time	Camera 1	Camera 2
5/8/2015	5:12:17 P	T08	
5/8/2015	5:12:18 P	T08	
5/8/2015	5:12:19 P	T08	
5/8/2015	5:12:20 P	T08	
5/8/2015	5:43:24 P	T09	
5/8/2015	5:43:25 P	T09	
5/8/2015	5:43:26 P	T09	
5/8/2015	5:43:27 P	T09	
5/8/2015	5:43:28 P	T09	
5/8/2015	7:11:29 P	T07	
5/8/2015	7:11:31 P	T07	
5/8/2015	7:11:32 P	T07	
5/8/2015	7:11:33 P	T07	
5/8/2015	7:11:34 P	T07	
5/8/2015	7:29:56 P	T06	
5/8/2015	7:29:57 P	T06	
5/8/2015	7:29:58 P	T06	
5/8/2015	7:29:59 P	T06	
5/8/2015	7:30:00 P	T06	
5/8/2015	7:46:29 P	T01	
5/8/2015	7:46:30 P	T01	
5/8/2015	7:46:31 P	T01	
5/8/2015	7:46:32 P	T01	
5/8/2015	7:46:33 P	T01	
5/8/2015	7:49:37 P	T06	
5/8/2015	7:49:38 P	T06	
5/8/2015	7:49:39 P	T06	
5/8/2015	7:49:40 P	T06	
5/8/2015	7:49:41 P	T06	
5/8/2015	9:03:55 P	T06	
5/8/2015	9:03:56 P	T06	
5/8/2015	9:03:58 P	T06	
5/8/2015	9:03:59 P	T06	
5/8/2015	9:04:00 P	T06	
5/8/2015	10:24:09 P	T01	
5/8/2015	10:24:10 P	T01	
5/8/2015	10:24:11 P	T01	
5/8/2015	10:24:12 P	T01	
5/8/2015	10:24:13 P	T01	

Date	Time	Camera 1	Camera 2
5/8/2015	10:24:28 P	T01	
5/8/2015	10:24:29 P	T01	
5/8/2015	10:24:30 P	T01	
5/8/2015	10:24:31 P	T01	
5/8/2015	10:24:32 P	T01	
6/8/2015	1:40:52 A	T01	
6/8/2015	1:40:53 A	T01	
6/8/2015	1:40:54 A	T01	
6/8/2015	1:40:55 A	T01	
6/8/2015	1:40:56 A	T01	
6/8/2015	1:41:21 A	T01	
6/8/2015	1:41:22 A	T01	
6/8/2015	1:41:23 A	T01	
6/8/2015	1:41:24 A	T01	
6/8/2015	1:41:25 A	T01	
6/8/2015	1:46:52 A	T06	
6/8/2015	1:46:53 A	T06	
6/8/2015	1:46:54 A	T06	
6/8/2015	1:46:55 A	T06	
6/8/2015	1:46:56 A	T06	
6/8/2015	2:00:24 A	T01	
6/8/2015	2:00:25 A	T01	
6/8/2015	2:00:26 A	T01	
6/8/2015	2:00:27 A	T01	
6/8/2015	2:00:28 A	T01	
6/8/2015	2:00:43 A	T01	
6/8/2015	2:00:44 A	T01	
6/8/2015	2:00:45 A	T01	
6/8/2015	2:00:46 A	T01	
6/8/2015	2:00:47 A	T01	
6/8/2015	2:01:33 A	T01	
6/8/2015	2:01:34 A	T01	
6/8/2015	2:01:35 A	T01	
6/8/2015	2:01:36 A	T01	
6/8/2015	2:01:37 A	T01	
6/8/2015	2:04:17 A	T01	
6/8/2015	2:04:18 A	T01	
6/8/2015	2:04:19 A	T01	
6/8/2015	2:04:20 A	T01	

Date	Time	Camera 1	Camera 2
6/8/2015	2:04:21 A	T01	
6/8/2015	2:48:25 A	T01	
6/8/2015	2:48:26 A	T01	
6/8/2015	2:48:27 A	T01	
6/8/2015	2:48:28 A	T01	
6/8/2015	2:48:29 A	T01	
6/8/2015	5:21:33 A	T01	
6/8/2015	5:21:34 A	T01	
6/8/2015	5:21:35 A	T01	
6/8/2015	5:21:36 A	T01	
6/8/2015	5:21:37 A	T01	
6/8/2015	6:11:29 A	T01	
6/8/2015	6:11:30 A	T01	
6/8/2015	6:11:31 A	T01	
6/8/2015	6:11:32 A	T01	
6/8/2015	6:11:33 A	T01	
6/8/2015	9:31:03 A	T07	
6/8/2015	9:31:05 A	T07	
6/8/2015	9:31:06 A	T07	
6/8/2015	9:31:07 A	T07	
6/8/2015	9:31:08 A	T07	
6/8/2015	10:15:29 A	T07	
6/8/2015	10:15:30 A	T07	
6/8/2015	10:15:31 A	T07	
6/8/2015	10:15:32 A	T07	
6/8/2015	10:15:33 A	T07	
6/8/2015	10:15:50 A	T07	
6/8/2015	10:15:51 A	T07	
6/8/2015	10:15:52 A	T07	
6/8/2015	10:15:53 A	T07	
6/8/2015	10:15:54 A	T07	
6/8/2015	10:16:46 A	T07	
6/8/2015	10:16:47 A	T07	
6/8/2015	10:16:48 A	T07	
6/8/2015	10:16:49 A	T07	
6/8/2015	10:16:50 A	T07	
6/8/2015	10:28:21 A	T07	
6/8/2015	10:28:22 A	T07	
6/8/2015	10:28:23 A	T07	

Date	Time	Camera 1	Camera 2
6/8/2015	10:28:24 A	T07	
6/8/2015	10:28:25 A	T07	
6/8/2015	10:28:41 A	T07	
6/8/2015	10:28:42 A	T07	
6/8/2015	10:28:43 A	T07	
6/8/2015	10:28:44 A	T07	
6/8/2015	10:28:45 A	T07	
6/8/2015	1:25:27 P	T07	
6/8/2015	1:25:28 P	T07	
6/8/2015	1:25:29 P	T07	
6/8/2015	1:25:30 P	T07	
6/8/2015	1:25:31 P	T07	
6/8/2015	3:09:11 P	T07	
6/8/2015	3:09:12 P	T07	
6/8/2015	3:09:13 P	T07	
6/8/2015	3:09:14 P	T07	
6/8/2015	3:09:15 P	T07	
6/8/2015	3:09:53 P	T07	
6/8/2015	3:09:54 P	T07	
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6/8/2015	3:09:56 P	T07	
6/8/2015	3:09:57 P	T07	
6/8/2015	3:10:32 P	T07	
6/8/2015	3:10:33 P	T07	
6/8/2015	3:10:34 P	T07	
6/8/2015	3:10:35 P	T07	
6/8/2015	3:10:36 P	T07	
6/8/2015	5:32:52 P	T06	
6/8/2015	5:32:53 P	T06	
6/8/2015	5:32:54 P	T06	
6/8/2015	5:32:55 P	T06	
6/8/2015	5:32:56 P	T06	
6/8/2015	5:33:29 P	T06	
6/8/2015	5:33:31 P	T06	
6/8/2015	5:33:32 P	T06	
6/8/2015	5:33:33 P	T06	
6/8/2015	5:33:34 P	T06	
6/8/2015	5:34:27 P	T06	
6/8/2015	5:34:28 P	T06	

Date	Time	Camera 1	Camera 2
6/8/2015	5:34:29 P	T06	
6/8/2015	5:34:30 P	T06	
6/8/2015	5:34:31 P	T06	
6/8/2015	5:34:48 P	T06	
6/8/2015	5:34:49 P	T06	
6/8/2015	5:34:50 P	T06	
6/8/2015	5:34:51 P	T06	
6/8/2015	5:34:52 P	T06	
6/8/2015	5:35:14 P	T06	
6/8/2015	5:35:15 P	T06	
6/8/2015	5:35:16 P	T06	
6/8/2015	5:35:17 P	T06	
6/8/2015	5:35:18 P	T06	
6/8/2015	6:18:51 P	T07	
6/8/2015	6:18:52 P	T07	
6/8/2015	6:18:53 P	T07	
6/8/2015	6:18:54 P	T07	
6/8/2015	6:18:55 P	T07	
6/8/2015	6:19:19 P	T07	
6/8/2015	6:19:20 P	T07	
6/8/2015	6:19:21 P	T07	
6/8/2015	6:19:22 P	T07	
6/8/2015	6:19:23 P	T07	
6/8/2015	6:20:24 P	T07	
6/8/2015	6:20:25 P	T07	
6/8/2015	6:20:26 P	T07	
6/8/2015	6:20:27 P	T07	
6/8/2015	6:20:28 P	T07	
6/8/2015	6:24:56 P	T07	
6/8/2015	6:24:58 P	T07	
6/8/2015	6:24:59 P	T07	
6/8/2015	6:25:00 P	T07	
6/8/2015	6:25:01 P	T07	
6/8/2015	6:25:27 P	T07	
6/8/2015	6:25:28 P	T07	
6/8/2015	6:25:29 P	T07	
6/8/2015	6:25:30 P	T07	
6/8/2015	6:25:31 P	T07	
6/8/2015	6:27:02 P	T07	

Date	Time	Camera 1	Camera 2
6/8/2015	6:27:03 P	T07	
6/8/2015	6:27:04 P	T07	
6/8/2015	6:27:05 P	T07	
6/8/2015	6:27:06 P	T07	
6/8/2015	6:27:28 P	T07	
6/8/2015	6:27:29 P	T07	
6/8/2015	6:27:30 P	T07	
6/8/2015	6:27:31 P	T07	
6/8/2015	6:27:32 P	T07	
6/8/2015	6:33:42 P	T07	
6/8/2015	6:33:43 P	T07	
6/8/2015	6:33:44 P	T07	
6/8/2015	6:33:45 P	T07	
6/8/2015	6:33:46 P	T07	
6/8/2015	6:34:23 P	T07	
6/8/2015	6:34:24 P	T07	
6/8/2015	6:34:25 P	T07	
6/8/2015	6:34:26 P	T07	
6/8/2015	6:34:27 P	T07	
6/8/2015	6:34:43 P	T07	
6/8/2015	6:34:44 P	T07	
6/8/2015	6:34:45 P	T07	
6/8/2015	6:34:46 P	T07	
6/8/2015	6:34:47 P	T07	
6/8/2015	6:35:02 P	T07	
6/8/2015	6:35:03 P	T07	
6/8/2015	6:35:04 P	T07	
6/8/2015	6:35:05 P	T07	
6/8/2015	6:35:06 P	T07	
6/8/2015	6:35:37 P	T07	
6/8/2015	6:35:38 P	T07	
6/8/2015	6:35:39 P	T07	
6/8/2015	6:35:40 P	T07	
6/8/2015	6:35:41 P	T07	
6/8/2015	6:36:16 P	T07	
6/8/2015	6:36:17 P	T07	
6/8/2015	6:36:18 P	T07	
6/8/2015	6:36:19 P	T07	
6/8/2015	6:36:20 P	T07	

Date	Time	Camera 1	Camera 2
6/8/2015	6:36:43 P	T07	
6/8/2015	6:36:44 P	T07	
6/8/2015	6:36:45 P	T07	
6/8/2015	6:36:46 P	T07	
6/8/2015	6:36:47 P	T07	
6/8/2015	6:37:05 P	T07	
6/8/2015	6:37:06 P	T07	
6/8/2015	6:37:07 P	T07	
6/8/2015	6:37:08 P	T07	
6/8/2015	6:37:09 P	T07	
6/8/2015	6:37:30 P	T01	
6/8/2015	6:37:31 P	T01	
6/8/2015	6:37:32 P	T01	
6/8/2015	6:37:33 P	T01	
6/8/2015	6:37:34 P	T01	
6/8/2015	6:38:59 P	T07	
6/8/2015	6:39:00 P	T07	
6/8/2015	6:39:01 P	T07	
6/8/2015	6:39:02 P	T07	
6/8/2015	6:39:03 P	T07	
6/8/2015	7:22:34 P	T01	
6/8/2015	7:22:35 P	T01	
6/8/2015	7:22:36 P	T01	
6/8/2015	7:22:37 P	T01	
6/8/2015	7:22:38 P	T01	
6/8/2015	8:14:12 P	T01	
6/8/2015	8:14:13 P	T01	
6/8/2015	8:14:14 P	T01	
6/8/2015	8:14:15 P	T01	
6/8/2015	8:14:16 P	T01	
6/8/2015	8:19:15 P	T06	
6/8/2015	8:19:16 P	T06	
6/8/2015	8:19:17 P	T06	
6/8/2015	8:19:18 P	T06	
6/8/2015	8:43:48 P	T06	
6/8/2015	8:43:49 P	T06	
6/8/2015	8:43:50 P	T06	
6/8/2015	8:43:51 P	T06	
6/8/2015	8:43:52 P	T06	

Date	Time	Camera 1	Camera 2
6/8/2015	8:44:07 P	T06	
6/8/2015	8:44:08 P	T06	
6/8/2015	8:44:09 P	T06	
6/8/2015	8:44:10 P	T06	
6/8/2015	8:44:11 P	T06	
6/8/2015	8:54:01 P	T06	
6/8/2015	8:54:03 P	T06	
6/8/2015	8:54:04 P	T06	
6/8/2015	8:54:05 P	T06	
6/8/2015	8:54:06 P	T06	
6/8/2015	9:17:57 P	T07	
6/8/2015	9:17:58 P	T07	
6/8/2015	9:17:59 P	T07	
6/8/2015	9:18:00 P	T07	
6/8/2015	9:18:01 P	T07	
6/8/2015	9:18:18 P	T07	
6/8/2015	9:18:19 P	T07	
6/8/2015	9:18:20 P	T07	
6/8/2015	9:18:21 P	T07	
6/8/2015	9:18:22 P	T07	
6/8/2015	9:18:40 P	T07	
6/8/2015	9:18:41 P	T07	
6/8/2015	9:18:42 P	T07	
6/8/2015	9:18:43 P	T07	
6/8/2015	9:18:44 P	T07	
6/8/2015	9:20:05 P	T07	
6/8/2015	9:20:06 P	T07	
6/8/2015	9:20:07 P	T07	
6/8/2015	9:20:08 P	T07	
6/8/2015	9:20:09 P	T07	
6/8/2015	9:40:02 P	T07	
6/8/2015	9:40:03 P	T07	
6/8/2015	9:40:04 P	T07	
6/8/2015	9:40:05 P	T07	
6/8/2015	9:40:06 P	T07	
6/8/2015	9:40:25 P	T07	
6/8/2015	9:40:26 P	T07	
6/8/2015	9:40:27 P	T07	
6/8/2015	9:40:28 P	T07	

Date	Time	Camera 1	Camera 2
6/8/2015	9:40:29 P	T07	
6/8/2015	9:40:44 P	T07	
6/8/2015	9:40:45 P	T07	
6/8/2015	9:40:46 P	T07	
6/8/2015	9:40:47 P	T07	
6/8/2015	9:40:48 P	T07	
6/8/2015	9:41:24 P	T07	
6/8/2015	9:41:25 P	T07	
6/8/2015	9:41:26 P	T07	
6/8/2015	9:41:27 P	T07	
6/8/2015	9:41:28 P	T07	
6/8/2015	9:45:32 P	T07	
6/8/2015	9:45:33 P	T07	
6/8/2015	9:45:34 P	T07	
6/8/2015	9:45:35 P	T07	
6/8/2015	9:45:36 P	T07	
6/8/2015	9:46:19 P	T07	
6/8/2015	9:46:20 P	T07	
6/8/2015	9:46:21 P	T07	
6/8/2015	9:46:22 P	T07	
6/8/2015	9:46:23 P	T07	
6/8/2015	9:46:43 P	T07	
6/8/2015	9:46:44 P	T07	
6/8/2015	9:46:45 P	T07	
6/8/2015	9:46:46 P	T07	
6/8/2015	9:46:47 P	T07	
6/8/2015	9:47:32 P	T07	
6/8/2015	9:47:33 P	T07	
6/8/2015	9:47:34 P	T07	
6/8/2015	9:47:35 P	T07	
6/8/2015	9:47:36 P	T07	
6/8/2015	9:48:13 P	T07	
6/8/2015	9:48:14 P	T07	
6/8/2015	9:48:15 P	T07	
6/8/2015	9:48:16 P	T07	
6/8/2015	9:48:17 P	T07	
6/8/2015	9:48:35 P	T07	
6/8/2015	9:48:36 P	T07	
6/8/2015	9:48:37 P	T07	

Date	Time	Camera 1	Camera 2
6/8/2015	9:48:38 P	T07	
6/8/2015	9:48:39 P	T07	
6/8/2015	9:50:07 P	T07	
6/8/2015	9:50:08 P	T07	
6/8/2015	9:50:09 P	T07	
6/8/2015	9:50:10 P	T07	
6/8/2015	9:50:11 P	T07	
6/8/2015	9:54:36 P	T07	
6/8/2015	9:54:37 P	T07	
6/8/2015	9:54:38 P	T07	
6/8/2015	9:54:39 P	T07	
6/8/2015	9:54:40 P	T07	
6/8/2015	10:44:37 P	T01	
6/8/2015	10:44:38 P	T01	
6/8/2015	10:44:39 P	T01	
6/8/2015	10:44:40 P	T01	
6/8/2015	10:44:41 P	T01	
6/8/2015	10:48:23 P	T01	
6/8/2015	10:48:24 P	T01	
6/8/2015	10:48:25 P	T01	
6/8/2015	10:48:26 P	T01	
6/8/2015	10:48:27 P	T01	
6/8/2015	10:48:43 P	T01	
6/8/2015	10:48:44 P	T01	
6/8/2015	10:48:45 P	T01	
6/8/2015	10:48:46 P	T01	
6/8/2015	10:48:47 P	T01	
6/8/2015	10:49:24 P	T01	
6/8/2015	10:49:25 P	T01	
6/8/2015	10:49:26 P	T01	
6/8/2015	10:49:27 P	T01	
6/8/2015	10:49:28 P	T01	
7/8/2015	8:11:28 A	T09	
7/8/2015	8:11:29 A	T09	
7/8/2015	8:11:30 A	T09	
7/8/2015	8:11:31 A	T09	
7/8/2015	8:11:32 A	T09	
7/8/2015	6:32:08 P	T08	
7/8/2015	6:32:09 P	T08	

Date	Time	Camera 1	Camera 2
7/8/2015	6:32:10 P	T08	
7/8/2015	6:32:11 P	T08	
7/8/2015	6:32:12 P	T08	
7/8/2015	6:42:17 P	T07	
7/8/2015	6:42:18 P	T07	
7/8/2015	6:42:19 P	T07	
7/8/2015	6:42:20 P	T07	
7/8/2015	6:42:21 P	T07	
7/8/2015	6:42:36 P	T07	
7/8/2015	6:42:37 P	T07	
7/8/2015	6:42:38 P	T07	
7/8/2015	6:42:39 P	T07	
7/8/2015	6:42:40 P	T07	
7/8/2015	6:46:59 P	T07	
7/8/2015	6:47:00 P	T07	
7/8/2015	6:47:01 P	T07	
7/8/2015	6:47:02 P	T07	
7/8/2015	6:47:03 P	T07	
7/8/2015	6:48:42 P	T07	
7/8/2015	6:48:43 P	T07	
7/8/2015	6:48:44 P	T07	
7/8/2015	6:48:45 P	T07	
7/8/2015	6:48:46 P	T07	
7/8/2015	6:49:48 P	T07	
7/8/2015	6:49:49 P	T07	
7/8/2015	6:49:50 P	T07	
7/8/2015	6:49:51 P	T07	
7/8/2015	6:49:52 P	T07	
7/8/2015	8:05:47 P	T06	
7/8/2015	8:05:48 P	T06	
7/8/2015	8:05:49 P	T06	
7/8/2015	8:05:50 P	T06	
7/8/2015	8:05:51 P	T06	
7/8/2015	8:06:07 P	T06	
7/8/2015	8:06:08 P	T06	
7/8/2015	8:06:09 P	T06	
7/8/2015	8:06:10 P	T06	
7/8/2015	8:06:11 P	T06	
7/8/2015	9:02:14 P	T06	

Date	Time	Camera 1	Camera 2
7/8/2015	9:02:15 P	T06	
7/8/2015	9:02:16 P	T06	
7/8/2015	9:02:17 P	T06	
7/8/2015	9:02:18 P	T06	
7/8/2015	9:02:43 P	T06	
7/8/2015	9:02:44 P	T06	
7/8/2015	9:02:45 P	T06	
7/8/2015	9:02:46 P	T06	
7/8/2015	9:02:47 P	T06	
7/8/2015	11:28:21 P	T06	
7/8/2015	11:28:22 P	T06	
7/8/2015	11:28:23 P	T06	
7/8/2015	11:28:24 P	T06	
7/8/2015	11:28:25 P	T06	
8/8/2015	12:26:23 A	T06	
8/8/2015	12:26:24 A	T06	
8/8/2015	12:26:25 A	T06	
8/8/2015	12:26:26 A	T06	
8/8/2015	12:26:27 A	T06	
8/8/2015	1:08:46 A	T06	
8/8/2015	1:08:47 A	T06	
8/8/2015	1:08:49 A	T06	
8/8/2015	1:08:50 A	T06	
8/8/2015	1:08:51 A	T06	
8/8/2015	2:37:08 A	T06	
8/8/2015	2:37:09 A	T06	
8/8/2015	2:37:10 A	T06	
8/8/2015	2:37:11 A	T06	
8/8/2015	2:37:12 A	T06	
8/8/2015	5:33:40 A	T06	
8/8/2015	5:33:42 A	T06	
8/8/2015	5:33:43 A	T06	
8/8/2015	5:33:44 A	T06	
8/8/2015	5:33:45 A	T06	
8/8/2015	5:34:08 A	T06	
8/8/2015	5:34:10 A	T06	
8/8/2015	5:34:11 A	T06	
8/8/2015	5:34:12 A	T06	
8/8/2015	5:34:13 A	T06	

Date	Time	Camera 1	Camera 2
8/8/2015	6:23:31 A	T07	
8/8/2015	6:23:33 A	T07	
8/8/2015	6:23:34 A	T07	
8/8/2015	6:23:35 A	T07	
8/8/2015	6:23:36 A	T07	
8/8/2015	6:23:52 A	T07	
8/8/2015	6:23:53 A	T07	
8/8/2015	6:23:54 A	T07	
8/8/2015	6:23:55 A	T07	
8/8/2015	6:23:56 A	T07	
8/8/2015	6:24:55 A	T07	
8/8/2015	6:24:56 A	T07	
8/8/2015	6:24:57 A	T07	
8/8/2015	6:24:58 A	T07	
8/8/2015	6:24:59 A	T07	
8/8/2015	7:03:10 A	T07	
8/8/2015	7:03:11 A	T07	
8/8/2015	7:03:12 A	T07	
8/8/2015	7:03:13 A	T07	
8/8/2015	7:03:14 A	T07	
8/8/2015	7:03:31 A	T07	
8/8/2015	7:03:32 A	T07	
8/8/2015	7:03:33 A	T07	
8/8/2015	7:03:34 A	T07	
8/8/2015	7:03:35 A	T07	
8/8/2015	7:04:09 A	T07	
8/8/2015	7:04:10 A	T07	
8/8/2015	7:04:11 A	T07	
8/8/2015	7:04:12 A	T07	
8/8/2015	7:04:13 A	T07	
8/8/2015	7:05:02 A	T07	
8/8/2015	7:05:03 A	T07	
8/8/2015	7:05:04 A	T07	
8/8/2015	7:05:05 A	T07	
8/8/2015	7:05:06 A	T07	
8/8/2015	7:06:47 A	T07	
8/8/2015	7:06:48 A	T07	
8/8/2015	7:06:49 A	T07	
8/8/2015	7:06:50 A	T07	

Date	Time	Camera 1	Camera 2
8/8/2015	7:06:51 A	T07	
8/8/2015	7:07:08 A	T07	
8/8/2015	7:07:09 A	T07	
8/8/2015	7:07:10 A	T07	
8/8/2015	7:07:11 A	T07	
8/8/2015	7:07:12 A	T07	
8/8/2015	7:07:28 A	T07	
8/8/2015	7:07:29 A	T07	
8/8/2015	7:07:30 A	T07	
8/8/2015	7:07:31 A	T07	
8/8/2015	7:07:32 A	T07	
8/8/2015	7:10:34 A	T07	
8/8/2015	7:10:35 A	T07	
8/8/2015	7:10:37 A	T07	
8/8/2015	7:10:38 A	T07	
8/8/2015	7:10:39 A	T07	
8/8/2015	7:24:50 A	T07	
8/8/2015	7:24:52 A	T07	
8/8/2015	7:24:53 A	T07	
8/8/2015	7:24:54 A	T07	
8/8/2015	7:24:55 A	T07	
8/8/2015	7:25:15 A	T07	
8/8/2015	7:25:16 A	T07	
8/8/2015	7:25:17 A	T07	
8/8/2015	7:25:18 A	T07	
8/8/2015	7:25:19 A	T07	
8/8/2015	7:02:14 P	T07	
8/8/2015	7:02:15 P	T07	
8/8/2015	7:02:16 P	T07	
8/8/2015	7:02:17 P	T07	
8/8/2015	7:02:18 P	T07	
9/8/2015	2:00:00 A	T06	
9/8/2015	2:00:02 A	T06	
9/8/2015	2:00:03 A	T06	
9/8/2015	2:00:04 A	T06	
9/8/2015	2:00:05 A	T06	
9/8/2015	5:57:36 A	T06	
9/8/2015	5:57:37 A	T06	
9/8/2015	5:57:39 A	T06	

Date	Time	Camera 1	Camera 2
9/8/2015	5:57:40 A	T06	
9/8/2015	5:57:41 A	T06	
9/8/2015	6:53:52 A	T07	
9/8/2015	6:53:53 A	T07	
9/8/2015	6:53:54 A	T07	
9/8/2015	6:53:55 A	T07	
9/8/2015	6:53:56 A	T07	
9/8/2015	6:54:15 A	T07	
9/8/2015	6:54:17 A	T07	
9/8/2015	6:54:18 A	T07	
9/8/2015	6:54:19 A	T07	
9/8/2015	6:54:20 A	T07	
9/8/2015	6:56:50 A	T07	
9/8/2015	6:56:51 A	T07	
9/8/2015	6:56:52 A	T07	
9/8/2015	6:56:53 A	T07	
9/8/2015	6:56:54 A	T07	
9/8/2015	6:57:09 A	T07	
9/8/2015	6:57:10 A	T07	
9/8/2015	6:57:11 A	T07	
9/8/2015	6:57:12 A	T07	
9/8/2015	6:57:13 A	T07	
9/8/2015	5:22:07 P	T07	
9/8/2015	5:22:08 P	T07	
9/8/2015	5:22:09 P	T07	
9/8/2015	5:22:10 P	T07	
9/8/2015	5:22:11 P	T07	
9/8/2015	5:44:12 P	T07	
9/8/2015	5:44:13 P	T07	
9/8/2015	5:44:14 P	T07	
9/8/2015	5:44:15 P	T07	
9/8/2015	5:44:16 P	T07	
9/8/2015	5:44:34 P	T07	
9/8/2015	5:44:36 P	T07	
9/8/2015	5:44:37 P	T07	
9/8/2015	5:44:38 P	T07	
9/8/2015	5:44:39 P	T07	
9/8/2015	5:44:57 P	T07	
9/8/2015	5:44:58 P	T07	

Date	Time	Camera 1	Camera 2
9/8/2015	5:44:59 P	T07	
9/8/2015	5:45:00 P	T07	
9/8/2015	5:45:01 P	T07	
9/8/2015	5:45:19 P	T07	
9/8/2015	5:45:21 P	T07	
9/8/2015	5:45:22 P	T07	
9/8/2015	5:45:23 P	T07	
9/8/2015	5:45:24 P	T07	
9/8/2015	7:48:16 P	T06	
9/8/2015	7:48:17 P	T06	
9/8/2015	7:48:18 P	T06	
9/8/2015	7:48:19 P	T06	
9/8/2015	7:48:20 P	T06	
9/8/2015	9:47:56 P	T02	
9/8/2015	9:47:58 P	T02	
9/8/2015	9:47:59 P	T02	
9/8/2015	9:48:00 P	T02	
9/8/2015	9:48:01 P	T02	
10/8/2015	12:28:42 A	T06	
10/8/2015	12:28:43 A	T06	
10/8/2015	12:28:44 A	T06	
10/8/2015	12:28:45 A	T06	
10/8/2015	12:28:46 A	T06	
10/8/2015	1:06:24 A	T06	
10/8/2015	1:06:25 A	T06	
10/8/2015	1:06:28 A	T06	
10/8/2015	1:06:29 A	T06	
10/8/2015	1:06:30 A	T06	
10/8/2015	5:17:02 A	T07	
10/8/2015	5:17:04 A	T07	
10/8/2015	5:17:05 A	T07	
10/8/2015	5:17:06 A	T07	
10/8/2015	5:17:07 A	T07	
10/8/2015	5:17:43 A	T07	
10/8/2015	5:17:44 A	T07	
10/8/2015	5:17:45 A	T07	
10/8/2015	5:17:46 A	T07	
10/8/2015	5:17:47 A	T07	
10/8/2015	3:57:57 P	T07	

Date	Time	Camera 1	Camera 2
10/8/2015	3:57:58 P	T07	
10/8/2015	3:57:59 P	T07	
10/8/2015	3:58:00 P	T07	
10/8/2015	3:58:01 P	T07	
10/8/2015	7:31:52 P	T07	
10/8/2015	7:31:53 P	T07	
10/8/2015	7:31:54 P	T07	
10/8/2015	7:31:55 P	T07	
10/8/2015	7:31:56 P	T07	
10/8/2015	7:33:36 P	T07	
10/8/2015	7:33:37 P	T07	
10/8/2015	7:33:38 P	T07	
10/8/2015	7:33:39 P	T07	
10/8/2015	7:33:40 P	T07	
10/8/2015	7:34:34 P	T07	
10/8/2015	7:34:35 P	T07	
10/8/2015	7:34:36 P	T07	
10/8/2015	7:34:37 P	T07	
10/8/2015	7:34:38 P	T07	
10/8/2015	7:44:54 P	T06	
10/8/2015	7:44:55 P	T06	
10/8/2015	7:44:56 P	T06	
10/8/2015	7:44:57 P	T06	
10/8/2015	7:44:58 P	T06	
10/8/2015	7:45:24 P	T07	
10/8/2015	7:45:25 P	T07	
10/8/2015	7:45:26 P	T07	
10/8/2015	7:45:27 P	T07	
10/8/2015	7:45:28 P	T07	
10/8/2015	8:15:23 P	T07	
10/8/2015	8:15:24 P	T07	
10/8/2015	8:15:25 P	T07	
10/8/2015	8:15:26 P	T07	
10/8/2015	8:15:27 P	T07	
11/8/2015	2:55:47 A	T07	
11/8/2015	2:55:48 A	T07	
11/8/2015	2:55:49 A	T07	
11/8/2015	2:55:50 A	T07	
11/8/2015	2:55:51 A	T07	

Date	Time	Camera 1	Camera 2
11/8/2015	2:56:08 A	T07	
11/8/2015	2:56:09 A	T07	
11/8/2015	2:56:10 A	T07	
11/8/2015	2:56:11 A	T07	
11/8/2015	2:56:12 A	T07	
11/8/2015	2:59:24 A	T07	
11/8/2015	2:59:25 A	T07	
11/8/2015	2:59:26 A	T07	
11/8/2015	2:59:27 A	T07	
11/8/2015	2:59:28 A	T07	
11/8/2015	3:20:15 A	T06	
11/8/2015	3:20:16 A	T06	
11/8/2015	3:20:18 A	T06	
11/8/2015	3:20:19 A	T06	
11/8/2015	3:20:20 A	T06	
11/8/2015	3:46:48 A	T06	
11/8/2015	3:46:49 A	T06	
11/8/2015	3:46:50 A	T06	
11/8/2015	3:46:51 A	T06	
11/8/2015	3:46:52 A	T06	
11/8/2015	3:47:08 A	T06	
11/8/2015	3:47:09 A	T06	
11/8/2015	3:47:10 A	T06	
11/8/2015	3:47:11 A	T06	
11/8/2015	3:47:12 A	T06	
11/8/2015	3:59:48 A	T06	
11/8/2015	3:59:49 A	T06	
11/8/2015	3:59:50 A	T06	
11/8/2015	3:59:51 A	T06	
11/8/2015	3:59:52 A	T06	
11/8/2015	4:24:55 A	T07	
11/8/2015	4:24:56 A	T07	
11/8/2015	4:24:58 A	T07	
11/8/2015	4:24:59 A	T07	
11/8/2015	4:25:00 A	T07	
11/8/2015	5:36:57 A	T07	
11/8/2015	5:36:58 A	T07	
11/8/2015	5:36:59 A	T07	
11/8/2015	5:37:00 A	T07	

Date	Time	Camera 1	Camera 2
11/8/2015	5:37:01 A	T07	
11/8/2015	6:08:07 A	T07	
11/8/2015	6:08:08 A	T07	
11/8/2015	6:08:09 A	T07	
11/8/2015	6:08:10 A	T07	
11/8/2015	6:08:11 A	T07	
11/8/2015	6:47:51 A	T06	
11/8/2015	6:47:52 A	T06	
11/8/2015	6:47:54 A	T06	
11/8/2015	6:47:55 A	T06	
11/8/2015	6:47:56 A	T06	
11/8/2015	6:48:16 A	T06	
11/8/2015	6:48:17 A	T06	
11/8/2015	6:48:18 A	T06	
11/8/2015	6:48:19 A	T06	
11/8/2015	6:48:20 A	T06	
11/8/2015	6:48:40 A	T06	
11/8/2015	6:48:41 A	T06	
11/8/2015	6:48:42 A	T06	
11/8/2015	6:48:43 A	T06	
11/8/2015	6:48:44 A	T06	
11/8/2015	6:49:00 A	T06	
11/8/2015	6:49:01 A	T06	
11/8/2015	6:49:02 A	T06	
11/8/2015	6:49:03 A	T06	
11/8/2015	6:49:04 A	T06	
11/8/2015	5:05:34 P	T07	
11/8/2015	5:05:36 P	T07	
11/8/2015	5:05:37 P	T07	
11/8/2015	5:05:38 P	T07	
11/8/2015	5:05:39 P	T07	
11/8/2015	5:07:50 P	T07	
11/8/2015	5:07:51 P	T07	
11/8/2015	5:07:52 P	T07	
11/8/2015	5:07:53 P	T07	
11/8/2015	5:07:54 P	T07	
11/8/2015	7:12:26 P	T07	
11/8/2015	7:12:27 P	T07	
11/8/2015	7:12:28 P	T07	

Date	Time	Camera 1	Camera 2
11/8/2015	7:12:29 P	T07	
11/8/2015	7:12:30 P	T07	
11/8/2015	7:29:41 P	T07	
11/8/2015	7:29:42 P	T07	
11/8/2015	7:29:43 P	T07	
11/8/2015	7:29:44 P	T07	
11/8/2015	7:29:45 P	T07	
11/8/2015	7:30:24 P	T07	
11/8/2015	7:30:25 P	T07	
11/8/2015	7:30:26 P	T07	
11/8/2015	7:30:27 P	T07	
11/8/2015	7:30:28 P	T07	
11/8/2015	7:31:13 P	T07	
11/8/2015	7:31:14 P	T07	
11/8/2015	7:31:15 P	T07	
11/8/2015	7:31:16 P	T07	
11/8/2015	7:31:17 P	T07	
11/8/2015	8:52:13 P	T06	
11/8/2015	8:52:14 P	T06	
11/8/2015	8:52:16 P	T06	
11/8/2015	8:52:17 P	T06	
11/8/2015	8:52:18 P	T06	
11/8/2015	8:52:33 P	T06	
11/8/2015	8:52:35 P	T06	
11/8/2015	8:52:36 P	T06	
11/8/2015	8:52:37 P	T06	
11/8/2015	8:52:38 P	T06	
11/8/2015	8:54:42 P	T06	
11/8/2015	8:54:43 P	T06	
11/8/2015	8:54:45 P	T06	
11/8/2015	8:54:46 P	T06	
11/8/2015	8:54:47 P	T06	
11/8/2015	8:55:04 P	T06	
11/8/2015	8:55:05 P	T06	
11/8/2015	8:55:06 P	T06	
11/8/2015	8:55:07 P	T06	
11/8/2015	8:55:08 P	T06	
12/8/2015	12:02:46 A	T06	
12/8/2015	12:02:47 A	T06	

Date	Time	Camera 1	Camera 2
12/8/2015	12:02:48 A	T06	
12/8/2015	12:02:49 A	T06	
12/8/2015	12:02:50 A	T06	
12/8/2015	12:38:23 A	T07	
12/8/2015	12:38:24 A	T07	
12/8/2015	12:38:25 A	T07	
12/8/2015	12:38:26 A	T07	
12/8/2015	12:38:27 A	T07	
12/8/2015	6:55:49 A	T07	
12/8/2015	6:55:50 A	T07	
12/8/2015	6:55:51 A	T07	
12/8/2015	6:55:52 A	T07	
12/8/2015	6:55:53 A	T07	
12/8/2015	6:56:12 A	T07	
12/8/2015	6:56:13 A	T07	
12/8/2015	6:56:14 A	T07	
12/8/2015	6:56:15 A	T07	
12/8/2015	6:56:16 A	T07	
12/8/2015	7:12:01 A	T07	
12/8/2015	7:12:02 A	T07	
12/8/2015	7:12:03 A	T07	
12/8/2015	7:12:04 A	T07	
12/8/2015	7:12:05 A	T07	
12/8/2015	7:13:06 A	T07	
12/8/2015	7:13:07 A	T07	
12/8/2015	7:13:08 A	T07	
12/8/2015	7:13:09 A	T07	
12/8/2015	7:13:10 A	T07	
12/8/2015	7:14:08 A	T07	
12/8/2015	7:14:09 A	T07	
12/8/2015	7:14:10 A	T07	
12/8/2015	7:14:11 A	T07	
12/8/2015	7:14:12 A	T07	
12/8/2015	7:14:42 A	T07	
12/8/2015	7:14:43 A	T07	
12/8/2015	7:14:44 A	T07	
12/8/2015	7:14:45 A	T07	
12/8/2015	7:14:46 A	T07	
12/8/2015	7:33:38 A	T07	

Date	Time	Camera 1	Camera 2
12/8/2015	7:33:39 A	T07	
12/8/2015	7:33:40 A	T07	
12/8/2015	7:33:41 A	T07	
12/8/2015	7:33:42 A	T07	
12/8/2015	10:48:46 A	T07	
12/8/2015	10:48:47 A	T07	
12/8/2015	10:48:48 A	T07	
12/8/2015	10:48:49 A	T07	
12/8/2015	10:48:50 A	T07	
12/8/2015	4:45:06 P	T07	
12/8/2015	4:45:07 P	T07	
12/8/2015	4:45:08 P	T07	
12/8/2015	4:45:09 P	T07	
12/8/2015	4:45:10 P	T07	
12/8/2015	6:56:21 P	T07	
12/8/2015	6:56:22 P	T07	
12/8/2015	6:56:23 P	T07	
12/8/2015	6:56:24 P	T07	
12/8/2015	6:56:25 P	T07	
12/8/2015	6:56:41 P	T07	
12/8/2015	6:56:42 P	T07	
12/8/2015	6:56:43 P	T07	
12/8/2015	6:56:44 P	T07	
12/8/2015	6:56:45 P	T07	
12/8/2015	9:43:23 P	T06	
12/8/2015	9:43:24 P	T06	
12/8/2015	9:43:25 P	T06	
12/8/2015	9:43:26 P	T06	
12/8/2015	9:43:27 P	T06	
12/8/2015	9:43:42 P	T06	
12/8/2015	9:43:43 P	T06	
12/8/2015	9:43:44 P	T06	
12/8/2015	9:43:45 P	T06	
12/8/2015	9:43:46 P	T06	
12/8/2015	9:44:02 P	T06	
12/8/2015	9:44:03 P	T06	
12/8/2015	9:44:04 P	T06	
12/8/2015	9:44:05 P	T06	
12/8/2015	9:44:06 P	T06	

Date	Time	Camera 1	Camera 2
12/8/2015	9:47:18 P	T06	
12/8/2015	9:47:20 P	T06	
12/8/2015	9:47:21 P	T06	
12/8/2015	9:47:22 P	T06	
12/8/2015	9:47:23 P	T06	
13/8/2015	1:59:59 A	T08	
13/8/2015	2:00:00 A	T08	
13/8/2015	2:00:01 A	T08	
13/8/2015	2:00:02 A	T08	
13/8/2015	2:00:03 A	T08	
13/8/2015	7:26:22 A	T07	
13/8/2015	7:26:23 A	T07	
13/8/2015	7:26:24 A	T07	
13/8/2015	7:26:25 A	T07	
13/8/2015	7:26:26 A	T07	
13/8/2015	7:35:29 A	T07	
13/8/2015	7:35:30 A	T07	
13/8/2015	7:35:31 A	T07	
13/8/2015	7:35:32 A	T07	
13/8/2015	7:35:33 A	T07	
13/8/2015	7:36:42 A	T08	
13/8/2015	7:36:43 A	T08	
13/8/2015	7:36:44 A	T08	
13/8/2015	7:36:45 A	T08	
13/8/2015	7:36:46 A	T08	
13/8/2015	7:46:47 A	T06	
13/8/2015	7:46:49 A	T06	
13/8/2015	7:46:50 A	T06	
13/8/2015	7:46:51 A	T06	
13/8/2015	7:46:52 A	T06	
13/8/2015	8:07:30 A	T07	
13/8/2015	8:07:31 A	T07	
13/8/2015	8:07:32 A	T07	
13/8/2015	8:07:33 A	T07	
13/8/2015	8:07:34 A	T07	
13/8/2015	1:15:32 P	T05	
13/8/2015	1:15:33 P	T05	
13/8/2015	1:15:34 P	T05	
13/8/2015	1:15:35 P	T05	

Date	Time	Camera 1	Camera 2
13/8/2015	1:15:36 P	T05	
13/8/2015	1:17:06 P	T05	
13/8/2015	1:17:07 P	T05	
13/8/2015	1:17:08 P	T05	
13/8/2015	1:17:09 P	T05	
13/8/2015	1:17:10 P	T05	
13/8/2015	1:17:27 P	T05	
13/8/2015	1:17:28 P	T05	
13/8/2015	1:17:29 P	T05	
13/8/2015	1:17:30 P	T05	
13/8/2015	1:17:31 P	T05	
13/8/2015	7:04:41 P	T07	
13/8/2015	7:04:42 P	T07	
13/8/2015	7:04:43 P	T07	
13/8/2015	7:04:44 P	T07	
13/8/2015	7:04:45 P	T07	
13/8/2015	7:05:01 P	T07	
13/8/2015	7:05:02 P	T07	
13/8/2015	7:05:03 P	T07	
13/8/2015	7:05:04 P	T07	
13/8/2015	7:05:05 P	T07	
13/8/2015	7:05:36 P	T07	
13/8/2015	7:05:37 P	T07	
13/8/2015	7:05:38 P	T07	
13/8/2015	7:05:39 P	T07	
13/8/2015	7:05:40 P	T07	
13/8/2015	8:11:51 P	T06	
13/8/2015	8:11:52 P	T06	
13/8/2015	8:11:53 P	T06	
13/8/2015	8:11:55 P	T06	
13/8/2015	8:11:56 P	T06	
13/8/2015	8:46:53 P	T06	
13/8/2015	8:46:54 P	T06	
13/8/2015	8:46:55 P	T06	
13/8/2015	8:46:56 P	T06	
13/8/2015	8:46:57 P	T06	
14/8/2015	6:20:28 A	T06	
14/8/2015	6:20:29 A	T06	
14/8/2015	6:20:31 A	T06	

Date	Time	Camera 1	Camera 2
14/8/2015	6:20:32 A	T06	
14/8/2015	6:20:33 A	T06	
14/8/2015	9:00:59 A	T07	
14/8/2015	9:01:01 A	T07	
14/8/2015	9:01:02 A	T07	
14/8/2015	9:01:03 A	T07	
14/8/2015	9:01:04 A	T07	
14/8/2015	9:03:45 A	T07	
14/8/2015	9:03:46 A	T07	
14/8/2015	9:03:47 A	T07	
14/8/2015	9:03:48 A	T07	
14/8/2015	9:03:49 A	T07	
14/8/2015	10:19:09 A	T07	
14/8/2015	10:19:10 A	T07	
14/8/2015	10:19:11 A	T07	
14/8/2015	10:19:12 A	T07	
14/8/2015	10:19:13 A	T07	
14/8/2015	10:19:28 A	T07	
14/8/2015	10:19:29 A	T07	
14/8/2015	10:19:30 A	T07	
14/8/2015	10:19:31 A	T07	
14/8/2015	10:19:32 A	T07	
14/8/2015	4:14:07 P	T07	
14/8/2015	4:14:08 P	T07	
14/8/2015	4:14:09 P	T07	
14/8/2015	4:14:10 P	T07	
14/8/2015	4:14:11 P	T07	
14/8/2015	4:16:10 P	T07	
14/8/2015	4:16:12 P	T07	
14/8/2015	4:16:13 P	T07	
14/8/2015	4:16:14 P	T07	
14/8/2015	4:16:15 P	T07	
14/8/2015	4:16:34 P	T07	
14/8/2015	4:16:35 P	T07	
14/8/2015	4:16:36 P	T07	
14/8/2015	4:16:37 P	T07	
14/8/2015	4:16:38 P	T07	
14/8/2015	4:16:53 P	T07	
14/8/2015	4:16:54 P	T07	

Date	Time	Camera 1	Camera 2
14/8/2015	4:16:55 P	T07	
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14/8/2015	4:16:57 P	T07	
14/8/2015	4:17:14 P	T07	
14/8/2015	4:17:15 P	T07	
14/8/2015	4:17:16 P	T07	
14/8/2015	4:17:17 P	T07	
14/8/2015	4:17:18 P	T07	
14/8/2015	4:17:34 P	T07	
14/8/2015	4:17:35 P	T07	
14/8/2015	4:17:36 P	T07	
14/8/2015	4:17:37 P	T07	
14/8/2015	4:17:38 P	T07	
14/8/2015	4:17:53 P	T07	
14/8/2015	4:17:54 P	T07	
14/8/2015	4:17:55 P	T07	
14/8/2015	4:17:56 P	T07	
14/8/2015	4:17:57 P	T07	
14/8/2015	4:18:13 P	T07	
14/8/2015	4:18:14 P	T07	
14/8/2015	4:18:15 P	T07	
14/8/2015	4:18:16 P	T07	
14/8/2015	4:18:17 P	T07	
14/8/2015	4:52:21 P	T07	
14/8/2015	4:52:22 P	T07	
14/8/2015	4:52:23 P	T07	
14/8/2015	4:52:24 P	T07	
14/8/2015	4:52:25 P	T07	
14/8/2015	4:52:50 P	T07	
14/8/2015	4:52:51 P	T07	
14/8/2015	4:52:52 P	T07	
14/8/2015	4:52:53 P	T07	
14/8/2015	4:52:54 P	T07	
14/8/2015	4:53:13 P	T07	
14/8/2015	4:53:14 P	T07	
14/8/2015	4:53:15 P	T07	
14/8/2015	4:53:16 P	T07	
14/8/2015	4:53:17 P	T07	
14/8/2015	4:54:47 P	T07	

Date	Time	Camera 1	Camera 2
14/8/2015	4:54:48 P	T07	
14/8/2015	4:54:49 P	T07	
14/8/2015	4:54:50 P	T07	
14/8/2015	4:54:51 P	T07	
14/8/2015	4:55:47 P	T07	
14/8/2015	4:55:49 P	T07	
14/8/2015	4:55:50 P	T07	
14/8/2015	4:55:51 P	T07	
14/8/2015	4:55:52 P	T07	
14/8/2015	4:58:41 P	T07	
14/8/2015	4:58:42 P	T07	
14/8/2015	4:58:43 P	T07	
14/8/2015	4:58:44 P	T07	
14/8/2015	4:58:45 P	T07	
14/8/2015	4:59:06 P	T07	
14/8/2015	4:59:07 P	T07	
14/8/2015	4:59:08 P	T07	
14/8/2015	4:59:09 P	T07	
14/8/2015	4:59:10 P	T07	
14/8/2015	4:59:36 P	T07	
14/8/2015	4:59:37 P	T07	
14/8/2015	4:59:38 P	T07	
14/8/2015	4:59:39 P	T07	
14/8/2015	4:59:40 P	T07	
14/8/2015	4:59:55 P	T07	
14/8/2015	4:59:56 P	T07	
14/8/2015	4:59:57 P	T07	
14/8/2015	4:59:58 P	T07	
14/8/2015	4:59:59 P	T07	
14/8/2015	5:02:59 P	T07	
14/8/2015	5:03:00 P	T07	
14/8/2015	5:03:01 P	T07	
14/8/2015	5:03:02 P	T07	
14/8/2015	5:03:03 P	T07	
14/8/2015	7:24:45 P	T06	
14/8/2015	7:24:47 P	T06	
14/8/2015	7:24:48 P	T06	
14/8/2015	7:24:49 P	T06	
14/8/2015	7:24:50 P	T06	

Date	Time	Camera 1	Camera 2
14/8/2015	7:57:24 P	T06	
14/8/2015	7:57:26 P	T06	
14/8/2015	7:57:27 P	T06	
14/8/2015	7:57:28 P	T06	
14/8/2015	7:57:29 P	T06	
14/8/2015	9:25:58 P	T06	
14/8/2015	9:25:59 P	T06	
14/8/2015	9:26:00 P	T06	
14/8/2015	9:26:01 P	T06	
14/8/2015	9:26:02 P	T06	
14/8/2015	9:26:18 P	T06	
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14/8/2015	9:26:21 P	T06	
14/8/2015	9:26:22 P	T06	
14/8/2015	9:26:39 P	T06	
14/8/2015	9:26:41 P	T06	
14/8/2015	9:26:42 P	T06	
14/8/2015	9:26:43 P	T06	
14/8/2015	9:26:44 P	T06	
15/8/2015	4:54:16 P	T07	
15/8/2015	4:54:17 P	T07	
15/8/2015	4:54:18 P	T07	
15/8/2015	4:54:19 P	T07	
15/8/2015	4:54:20 P	T07	
15/8/2015	4:54:35 P	T07	
15/8/2015	4:54:36 P	T07	
15/8/2015	4:54:37 P	T07	
15/8/2015	4:54:38 P	T07	
15/8/2015	4:54:39 P	T07	
15/8/2015	4:54:55 P	T07	
15/8/2015	4:54:56 P	T07	
15/8/2015	4:54:57 P	T07	
15/8/2015	4:54:58 P	T07	
15/8/2015	4:54:59 P	T07	
15/8/2015	4:55:15 P	T07	
15/8/2015	4:55:16 P	T07	
15/8/2015	4:55:17 P	T07	
15/8/2015	4:55:18 P	T07	

Date	Time	Camera 1	Camera 2
15/8/2015	4:55:19 P	T07	
15/8/2015	4:55:35 P	T07	
15/8/2015	4:55:36 P	T07	
15/8/2015	4:55:37 P	T07	
15/8/2015	4:55:38 P	T07	
15/8/2015	4:55:39 P	T07	
15/8/2015	4:56:01 P	T07	
15/8/2015	4:56:02 P	T07	
15/8/2015	4:56:03 P	T07	
15/8/2015	4:56:04 P	T07	
15/8/2015	4:56:05 P	T07	
15/8/2015	9:06:41 P	T07	
15/8/2015	9:06:42 P	T07	
15/8/2015	9:06:43 P	T07	
15/8/2015	9:06:44 P	T07	
15/8/2015	9:06:45 P	T07	
16/8/2015	3:26:16 A	T06	
16/8/2015	3:26:17 A	T06	
16/8/2015	3:26:18 A	T06	
16/8/2015	3:26:20 A	T06	
16/8/2015	3:26:21 A	T06	
16/8/2015	7:30:07 A	T08	
16/8/2015	7:30:08 A	T08	
16/8/2015	7:30:09 A	T08	
16/8/2015	7:30:10 A	T08	
16/8/2015	7:30:11 A	T08	
16/8/2015	7:16:06 P	T07	
16/8/2015	7:16:07 P	T07	
16/8/2015	7:16:08 P	T07	
16/8/2015	7:16:09 P	T07	
16/8/2015	7:16:10 P	T07	
16/8/2015	7:16:31 P	T07	
16/8/2015	7:16:32 P	T07	
16/8/2015	7:16:33 P	T07	
16/8/2015	7:16:34 P	T07	
16/8/2015	7:16:35 P	T07	
16/8/2015	7:17:39 P	T07	
16/8/2015	7:17:40 P	T07	
16/8/2015	7:17:41 P	T07	

Date	Time	Camera 1	Camera 2
16/8/2015	7:17:42 P	T07	
16/8/2015	7:17:43 P	T07	
16/8/2015	7:17:58 P	T07	
16/8/2015	7:18:00 P	T07	
16/8/2015	7:18:01 P	T07	
16/8/2015	7:18:02 P	T07	
16/8/2015	7:18:03 P	T07	
16/8/2015	7:30:35 P	T06	
16/8/2015	7:30:36 P	T06	
16/8/2015	7:30:38 P	T06	
16/8/2015	7:30:39 P	T06	
16/8/2015	7:30:40 P	T06	
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16/8/2015	10:21:31 P	T06	
16/8/2015	10:21:32 P	T06	
16/8/2015	10:21:33 P	T06	
16/8/2015	11:31:06 P	T06	
16/8/2015	11:31:07 P	T06	
16/8/2015	11:31:09 P	T06	
16/8/2015	11:31:11 P	T06	
16/8/2015	11:31:12 P	T06	
16/8/2015	11:31:29 P	T06	
16/8/2015	11:31:31 P	T06	
16/8/2015	11:31:32 P	T06	
16/8/2015	11:31:33 P	T06	
16/8/2015	11:31:34 P	T06	
17/8/2015	4:56:01 A	T06	
17/8/2015	4:56:02 A	T06	
17/8/2015	4:56:03 A	T06	
17/8/2015	4:56:04 A	T06	
17/8/2015	4:56:05 A	T06	
17/8/2015	10:38:36 A	T07	
17/8/2015	10:38:37 A	T07	
17/8/2015	10:38:38 A	T07	
17/8/2015	10:38:39 A	T07	
17/8/2015	10:38:40 A	T07	
17/8/2015	4:16:22 P	T07	
17/8/2015	4:16:23 P	T07	

Date	Time	Camera 1	Camera 2
17/8/2015	4:16:24 P	T07	
17/8/2015	4:16:25 P	T07	
17/8/2015	4:16:26 P	T07	
17/8/2015	4:16:58 P	T07	
17/8/2015	4:16:59 P	T07	
17/8/2015	4:17:00 P	T07	
17/8/2015	4:17:01 P	T07	
17/8/2015	4:17:02 P	T07	
17/8/2015	4:17:19 P	T07	
17/8/2015	4:17:20 P	T07	
17/8/2015	4:17:21 P	T07	
17/8/2015	4:17:22 P	T07	
17/8/2015	4:17:23 P	T07	
17/8/2015	4:17:38 P	T07	
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17/8/2015	4:17:41 P	T07	
17/8/2015	4:17:42 P	T07	
17/8/2015	4:19:12 P	T07	
17/8/2015	4:19:13 P	T07	
17/8/2015	4:19:14 P	T07	
17/8/2015	4:19:15 P	T07	
17/8/2015	4:19:16 P	T07	
17/8/2015	5:42:25 P	T07	
17/8/2015	5:42:26 P	T07	
17/8/2015	5:42:27 P	T07	
17/8/2015	5:42:28 P	T07	
17/8/2015	5:42:29 P	T07	
17/8/2015	5:45:37 P	T07	
17/8/2015	5:45:38 P	T07	
17/8/2015	5:45:39 P	T07	
17/8/2015	5:45:40 P	T07	
17/8/2015	5:45:41 P	T07	
17/8/2015	6:03:20 P	T07	
17/8/2015	6:03:21 P	T07	
17/8/2015	6:03:22 P	T07	
17/8/2015	6:03:23 P	T07	
17/8/2015	6:03:24 P	T07	
17/8/2015	11:50:00 P	T07	

Date	Time	Camera 1	Camera 2
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17/8/2015	11:50:02 P	T07	
17/8/2015	11:50:03 P	T07	
17/8/2015	11:50:04 P	T07	
17/8/2015	11:50:21 P	T07	
17/8/2015	11:50:22 P	T07	
17/8/2015	11:50:23 P	T07	
17/8/2015	11:50:24 P	T07	
17/8/2015	11:50:25 P	T07	
17/8/2015	11:50:43 P	T07	
17/8/2015	11:50:44 P	T07	
17/8/2015	11:50:45 P	T07	
17/8/2015	11:50:46 P	T07	
17/8/2015	11:50:47 P	T07	
17/8/2015	11:51:07 P	T07	
17/8/2015	11:51:08 P	T07	
17/8/2015	11:51:09 P	T07	
17/8/2015	11:51:10 P	T07	
17/8/2015	11:51:11 P	T07	
17/8/2015	11:51:26 P	T07	
17/8/2015	11:51:27 P	T07	
17/8/2015	11:51:28 P	T07	
17/8/2015	11:51:29 P	T07	
17/8/2015	11:51:30 P	T07	
17/8/2015	11:52:26 P	T07	
17/8/2015	11:52:27 P	T07	
17/8/2015	11:52:28 P	T07	
17/8/2015	11:52:29 P	T07	
17/8/2015	11:52:30 P	T07	
17/8/2015	11:52:45 P	T07	
17/8/2015	11:52:46 P	T07	
17/8/2015	11:52:47 P	T07	
17/8/2015	11:52:48 P	T07	
17/8/2015	11:52:49 P	T07	
17/8/2015	11:53:05 P	T07	
17/8/2015	11:53:06 P	T07	
17/8/2015	11:53:07 P	T07	
17/8/2015	11:53:08 P	T07	
17/8/2015	11:53:09 P	T07	

Date	Time	Camera 1	Camera 2
18/8/2015	12:11:26 A	T07	
18/8/2015	12:11:27 A	T07	
18/8/2015	12:11:28 A	T07	
18/8/2015	12:11:29 A	T07	
18/8/2015	12:11:30 A	T07	
18/8/2015	12:11:52 A	T07	
18/8/2015	12:11:53 A	T07	
18/8/2015	12:11:54 A	T07	
18/8/2015	12:11:55 A	T07	
18/8/2015	12:11:56 A	T07	
18/8/2015	12:12:14 A	T07	
18/8/2015	12:12:15 A	T07	
18/8/2015	12:12:16 A	T07	
18/8/2015	12:12:17 A	T07	
18/8/2015	12:12:18 A	T07	
18/8/2015	12:52:03 A	T06	
18/8/2015	12:52:04 A	T06	
18/8/2015	12:52:05 A	T06	
18/8/2015	12:52:06 A	T06	
18/8/2015	12:52:07 A	T06	
18/8/2015	4:06:31 A	T07	
18/8/2015	4:06:32 A	T07	
18/8/2015	4:06:33 A	T07	
18/8/2015	4:06:34 A	T07	
18/8/2015	4:06:35 A	T07	
18/8/2015	4:07:10 A	T07	
18/8/2015	4:07:12 A	T07	
18/8/2015	4:07:13 A	T07	
18/8/2015	4:07:14 A	T07	
18/8/2015	4:07:15 A	T07	
18/8/2015	4:07:30 A	T07	
18/8/2015	4:07:31 A	T07	
18/8/2015	4:07:32 A	T07	
18/8/2015	4:07:33 A	T07	
18/8/2015	4:07:34 A	T07	
18/8/2015	4:07:49 A	T07	
18/8/2015	4:07:50 A	T07	
18/8/2015	4:07:51 A	T07	
18/8/2015	4:07:52 A	T07	

Date	Time	Camera 1	Camera 2
18/8/2015	4:07:53 A	T07	
18/8/2015	4:08:14 A	T07	
18/8/2015	4:08:15 A	T07	
18/8/2015	4:08:16 A	T07	
18/8/2015	4:08:17 A	T07	
18/8/2015	4:08:18 A	T07	
18/8/2015	5:49:27 A	T06	
18/8/2015	5:49:28 A	T06	
18/8/2015	5:49:31 A	T06	
18/8/2015	5:49:32 A	T06	
18/8/2015	5:49:33 A	T06	
18/8/2015	4:56:11 P	T07	
18/8/2015	4:56:12 P	T07	
18/8/2015	4:56:13 P	T07	
18/8/2015	4:56:14 P	T07	
18/8/2015	4:56:15 P	T07	
18/8/2015	4:56:32 P	T07	
18/8/2015	4:56:33 P	T07	
18/8/2015	4:56:34 P	T07	
18/8/2015	4:56:35 P	T07	
18/8/2015	4:56:36 P	T07	
18/8/2015	4:56:53 P	T07	
18/8/2015	4:56:55 P	T07	
18/8/2015	4:56:56 P	T07	
18/8/2015	4:56:57 P	T07	
18/8/2015	4:56:58 P	T07	
18/8/2015	5:29:32 P	T07	
18/8/2015	5:29:33 P	T07	
18/8/2015	5:29:34 P	T07	
18/8/2015	5:29:35 P	T07	
18/8/2015	5:29:36 P	T07	
18/8/2015	5:30:07 P	T07	
18/8/2015	5:30:08 P	T07	
18/8/2015	5:30:09 P	T07	
18/8/2015	5:30:10 P	T07	
18/8/2015	5:30:11 P	T07	
18/8/2015	5:33:05 P	T07	
18/8/2015	5:33:06 P	T07	
18/8/2015	5:33:07 P	T07	

Date	Time	Camera 1	Camera 2
18/8/2015	5:33:08 P	T07	
18/8/2015	5:33:09 P	T07	
18/8/2015	5:36:30 P	T07	
18/8/2015	5:36:31 P	T07	
18/8/2015	5:36:32 P	T07	
18/8/2015	5:36:33 P	T07	
18/8/2015	5:36:34 P	T07	
18/8/2015	9:30:45 P	T06	
18/8/2015	9:30:46 P	T06	
18/8/2015	9:30:47 P	T06	
18/8/2015	9:30:48 P	T06	
18/8/2015	9:30:49 P	T06	
18/8/2015	9:31:15 P	T06	
18/8/2015	9:31:16 P	T06	
18/8/2015	9:31:17 P	T06	
18/8/2015	9:31:18 P	T06	
18/8/2015	9:31:19 P	T06	
18/8/2015	9:45:01 P	T07	
18/8/2015	9:45:02 P	T07	
18/8/2015	9:45:03 P	T07	
18/8/2015	9:45:04 P	T07	
18/8/2015	9:45:05 P	T07	
19/8/2015	1:16:45 A	T06	
19/8/2015	1:16:47 A	T06	
19/8/2015	1:16:48 A	T06	
19/8/2015	1:16:49 A	T06	
19/8/2015	1:16:50 A	T06	
19/8/2015	3:25:33 A	T07	
19/8/2015	3:25:34 A	T07	
19/8/2015	3:25:35 A	T07	
19/8/2015	3:25:36 A	T07	
19/8/2015	3:25:37 A	T07	
19/8/2015	3:25:52 A	T07	
19/8/2015	3:25:53 A	T07	
19/8/2015	3:25:54 A	T07	
19/8/2015	3:25:55 A	T07	
19/8/2015	3:25:56 A	T07	
19/8/2015	3:26:14 A	T07	
19/8/2015	3:26:15 A	T07	

Date	Time	Camera 1	Camera 2
19/8/2015	3:26:16 A	T07	
19/8/2015	3:26:17 A	T07	
19/8/2015	3:26:18 A	T07	
19/8/2015	4:34:40 A	T07	
19/8/2015	4:34:41 A	T07	
19/8/2015	4:34:42 A	T07	
19/8/2015	4:34:43 A	T07	
19/8/2015	4:34:44 A	T07	
19/8/2015	4:35:00 A	T07	
19/8/2015	4:35:01 A	T07	
19/8/2015	4:35:02 A	T07	
19/8/2015	4:35:03 A	T07	
19/8/2015	4:35:04 A	T07	
19/8/2015	4:35:21 A	T07	
19/8/2015	4:35:22 A	T07	
19/8/2015	4:35:23 A	T07	
19/8/2015	4:35:24 A	T07	
19/8/2015	4:35:25 A	T07	
19/8/2015	4:35:43 A	T07	
19/8/2015	4:35:44 A	T07	
19/8/2015	4:35:45 A	T07	
19/8/2015	4:35:46 A	T07	
19/8/2015	4:35:47 A	T07	
19/8/2015	4:36:03 A	T07	
19/8/2015	4:36:04 A	T07	
19/8/2015	4:36:05 A	T07	
19/8/2015	4:36:06 A	T07	
19/8/2015	4:36:07 A	T07	
19/8/2015	4:36:34 A	T07	
19/8/2015	4:36:35 A	T07	
19/8/2015	4:36:36 A	T07	
19/8/2015	4:36:37 A	T07	
19/8/2015	4:36:38 A	T07	
19/8/2015	4:38:44 A	T07	
19/8/2015	4:38:45 A	T07	
19/8/2015	4:38:46 A	T07	
19/8/2015	4:38:47 A	T07	
19/8/2015	4:38:48 A	T07	
19/8/2015	4:39:04 A	T07	

Date	Time	Camera 1	Camera 2
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19/8/2015	4:39:07 A	T07	
19/8/2015	4:39:08 A	T07	
19/8/2015	4:39:36 A	T07	
19/8/2015	4:39:37 A	T07	
19/8/2015	4:39:38 A	T07	
19/8/2015	4:39:39 A	T07	
19/8/2015	4:39:40 A	T07	
19/8/2015	4:39:58 A	T07	
19/8/2015	4:39:59 A	T07	
19/8/2015	4:40:00 A	T07	
19/8/2015	4:40:01 A	T07	
19/8/2015	4:40:02 A	T07	
19/8/2015	4:40:26 A	T07	
19/8/2015	4:40:27 A	T07	
19/8/2015	4:40:28 A	T07	
19/8/2015	4:40:29 A	T07	
19/8/2015	4:40:30 A	T07	
19/8/2015	4:40:47 A	T07	
19/8/2015	4:40:48 A	T07	
19/8/2015	4:40:49 A	T07	
19/8/2015	4:40:50 A	T07	
19/8/2015	4:40:51 A	T07	
19/8/2015	4:41:15 A	T07	
19/8/2015	4:41:16 A	T07	
19/8/2015	4:41:17 A	T07	
19/8/2015	4:41:18 A	T07	
19/8/2015	4:41:19 A	T07	
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19/8/2015	4:41:46 A	T07	
19/8/2015	4:41:47 A	T07	
19/8/2015	4:41:48 A	T07	
19/8/2015	4:41:49 A	T07	
19/8/2015	4:42:04 A	T07	
19/8/2015	4:42:05 A	T07	
19/8/2015	4:42:06 A	T07	
19/8/2015	4:42:07 A	T07	
19/8/2015	4:42:08 A	T07	

Date	Time	Camera 1	Camera 2
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19/8/2015	4:42:32 A	T07	
19/8/2015	4:42:33 A	T07	
19/8/2015	4:42:34 A	T07	
19/8/2015	4:42:35 A	T07	
19/8/2015	4:43:15 A	T07	
19/8/2015	4:43:16 A	T07	
19/8/2015	4:43:17 A	T07	
19/8/2015	4:43:18 A	T07	
19/8/2015	4:43:19 A	T07	
19/8/2015	4:43:40 A	T07	
19/8/2015	4:43:41 A	T07	
19/8/2015	4:43:42 A	T07	
19/8/2015	4:43:43 A	T07	
19/8/2015	4:43:44 A	T07	
19/8/2015	4:43:59 A	T07	
19/8/2015	4:44:00 A	T07	
19/8/2015	4:44:01 A	T07	
19/8/2015	4:44:02 A	T07	
19/8/2015	4:44:03 A	T07	
19/8/2015	7:10:04 A	T07	
19/8/2015	7:10:05 A	T07	
19/8/2015	7:10:06 A	T07	
19/8/2015	7:10:07 A	T07	
19/8/2015	7:10:08 A	T07	
19/8/2015	7:10:23 A	T07	
19/8/2015	7:10:24 A	T07	
19/8/2015	7:10:25 A	T07	
19/8/2015	7:10:26 A	T07	
19/8/2015	7:10:27 A	T07	
19/8/2015	7:13:23 A	T07	
19/8/2015	7:13:24 A	T07	
19/8/2015	7:13:25 A	T07	
19/8/2015	7:13:26 A	T07	
19/8/2015	7:13:27 A	T07	
19/8/2015	7:15:01 A	T07	
19/8/2015	7:15:02 A	T07	
19/8/2015	7:15:03 A	T07	
19/8/2015	7:15:04 A	T07	

Date	Time	Camera 1	Camera 2
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19/8/2015	7:15:58 A	T07	
19/8/2015	7:15:59 A	T07	
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19/8/2015	7:16:42 A	T07	
19/8/2015	7:16:43 A	T07	
19/8/2015	7:16:44 A	T07	
19/8/2015	7:16:45 A	T07	
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19/8/2015	7:17:48 A	T07	
19/8/2015	7:17:49 A	T07	
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19/8/2015	7:18:05 A	T07	
19/8/2015	7:18:06 A	T07	
19/8/2015	7:18:07 A	T07	
19/8/2015	7:18:08 A	T07	
19/8/2015	8:48:47 A	T07	
19/8/2015	8:48:48 A	T07	
19/8/2015	8:48:49 A	T07	
19/8/2015	8:48:50 A	T07	
19/8/2015	8:48:51 A	T07	
19/8/2015	8:49:07 A	T07	
19/8/2015	8:49:08 A	T07	
19/8/2015	8:49:09 A	T07	
19/8/2015	8:49:10 A	T07	
19/8/2015	8:49:11 A	T07	
19/8/2015	9:00:55 A	T07	
19/8/2015	9:00:56 A	T07	
19/8/2015	9:00:57 A	T07	
19/8/2015	9:00:58 A	T07	
19/8/2015	9:00:59 A	T07	
19/8/2015	9:01:16 A	T07	
19/8/2015	9:01:17 A	T07	
19/8/2015	9:01:18 A	T07	

Date	Time	Camera 1	Camera 2
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19/8/2015	9:01:20 A	T07	
19/8/2015	9:01:36 A	T07	
19/8/2015	9:01:37 A	T07	
19/8/2015	9:01:38 A	T07	
19/8/2015	9:01:39 A	T07	
19/8/2015	9:01:40 A	T07	
19/8/2015	12:16:51 P	T06	
19/8/2015	12:16:53 P	T06	
19/8/2015	12:16:54 P	T06	
19/8/2015	12:16:55 P	T06	
19/8/2015	12:16:56 P	T06	
19/8/2015	12:17:50 P	T06	
19/8/2015	12:17:52 P	T06	
19/8/2015	12:17:53 P	T06	
19/8/2015	12:17:54 P	T06	
19/8/2015	12:17:55 P	T06	
19/8/2015	12:18:19 P	T06	
19/8/2015	12:18:20 P	T06	
19/8/2015	12:18:21 P	T06	
19/8/2015	12:18:22 P	T06	
19/8/2015	12:18:23 P	T06	
19/8/2015	12:21:19 P	T07	
19/8/2015	12:21:20 P	T07	
19/8/2015	12:21:21 P	T07	
19/8/2015	12:21:22 P	T07	
19/8/2015	12:21:23 P	T07	
19/8/2015	5:15:05 P	T07	
19/8/2015	5:15:06 P	T07	
19/8/2015	5:15:07 P	T07	
19/8/2015	5:15:08 P	T07	
19/8/2015	5:15:09 P	T07	
19/8/2015	5:15:24 P	T07	
19/8/2015	5:15:25 P	T07	
19/8/2015	5:15:26 P	T07	
19/8/2015	5:15:27 P	T07	
19/8/2015	5:15:28 P	T07	
19/8/2015	5:15:49 P	T07	
19/8/2015	5:15:50 P	T07	

Date	Time	Camera 1	Camera 2
19/8/2015	5:15:51 P	T07	
19/8/2015	5:15:52 P	T07	
19/8/2015	5:15:53 P	T07	
19/8/2015	5:19:43 P	T07	
19/8/2015	5:19:44 P	T07	
19/8/2015	5:19:45 P	T07	
19/8/2015	5:19:46 P	T07	
19/8/2015	5:19:47 P	T07	
19/8/2015	5:20:03 P	T07	
19/8/2015	5:20:04 P	T07	
19/8/2015	5:20:05 P	T07	
19/8/2015	5:20:06 P	T07	
19/8/2015	5:20:07 P	T07	
19/8/2015	5:20:25 P	T07	
19/8/2015	5:20:26 P	T07	
19/8/2015	5:20:27 P	T07	
19/8/2015	5:20:28 P	T07	
19/8/2015	5:20:29 P	T07	
19/8/2015	5:22:50 P	T07	
19/8/2015	5:22:51 P	T07	
19/8/2015	5:22:52 P	T07	
19/8/2015	5:22:53 P	T07	
19/8/2015	5:22:54 P	T07	
19/8/2015	6:39:28 P	T07	
19/8/2015	6:39:30 P	T07	
19/8/2015	6:39:31 P	T07	
19/8/2015	6:39:32 P	T07	
19/8/2015	6:39:33 P	T07	
19/8/2015	6:39:52 P	T07	
19/8/2015	6:39:53 P	T07	
19/8/2015	6:39:54 P	T07	
19/8/2015	6:39:55 P	T07	
19/8/2015	6:39:56 P	T07	
19/8/2015	6:40:25 P	T07	
19/8/2015	6:40:26 P	T07	
19/8/2015	6:40:27 P	T07	
19/8/2015	6:40:28 P	T07	
19/8/2015	6:40:29 P	T07	
19/8/2015	6:40:44 P	T07	

Date	Time	Camera 1	Camera 2
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19/8/2015	6:40:46 P	T07	
19/8/2015	6:40:47 P	T07	
19/8/2015	6:40:48 P	T07	
19/8/2015	6:41:03 P	T07	
19/8/2015	6:41:04 P	T07	
19/8/2015	6:41:05 P	T07	
19/8/2015	6:41:06 P	T07	
19/8/2015	6:41:07 P	T07	
19/8/2015	6:41:23 P	T07	
19/8/2015	6:41:24 P	T07	
19/8/2015	6:41:25 P	T07	
19/8/2015	6:41:26 P	T07	
19/8/2015	6:41:27 P	T07	
19/8/2015	6:43:02 P	T07	
19/8/2015	6:43:03 P	T07	
19/8/2015	6:43:04 P	T07	
19/8/2015	6:43:05 P	T07	
19/8/2015	6:43:06 P	T07	
19/8/2015	7:06:47 P	T06	
19/8/2015	7:06:48 P	T06	
19/8/2015	7:06:50 P	T06	
19/8/2015	7:06:51 P	T06	
19/8/2015	7:06:52 P	T06	
19/8/2015	8:32:54 P	T06	
19/8/2015	8:32:55 P	T06	
19/8/2015	8:32:56 P	T06	
19/8/2015	8:32:57 P	T06	
19/8/2015	8:32:58 P	T06	
19/8/2015	8:34:19 P	T06	
19/8/2015	8:34:20 P	T06	
19/8/2015	8:34:21 P	T06	
19/8/2015	8:34:22 P	T06	
19/8/2015	8:34:23 P	T06	
19/8/2015	8:34:39 P	T06	
19/8/2015	8:34:40 P	T06	
19/8/2015	8:34:41 P	T06	
19/8/2015	8:34:42 P	T06	
19/8/2015	8:34:43 P	T06	

Date	Time	Camera 1	Camera 2
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19/8/2015	8:35:00 P	T06	
19/8/2015	8:35:01 P	T06	
19/8/2015	8:35:02 P	T06	
19/8/2015	8:35:03 P	T06	
19/8/2015	11:36:45 P	T06	
19/8/2015	11:36:46 P	T06	
19/8/2015	11:36:47 P	T06	
19/8/2015	11:36:48 P	T06	
19/8/2015	11:36:49 P	T06	
19/8/2015	11:37:05 P	T06	
19/8/2015	11:37:06 P	T06	
19/8/2015	11:37:07 P	T06	
19/8/2015	11:37:08 P	T06	
19/8/2015	11:37:09 P	T06	
19/8/2015	11:37:25 P	T06	
19/8/2015	11:37:26 P	T06	
19/8/2015	11:37:27 P	T06	
19/8/2015	11:37:28 P	T06	
19/8/2015	11:37:29 P	T06	
19/8/2015	11:50:11 P	T06	
19/8/2015	11:50:12 P	T06	
19/8/2015	11:50:13 P	T06	
19/8/2015	11:50:14 P	T06	
19/8/2015	11:50:15 P	T06	
19/8/2015	11:53:55 P	T06	
19/8/2015	11:53:56 P	T06	
19/8/2015	11:53:57 P	T06	
19/8/2015	11:53:58 P	T06	
19/8/2015	11:53:59 P	T06	
19/8/2015	11:54:16 P	T06	
19/8/2015	11:54:17 P	T06	
19/8/2015	11:54:18 P	T06	
19/8/2015	11:54:19 P	T06	
19/8/2015	11:54:20 P	T06	
19/8/2015	11:54:48 P	T06	
19/8/2015	11:54:49 P	T06	
19/8/2015	11:54:50 P	T06	
19/8/2015	11:54:51 P	T06	

Date	Time	Camera 1	Camera 2
19/8/2015	11:54:52 P	T06	
19/8/2015	11:55:11 P	T06	
19/8/2015	11:55:12 P	T06	
19/8/2015	11:55:13 P	T06	
19/8/2015	11:55:14 P	T06	
19/8/2015	11:55:15 P	T06	
19/8/2015	11:55:31 P	T06	
19/8/2015	11:55:32 P	T06	
19/8/2015	11:55:33 P	T06	
19/8/2015	11:55:34 P	T06	
19/8/2015	11:55:35 P	T06	
20/8/2015	4:00:35 A	T06	
20/8/2015	4:00:36 A	T06	
20/8/2015	4:00:37 A	T06	
20/8/2015	4:00:38 A	T06	
20/8/2015	4:00:39 A	T06	
20/8/2015	4:00:58 A	T06	
20/8/2015	4:01:00 A	T06	
20/8/2015	4:01:01 A	T06	
20/8/2015	4:01:02 A	T06	
20/8/2015	4:01:03 A	T06	
20/8/2015	4:04:35 A	T06	
20/8/2015	4:04:37 A	T06	
20/8/2015	4:04:38 A	T06	
20/8/2015	4:04:39 A	T06	
20/8/2015	4:04:40 A	T06	
20/8/2015	7:25:48 A	T07	
20/8/2015	7:25:49 A	T07	
20/8/2015	7:25:50 A	T07	
20/8/2015	7:25:51 A	T07	
20/8/2015	7:25:52 A	T07	
20/8/2015	7:30:50 A	T07	
20/8/2015	7:30:51 A	T07	
20/8/2015	7:30:52 A	T07	
20/8/2015	7:30:53 A	T07	
20/8/2015	7:30:54 A	T07	
20/8/2015	7:35:48 A	T07	
20/8/2015	7:35:49 A	T07	
20/8/2015	7:35:50 A	T07	

Date	Time	Camera 1	Camera 2
20/8/2015	7:35:51 A	T07	
20/8/2015	7:35:52 A	T07	
20/8/2015	7:37:18 A	T07	
20/8/2015	7:37:19 A	T07	
20/8/2015	7:37:20 A	T07	
20/8/2015	7:37:21 A	T07	
20/8/2015	7:37:22 A	T07	
20/8/2015	7:40:29 A	T07	
20/8/2015	7:40:30 A	T07	
20/8/2015	7:40:31 A	T07	
20/8/2015	7:40:32 A	T07	
20/8/2015	7:40:33 A	T07	
20/8/2015	7:40:56 A	T07	
20/8/2015	7:40:57 A	T07	
20/8/2015	7:40:58 A	T07	
20/8/2015	7:40:59 A	T07	
20/8/2015	7:41:00 A	T07	
20/8/2015	9:09:01 A	T07	
20/8/2015	9:09:02 A	T07	
20/8/2015	9:09:03 A	T07	
20/8/2015	9:09:04 A	T07	
20/8/2015	9:09:05 A	T07	
20/8/2015	7:02:48 P	T07	
20/8/2015	7:02:49 P	T07	
20/8/2015	7:02:50 P	T07	
20/8/2015	7:02:51 P	T07	
20/8/2015	7:02:52 P	T07	
20/8/2015	8:31:35 P	T07	
20/8/2015	8:31:36 P	T07	
20/8/2015	8:31:37 P	T07	
20/8/2015	8:31:38 P	T07	
20/8/2015	8:31:39 P	T07	
21/8/2015	8:46:07 A	T07	
21/8/2015	8:46:08 A	T07	
21/8/2015	8:46:09 A	T07	
21/8/2015	8:46:10 A	T07	
21/8/2015	8:46:11 A	T07	
21/8/2015	8:46:28 A	T07	
21/8/2015	8:46:29 A	T07	

Date	Time	Camera 1	Camera 2
21/8/2015	8:46:30 A	T07	
21/8/2015	8:46:31 A	T07	
21/8/2015	8:46:32 A	T07	
21/8/2015	8:48:46 A	T07	
21/8/2015	8:48:47 A	T07	
21/8/2015	8:48:48 A	T07	
21/8/2015	8:48:49 A	T07	
21/8/2015	8:48:50 A	T07	
21/8/2015	9:06:26 A	T07	
21/8/2015	9:06:27 A	T07	
21/8/2015	9:06:28 A	T07	
21/8/2015	9:06:29 A	T07	
21/8/2015	9:06:30 A	T07	
21/8/2015	9:07:08 A	T07	
21/8/2015	9:07:09 A	T07	
21/8/2015	9:07:10 A	T07	
21/8/2015	9:07:11 A	T07	
21/8/2015	9:07:12 A	T07	
21/8/2015	10:27:46 P	T06	
21/8/2015	10:27:47 P	T06	
21/8/2015	10:27:48 P	T06	
21/8/2015	10:27:49 P	T06	
21/8/2015	10:27:50 P	T06	
21/8/2015	10:28:07 P	T06	
21/8/2015	10:28:08 P	T06	
21/8/2015	10:28:09 P	T06	
21/8/2015	10:28:10 P	T06	
21/8/2015	10:28:11 P	T06	
22/8/2015	7:24:59 P	T06	
22/8/2015	7:25:00 P	T06	
22/8/2015	7:25:01 P	T06	
22/8/2015	7:25:02 P	T06	
22/8/2015	7:45:52 P	T06	
22/8/2015	7:45:53 P	T06	
22/8/2015	7:45:54 P	T06	
22/8/2015	7:45:55 P	T06	
22/8/2015	7:45:56 P	T06	
22/8/2015	7:46:12 P	T06	
22/8/2015	7:46:13 P	T06	

Date	Time	Camera 1	Camera 2
22/8/2015	7:46:14 P	T06	
22/8/2015	7:46:15 P	T06	
22/8/2015	7:46:16 P	T06	
22/8/2015	7:51:50 P	T06	
22/8/2015	7:51:51 P	T06	
22/8/2015	7:51:52 P	T06	
22/8/2015	7:51:53 P	T06	
22/8/2015	7:51:54 P	T06	
23/8/2015	6:23:50 A	T06	
23/8/2015	6:23:51 A	T06	
23/8/2015	6:23:53 A	T06	
23/8/2015	6:23:54 A	T06	
23/8/2015	6:23:55 A	T06	
23/8/2015	6:55:41 A	T06	
23/8/2015	6:55:42 A	T06	
23/8/2015	6:55:43 A	T06	
23/8/2015	6:55:44 A	T06	
23/8/2015	6:55:45 A	T06	
23/8/2015	1:44:27 P	T06	
23/8/2015	1:44:28 P	T06	
23/8/2015	1:44:29 P	T06	
23/8/2015	1:44:30 P	T06	
23/8/2015	1:44:31 P	T06	
23/8/2015	1:44:48 P	T06	
23/8/2015	1:44:49 P	T06	
23/8/2015	1:44:50 P	T06	
23/8/2015	1:44:51 P	T06	
23/8/2015	1:44:52 P	T06	
23/8/2015	2:03:05 P	T06	
23/8/2015	2:03:06 P	T06	
23/8/2015	2:03:07 P	T06	
23/8/2015	2:03:08 P	T06	
23/8/2015	2:03:09 P	T06	
23/8/2015	6:31:31 P	T06	
23/8/2015	6:31:33 P	T06	
23/8/2015	6:31:34 P	T06	
23/8/2015	6:31:35 P	T06	
23/8/2015	6:31:36 P	T06	
23/8/2015	6:32:15 P	T06	

Date	Time	Camera 1	Camera 2
23/8/2015	6:32:16 P	T06	
23/8/2015	6:32:17 P	T06	
23/8/2015	6:32:18 P	T06	
23/8/2015	6:32:19 P	T06	
23/8/2015	7:35:59 P	T06	
23/8/2015	7:36:00 P	T06	
23/8/2015	7:36:01 P	T06	
23/8/2015	7:36:02 P	T06	
23/8/2015	7:36:03 P	T06	
23/8/2015	7:36:56 P	T06	
23/8/2015	7:36:57 P	T06	
23/8/2015	7:36:58 P	T06	
23/8/2015	7:36:59 P	T06	
23/8/2015	7:37:00 P	T06	
23/8/2015	7:37:58 P	T06	
23/8/2015	7:37:59 P	T06	
23/8/2015	7:38:00 P	T06	
23/8/2015	7:38:01 P	T06	
23/8/2015	7:38:02 P	T06	
23/8/2015	7:38:19 P	T06	
23/8/2015	7:38:20 P	T06	
23/8/2015	7:38:21 P	T06	
23/8/2015	7:38:22 P	T06	
23/8/2015	7:38:23 P	T06	
23/8/2015	7:38:38 P	T06	
23/8/2015	7:38:39 P	T06	
23/8/2015	7:38:40 P	T06	
23/8/2015	7:38:41 P	T06	
23/8/2015	7:38:42 P	T06	
23/8/2015	7:38:57 P	T06	
23/8/2015	7:38:58 P	T06	
23/8/2015	7:38:59 P	T06	
23/8/2015	7:39:00 P	T06	
23/8/2015	7:39:01 P	T06	
23/8/2015	8:16:58 P	T06	
23/8/2015	8:16:59 P	T06	
23/8/2015	8:17:00 P	T06	
23/8/2015	8:17:01 P	T06	
23/8/2015	8:17:02 P	T06	

Date	Time	Camera 1	Camera 2
24/8/2015	1:02:47 A	T06	
24/8/2015	1:02:48 A	T06	
24/8/2015	1:02:49 A	T06	
24/8/2015	1:02:50 A	T06	
24/8/2015	1:02:51 A	T06	
24/8/2015	2:33:02 P	T06	
24/8/2015	2:33:03 P	T06	
24/8/2015	2:33:04 P	T06	
24/8/2015	2:33:05 P	T06	
24/8/2015	2:33:06 P	T06	
24/8/2015	3:47:28 P	T06	
24/8/2015	3:47:30 P	T06	
24/8/2015	3:47:31 P	T06	
24/8/2015	3:47:32 P	T06	
24/8/2015	3:47:33 P	T06	
24/8/2015	4:56:02 P	T06	
24/8/2015	4:56:03 P	T06	
24/8/2015	4:56:04 P	T06	
24/8/2015	4:56:05 P	T06	
24/8/2015	4:56:06 P	T06	
24/8/2015	7:10:07 P	T06	
24/8/2015	7:10:08 P	T06	
24/8/2015	7:10:09 P	T06	
24/8/2015	7:10:10 P	T06	
24/8/2015	7:10:11 P	T06	
24/8/2015	7:15:00 P	T06	
24/8/2015	7:15:01 P	T06	
24/8/2015	7:15:02 P	T06	
24/8/2015	7:15:03 P	T06	
24/8/2015	7:15:04 P	T06	
24/8/2015	7:17:48 P	T06	
24/8/2015	7:17:49 P	T06	
24/8/2015	7:17:50 P	T06	
24/8/2015	7:17:51 P	T06	
24/8/2015	7:17:52 P	T06	
25/8/2015	3:28:19 A	T06	
25/8/2015	3:28:20 A	T06	
25/8/2015	3:28:21 A	T06	
25/8/2015	3:28:22 A	T06	

Date	Time	Camera 1	Camera 2
25/8/2015	3:28:23 A	T06	
25/8/2015	4:53:41 P	T06	
25/8/2015	4:53:42 P	T06	
25/8/2015	4:53:43 P	T06	
25/8/2015	4:53:44 P	T06	
25/8/2015	4:53:45 P	T06	
25/8/2015	4:56:56 P	T06	
25/8/2015	4:56:58 P	T06	
25/8/2015	4:56:59 P	T06	
25/8/2015	4:57:00 P	T06	
25/8/2015	4:57:01 P	T06	
25/8/2015	5:09:11 P	T06	
25/8/2015	5:09:12 P	T06	
25/8/2015	5:09:13 P	T06	
25/8/2015	5:09:14 P	T06	
25/8/2015	5:09:15 P	T06	
25/8/2015	5:09:36 P	T06	
25/8/2015	5:09:37 P	T06	
25/8/2015	5:09:38 P	T06	
25/8/2015	5:09:39 P	T06	
25/8/2015	5:09:40 P	T06	
26/8/2015	4:35:32 A	T06	
26/8/2015	4:35:33 A	T06	
26/8/2015	4:35:34 A	T06	
26/8/2015	4:35:35 A	T06	
26/8/2015	4:35:36 A	T06	
26/8/2015	5:35:43 P	T06	
26/8/2015	5:35:44 P	T06	
26/8/2015	5:35:46 P	T06	
26/8/2015	5:35:47 P	T06	
26/8/2015	5:35:48 P	T06	
26/8/2015	7:21:47 P	T06	
26/8/2015	7:21:49 P	T06	
26/8/2015	7:21:50 P	T06	
26/8/2015	7:21:51 P	T06	
26/8/2015	7:21:52 P	T06	
26/8/2015	7:24:58 P	T06	
26/8/2015	7:24:59 P	T06	
26/8/2015	7:25:00 P	T06	

Date	Time	Camera 1	Camera 2
26/8/2015	7:25:01 P	T06	
26/8/2015	7:25:02 P	T06	
26/8/2015	8:30:26 P	T06	
26/8/2015	8:30:27 P	T06	
26/8/2015	8:30:28 P	T06	
26/8/2015	8:30:29 P	T06	
26/8/2015	8:30:30 P	T06	
26/8/2015	9:37:23 P	T06	
26/8/2015	9:37:24 P	T06	
26/8/2015	9:37:25 P	T06	
26/8/2015	9:37:27 P	T06	
26/8/2015	9:37:28 P	T06	
26/8/2015	9:37:43 P	T06	
26/8/2015	9:37:44 P	T06	
26/8/2015	9:37:46 P	T06	
26/8/2015	9:37:47 P	T06	
26/8/2015	9:37:48 P	T06	
26/8/2015	10:29:27 P	T06	
26/8/2015	10:29:28 P	T06	
26/8/2015	10:29:29 P	T06	
26/8/2015	10:29:30 P	T06	
26/8/2015	10:29:31 P	T06	
26/8/2015	10:30:04 P	T06	
26/8/2015	10:30:05 P	T06	
26/8/2015	10:30:06 P	T06	
26/8/2015	10:30:07 P	T06	
26/8/2015	10:30:08 P	T06	
27/8/2015	4:06:48 A	T06	
27/8/2015	4:06:49 A	T06	
27/8/2015	4:06:50 A	T06	
27/8/2015	4:06:51 A	T06	
27/8/2015	4:06:52 A	T06	
27/8/2015	9:31:16 A	T06	
27/8/2015	9:31:18 A	T06	
27/8/2015	9:31:19 A	T06	
27/8/2015	9:31:20 A	T06	
27/8/2015	9:31:21 A	T06	
27/8/2015	6:06:05 P	T06	
27/8/2015	6:06:06 P	T06	

Date	Time	Camera 1	Camera 2
27/8/2015	6:06:07 P	T06	
27/8/2015	6:06:08 P	T06	
27/8/2015	6:06:09 P	T06	
27/8/2015	7:54:37 P	T06	
27/8/2015	7:54:38 P	T06	
27/8/2015	7:54:39 P	T06	
27/8/2015	7:54:40 P	T06	
27/8/2015	7:54:41 P	T06	
28/8/2015	7:40:35 A	T06	
28/8/2015	7:40:36 A	T06	
28/8/2015	7:40:37 A	T06	
28/8/2015	7:40:38 A	T06	
28/8/2015	7:40:39 A	T06	
28/8/2015	4:23:05 P	T06	
28/8/2015	4:23:07 P	T06	
28/8/2015	4:23:08 P	T06	
28/8/2015	4:23:09 P	T06	
28/8/2015	4:23:10 P	T06	
28/8/2015	4:23:26 P	T06	
28/8/2015	4:23:27 P	T06	
28/8/2015	4:23:28 P	T06	
28/8/2015	4:23:29 P	T06	
28/8/2015	4:23:30 P	T06	
28/8/2015	4:23:49 P	T06	
28/8/2015	4:23:50 P	T06	
28/8/2015	4:23:51 P	T06	
28/8/2015	4:23:52 P	T06	
28/8/2015	4:23:53 P	T06	
28/8/2015	8:30:49 P	T06	
28/8/2015	8:30:50 P	T06	
28/8/2015	8:30:51 P	T06	
28/8/2015	8:30:52 P	T06	
28/8/2015	8:30:53 P	T06	
28/8/2015	8:40:49 P	T06	
28/8/2015	8:40:50 P	T06	
28/8/2015	8:40:51 P	T06	
28/8/2015	8:40:55 P	T06	
28/8/2015	8:40:56 P	T06	
28/8/2015	8:42:54 P	T06	

Date	Time	Camera 1	Camera 2
28/8/2015	8:42:55 P	T06	
28/8/2015	8:42:56 P	T06	
28/8/2015	8:42:57 P	T06	
28/8/2015	8:42:58 P	T06	
28/8/2015	8:52:47 P	T06	
28/8/2015	8:52:48 P	T06	
28/8/2015	8:52:49 P	T06	
28/8/2015	8:52:50 P	T06	
28/8/2015	8:52:51 P	T06	
28/8/2015	9:44:21 P	T06	
28/8/2015	9:44:22 P	T06	
28/8/2015	9:44:23 P	T06	
28/8/2015	9:44:24 P	T06	
28/8/2015	9:44:25 P	T06	
29/8/2015	6:02:30 P	T06	
29/8/2015	6:02:32 P	T06	
29/8/2015	6:02:33 P	T06	
29/8/2015	6:02:34 P	T06	
29/8/2015	6:02:35 P	T06	
31/8/2015	5:16:45 P	T06	
31/8/2015	5:16:46 P	T06	
31/8/2015	5:16:47 P	T06	
31/8/2015	5:16:48 P	T06	
31/8/2015	5:16:49 P	T06	
31/8/2015	5:17:36 P	T06	
31/8/2015	5:17:37 P	T06	
31/8/2015	5:17:38 P	T06	
31/8/2015	5:17:39 P	T06	
31/8/2015	5:17:40 P	T06	
1/9/2015	12:40:45 P	T04	
1/9/2015	12:40:46 P	T04	
1/9/2015	12:40:47 P	T04	
1/9/2015	12:40:48 P	T04	
1/9/2015	12:40:49 P	T04	
6/9/2015	5:15:35 P	T06	
6/9/2015	5:15:36 P	T06	
6/9/2015	5:15:37 P	T06	
6/9/2015	5:15:38 P	T06	
6/9/2015	5:15:39 P	T06	

Date	Time	Camera 1	Camera 2
7/9/2015	4:06:16 P	T06	
7/9/2015	4:06:17 P	T06	
7/9/2015	4:06:18 P	T06	
7/9/2015	4:06:19 P	T06	
7/9/2015	4:06:20 P	T06	
7/9/2015	6:44:43 P	T06	
7/9/2015	6:44:44 P	T06	
7/9/2015	6:44:45 P	T06	
7/9/2015	6:44:46 P	T06	
7/9/2015	6:44:47 P	T06	
8/9/2015	10:20:13 A	T06	
8/9/2015	10:20:14 A	T06	
8/9/2015	10:20:15 A	T06	
8/9/2015	10:20:16 A	T06	
8/9/2015	10:20:17 A	T06	
9/9/2015	2:29:16 P	T04	
9/9/2015	2:29:17 P	T04	
9/9/2015	2:29:18 P	T04	
9/9/2015	2:29:19 P	T04	
9/9/2015	2:29:20 P	T04	
13/9/2015	2:49:14 P	T04	
13/9/2015	2:49:15 P	T04	
13/9/2015	2:49:16 P	T04	
13/9/2015	2:49:17 P	T04	
13/9/2015	2:49:18 P	T04	
13/9/2015	8:12:06 P	T06	
13/9/2015	8:12:07 P	T06	
13/9/2015	8:12:08 P	T06	
13/9/2015	8:12:09 P	T06	
13/9/2015	8:12:10 P	T06	
15/9/2015	12:06:53 P	T06	
15/9/2015	12:06:54 P	T06	
15/9/2015	12:06:55 P	T06	
15/9/2015	12:06:56 P	T06	
15/9/2015	12:06:57 P	T06	
16/9/2015	4:37:30 P	T06	
16/9/2015	4:37:32 P	T06	
16/9/2015	4:37:33 P	T06	
16/9/2015	4:37:34 P	T06	

Date	Time	Camera 1	Camera 2
16/9/2015	4:37:35 P	T06	
16/9/2015	4:37:50 P	T06	
16/9/2015	4:37:51 P	T06	
16/9/2015	4:37:52 P	T06	
16/9/2015	4:37:53 P	T06	
16/9/2015	4:37:54 P	T06	
16/9/2015	4:39:20 P	T06	
16/9/2015	4:39:21 P	T06	
16/9/2015	4:39:22 P	T06	
16/9/2015	4:39:23 P	T06	
16/9/2015	4:39:24 P	T06	
16/9/2015	4:39:45 P	T06	
16/9/2015	4:39:46 P	T06	
16/9/2015	4:39:47 P	T06	
16/9/2015	4:39:48 P	T06	
16/9/2015	4:39:49 P	T06	
16/9/2015	4:40:11 P	T06	
16/9/2015	4:40:12 P	T06	
16/9/2015	4:40:13 P	T06	
16/9/2015	4:40:14 P	T06	
16/9/2015	4:40:15 P	T06	
16/9/2015	4:40:37 P	T06	
16/9/2015	4:40:38 P	T06	
16/9/2015	4:40:39 P	T06	
16/9/2015	4:40:40 P	T06	
16/9/2015	4:40:41 P	T06	
20/9/2015	3:49:07 A	T06	
20/9/2015	3:49:08 A	T06	
20/9/2015	3:49:09 A	T06	
20/9/2015	3:49:10 A	T06	
20/9/2015	3:49:11 A	T06	
20/9/2015	3:49:27 A	T06	
20/9/2015	3:49:28 A	T06	
20/9/2015	3:49:29 A	T06	
20/9/2015	3:49:30 A	T06	
20/9/2015	3:49:31 A	T06	
20/9/2015	3:49:46 A	T06	
20/9/2015	3:49:47 A	T06	
20/9/2015	3:49:48 A	T06	

Date	Time	Camera 1	Camera 2
20/9/2015	3:49:49 A	T06	
20/9/2015	3:49:50 A	T06	
20/9/2015	9:15:57 A	T06	
20/9/2015	9:15:58 A	T06	
20/9/2015	9:15:59 A	T06	
20/9/2015	9:16:00 A	T06	
20/9/2015	9:16:01 A	T06	
20/9/2015	6:12:52 P	T06	
20/9/2015	6:12:53 P	T06	
20/9/2015	6:12:54 P	T06	
20/9/2015	6:12:55 P	T06	
20/9/2015	6:12:56 P	T06	
20/9/2015	10:09:57 P	T06	
20/9/2015	10:09:58 P	T06	
20/9/2015	10:09:59 P	T06	
20/9/2015	10:10:00 P	T06	
20/9/2015	10:10:01 P	T06	
22/9/2015	5:58:47 P	T06	
22/9/2015	5:58:48 P	T06	
22/9/2015	5:58:49 P	T06	
22/9/2015	5:58:50 P	T06	
22/9/2015	5:58:51 P	T06	

Test

21/5/2015	12:19:33 P	T04	
21/5/2015	12:19:34 P	T04	
21/5/2015	12:19:35 P	T04	
21/5/2015	12:19:36 P	T04	
21/5/2015	12:19:37 P	T04	
21/5/2015	12:19:52 P	T04	
21/5/2015	12:19:53 P	T04	
21/5/2015	12:19:54 P	T04	
21/5/2015	12:19:55 P	T04	
21/5/2015	12:19:56 P	T04	
4/6/2015	11:08:09 A	T05	
4/6/2015	11:08:14 A	T05	
4/6/2015	11:08:15 A	T05	
4/6/2015	11:08:16 A	T05	

Date	Time	Camera 1	Camera 2
4/6/2015	11:08:17 A	T05	
4/6/2015	11:08:32 A	T05	
4/6/2015	11:08:34 A	T05	
4/6/2015	11:08:35 A	T05	
4/6/2015	11:08:36 A	T05	
4/6/2015	11:08:37 A	T05	
11/6/2015	3:18:43 P	T06	
11/6/2015	3:18:52 P	T06	
11/6/2015	3:18:53 P	T06	
11/6/2015	3:18:54 P	T06	
11/6/2015	3:18:55 P	T06	
11/6/2015	3:19:12 P	T06	
11/6/2015	3:19:13 P	T06	
11/6/2015	3:19:14 P	T06	
11/6/2015	3:19:15 P	T06	
11/6/2015	3:19:16 P	T06	
11/6/2015	3:31:45 P	T07	
11/6/2015	3:31:46 P	T07	
11/6/2015	3:31:47 P	T07	
11/6/2015	3:31:48 P	T07	
11/6/2015	3:31:49 P	T07	
17/6/2015	12:25:06 P	T07	
17/6/2015	12:25:08 P	T07	
17/6/2015	12:25:09 P	T07	
17/6/2015	12:25:10 P	T07	
17/6/2015	12:25:11 P	T07	
17/6/2015	12:26:51 P	T07	
17/6/2015	12:26:52 P	T07	
17/6/2015	12:26:53 P	T07	
17/6/2015	12:26:54 P	T07	
17/6/2015	12:26:55 P	T07	
17/6/2015	1:45:41 P	T09	
17/6/2015	1:45:42 P	T09	
17/6/2015	1:45:43 P	T09	
17/6/2015	1:45:44 P	T09	
17/6/2015	1:45:45 P	T09	
25/6/2015	11:45:04 A	T06	
25/6/2015	11:45:13 A	T06	
25/6/2015	11:45:14 A	T06	

Date	Time	Camera 1	Camera 2
25/6/2015	11:45:15 A	T06	
25/6/2015	11:45:16 A	T06	
25/6/2015	12:11:25 P	T08	
25/6/2015	12:11:29 P	T08	
25/6/2015	12:11:30 P	T08	
25/6/2015	12:11:31 P	T08	
25/6/2015	12:11:32 P	T08	
25/6/2015	12:11:50 P	T08	
25/6/2015	12:11:51 P	T08	
25/6/2015	12:11:52 P	T08	
25/6/2015	12:11:53 P	T08	
25/6/2015	12:11:54 P	T08	
25/6/2015	12:18:40 P	T07	
25/6/2015	12:18:41 P	T07	
25/6/2015	12:18:42 P	T07	
25/6/2015	12:18:43 P	T07	
25/6/2015	12:18:44 P	T07	
25/6/2015	12:20:22 P	T07	
25/6/2015	12:20:23 P	T07	
25/6/2015	12:20:24 P	T07	
25/6/2015	12:20:25 P	T07	
25/6/2015	12:20:26 P	T07	
30/6/2015	4:49:39 P	T02	
30/6/2015	4:49:40 P	T02	
30/6/2015	4:49:41 P	T02	
30/6/2015	4:49:42 P	T02	
30/6/2015	4:49:43 P	T02	
30/6/2015	6:34:15 P	T01	
30/6/2015	6:34:16 P	T01	
30/6/2015	6:34:18 P	T01	
30/6/2015	6:34:19 P	T01	
30/6/2015	6:34:20 P	T01	
8/7/2015	3:40:32 P	T05	
8/7/2015	3:40:33 P	T05	
8/7/2015	3:40:35 P	T05	
8/7/2015	3:40:36 P	T05	
8/7/2015	3:40:37 P	T05	
8/7/2015	3:43:51 P	T05	
8/7/2015	3:43:52 P	T05	

Date	Time	Camera 1	Camera 2
8/7/2015	3:43:53 P	T05	
8/7/2015	3:43:54 P	T05	
8/7/2015	3:43:55 P	T05	
8/7/2015	5:19:01 P	T09	
8/7/2015	5:19:04 P	T09	
8/7/2015	5:19:05 P	T09	
8/7/2015	5:19:06 P	T09	
8/7/2015	5:19:07 P	T09	
4/8/2015	2:39:04 P	T03	
4/8/2015	2:39:09 P	T03	
4/8/2015	2:39:10 P	T03	
4/8/2015	2:39:11 P	T03	
4/8/2015	2:39:12 P	T03	
4/8/2015	2:39:27 P	T03	
4/8/2015	2:39:29 P	T03	
4/8/2015	2:39:30 P	T03	
4/8/2015	2:39:31 P	T03	
4/8/2015	2:39:32 P	T03	
4/8/2015	3:41:27 P	T01	
4/8/2015	3:41:28 P	T01	
4/8/2015	3:41:29 P	T01	
4/8/2015	3:41:30 P	T01	
4/8/2015	3:41:31 P	T01	
4/8/2015	3:41:55 P	T01	
4/8/2015	3:41:56 P	T01	
4/8/2015	3:41:57 P	T01	
4/8/2015	3:41:58 P	T01	
4/8/2015	3:41:59 P	T01	
4/8/2015	3:42:15 P	T01	
4/8/2015	3:42:16 P	T01	
4/8/2015	3:42:17 P	T01	
4/8/2015	3:42:18 P	T01	
4/8/2015	3:42:19 P	T01	
4/8/2015	4:06:47 P	T02	
4/8/2015	4:06:48 P	T02	
4/8/2015	4:06:49 P	T02	
4/8/2015	4:06:50 P	T02	
4/8/2015	4:06:51 P	T02	
4/8/2015	4:09:02 P	T02	

Date	Time	Camera 1	Camera 2
4/8/2015	4:09:10 P	T02	
4/8/2015	4:09:11 P	T02	
4/8/2015	4:09:12 P	T02	
4/8/2015	4:09:13 P	T02	
4/8/2015	5:01:12 P	T08	
4/8/2015	5:01:13 P	T08	
4/8/2015	5:01:14 P	T08	
4/8/2015	5:01:15 P	T08	
4/8/2015	5:01:16 P	T08	
4/8/2015	5:01:33 P	T08	
4/8/2015	5:01:35 P	T08	
4/8/2015	5:01:36 P	T08	
4/8/2015	5:01:37 P	T08	
4/8/2015	5:01:38 P	T08	
4/8/2015	5:03:11 P	T08	
4/8/2015	5:03:13 P	T08	
4/8/2015	5:03:14 P	T08	
4/8/2015	5:03:15 P	T08	
4/8/2015	5:03:16 P	T08	
4/8/2015	5:08:37 P	T07	
4/8/2015	5:08:39 P	T07	
4/8/2015	5:08:40 P	T07	
4/8/2015	5:08:41 P	T07	
4/8/2015	5:08:42 P	T07	
4/8/2015	5:08:58 P	T07	
4/8/2015	5:08:59 P	T07	
4/8/2015	5:09:00 P	T07	
4/8/2015	5:09:01 P	T07	
4/8/2015	5:09:02 P	T07	
4/8/2015	5:10:34 P	T07	
4/8/2015	5:10:38 P	T07	
4/8/2015	5:10:39 P	T07	
4/8/2015	5:10:40 P	T07	
4/8/2015	5:10:41 P	T07	
4/8/2015	5:20:53 P	T06	
4/8/2015	5:20:59 P	T06	
4/8/2015	5:21:00 P	T06	
4/8/2015	5:21:01 P	T06	
4/8/2015	5:21:02 P	T06	

Date	Time	Camera 1	Camera 2
21/8/2015	4:20:07 P	T03	
21/8/2015	4:20:09 P	T03	
21/8/2015	4:20:10 P	T03	
21/8/2015	4:20:11 P	T03	
21/8/2015	4:20:12 P	T03	
21/8/2015	4:20:32 P	T03	
21/8/2015	4:20:33 P	T03	
21/8/2015	4:20:34 P	T03	
21/8/2015	4:20:35 P	T03	
21/8/2015	4:20:36 P	T03	
21/8/2015	4:22:05 P	T03	
21/8/2015	4:22:09 P	T03	
21/8/2015	4:22:10 P	T03	
21/8/2015	4:22:11 P	T03	
21/8/2015	4:22:12 P	T03	
21/8/2015	5:18:11 P	T05	
21/8/2015	5:18:12 P	T05	
21/8/2015	5:18:13 P	T05	
21/8/2015	5:18:14 P	T05	
21/8/2015	5:18:16 P	T05	
21/8/2015	6:00:15 P	T06	
21/8/2015	6:00:16 P	T06	
21/8/2015	6:00:18 P	T06	
21/8/2015	6:00:19 P	T06	
21/8/2015	6:00:20 P	T06	
21/8/2015	6:01:36 P	T06	
21/8/2015	6:01:37 P	T06	
21/8/2015	6:01:38 P	T06	
21/8/2015	6:01:39 P	T06	
21/8/2015	6:01:40 P	T06	
25/8/2015	5:57:09 P	T04	
25/8/2015	6:14:15 P	T03	
25/8/2015	6:14:16 P	T03	
25/8/2015	6:14:17 P	T03	
25/8/2015	6:14:19 P	T03	
25/8/2015	6:15:43 P	T03	
25/8/2015	6:15:50 P	T03	
25/8/2015	6:15:52 P	T03	
25/8/2015	6:15:53 P	T03	

Date	Time	Camera 1	Camera 2
25/8/2015	6:15:54 P	T03	
23/9/2015	4:40:45 P	T06	
23/9/2015	4:40:46 P	T06	
23/9/2015	4:40:47 P	T06	
23/9/2015	4:40:48 P	T06	
23/9/2015	4:40:49 P	T06	

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24/7/2015	6:34:43 A	T09	
24/7/2015	6:34:44 A	T09	
24/7/2015	6:34:45 A	T09	
24/7/2015	6:34:46 A	T09	
24/7/2015	6:34:47 A	T09	
24/7/2015	6:35:03 A	T09	
24/7/2015	6:35:04 A	T09	
24/7/2015	6:35:05 A	T09	
24/7/2015	6:35:06 A	T09	
24/7/2015	6:35:07 A	T09	
4/8/2015	7:03:55 A	T09	
4/8/2015	7:03:56 A	T09	
4/8/2015	7:03:57 A	T09	
4/8/2015	7:03:58 A	T09	
4/8/2015	7:03:59 A	T09	
9/8/2015	7:12:03 A	T08	
9/8/2015	7:12:05 A	T08	
9/8/2015	7:12:06 A	T08	
9/8/2015	7:12:07 A	T08	
9/8/2015	7:12:08 A	T08	
9/8/2015	7:31:26 A	T08	
9/8/2015	7:31:27 A	T08	
9/8/2015	7:31:29 A	T08	
9/8/2015	7:31:30 A	T08	
9/8/2015	7:31:31 A	T08	
9/8/2015	7:35:16 A	T08	
9/8/2015	7:35:17 A	T08	
9/8/2015	7:35:18 A	T08	
9/8/2015	7:35:19 A	T08	
9/8/2015	7:35:20 A	T08	

Date	Time	Camera 1	Camera 2
11/8/2015	12:57:31 A	T08	
11/8/2015	12:57:32 A	T08	
11/8/2015	12:57:33 A	T08	
11/8/2015	12:57:34 A	T08	
11/8/2015	12:57:35 A	T08	

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21/5/2015	6:16:52 P	T04	
21/5/2015	6:16:53 P	T04	
21/5/2015	6:16:54 P	T04	
21/5/2015	6:16:55 P	T04	
21/5/2015	6:16:56 P	T04	
23/5/2015	5:12:11 P	T04	
23/5/2015	5:12:13 P	T04	
23/5/2015	5:12:14 P	T04	
23/5/2015	5:12:15 P	T04	
23/5/2015	5:12:16 P	T04	
17/6/2015	7:07:54 P	T07	
17/6/2015	7:07:56 P	T07	
17/6/2015	7:07:57 P	T07	
17/6/2015	7:07:58 P	T07	
17/6/2015	7:07:59 P	T07	
2/7/2015	7:55:39 A	T02	
2/7/2015	7:55:40 A	T02	
2/7/2015	7:55:41 A	T02	
2/7/2015	7:55:42 A	T02	
2/7/2015	7:55:43 A	T02	
3/7/2015	7:00:49 A	T07	
3/7/2015	7:00:50 A	T07	
3/7/2015	7:00:51 A	T07	
3/7/2015	7:00:52 A	T07	
3/7/2015	7:00:53 A	T07	
3/7/2015	8:22:09 A	T02	
3/7/2015	8:22:10 A	T02	
3/7/2015	8:22:11 A	T02	
3/7/2015	8:22:12 A	T02	
3/7/2015	8:22:13 A	T02	
3/7/2015	2:54:57 P	T02	

Date	Time	Camera 1	Camera 2
3/7/2015	2:54:58 P	T02	
3/7/2015	2:54:59 P	T02	
3/7/2015	2:55:00 P	T02	
3/7/2015	2:55:01 P	T02	
5/7/2015	9:41:25 A	T02	
5/7/2015	9:41:26 A	T02	
5/7/2015	9:41:27 A	T02	
5/7/2015	9:41:28 A	T02	
5/7/2015	9:41:29 A	T02	
5/7/2015	1:49:36 P	T02	
5/7/2015	1:49:37 P	T02	
5/7/2015	1:49:38 P	T02	
5/7/2015	1:49:39 P	T02	
5/7/2015	1:49:40 P	T02	
6/7/2015	12:19:57 P	T02	
6/7/2015	12:19:58 P	T02	
6/7/2015	12:19:59 P	T02	
6/7/2015	12:20:00 P	T02	
6/7/2015	12:20:01 P	T02	
6/7/2015	5:01:38 P	T02	
6/7/2015	5:01:39 P	T02	
6/7/2015	5:01:40 P	T02	
6/7/2015	5:01:41 P	T02	
6/7/2015	5:01:42 P	T02	
8/7/2015	11:39:37 A	T02	
8/7/2015	11:39:38 A	T02	
8/7/2015	11:39:39 A	T02	
8/7/2015	11:39:40 A	T02	
8/7/2015	11:39:41 A	T02	
9/7/2015	2:38:15 P	T02	
9/7/2015	2:38:16 P	T02	
9/7/2015	2:38:17 P	T02	
9/7/2015	2:38:18 P	T02	
9/7/2015	2:38:19 P	T02	
10/7/2015	3:30:50 P	T02	
10/7/2015	3:30:51 P	T02	
10/7/2015	3:30:52 P	T02	
10/7/2015	3:30:53 P	T02	
10/7/2015	3:30:54 P	T02	

Date	Time	Camera 1	Camera 2
11/7/2015	2:53:55 P	T02	
11/7/2015	2:53:57 P	T02	
11/7/2015	2:53:58 P	T02	
11/7/2015	2:53:59 P	T02	
11/7/2015	2:54:00 P	T02	
16/7/2015	8:32:39 A	T02	
16/7/2015	8:32:41 A	T02	
16/7/2015	8:32:42 A	T02	
16/7/2015	8:32:43 A	T02	
16/7/2015	8:32:44 A	T02	
16/7/2015	4:45:31 P	T07	
16/7/2015	4:45:32 P	T07	
16/7/2015	4:45:33 P	T07	
16/7/2015	4:45:34 P	T07	
16/7/2015	4:45:35 P	T07	
18/7/2015	1:06:31 P	T02	
18/7/2015	1:06:33 P	T02	
18/7/2015	1:06:34 P	T02	
18/7/2015	1:06:35 P	T02	
18/7/2015	1:06:36 P	T02	
19/7/2015	10:47:24 A	T02	
19/7/2015	10:47:26 A	T02	
19/7/2015	10:47:27 A	T02	
19/7/2015	10:47:28 A	T02	
19/7/2015	10:47:29 A	T02	
21/7/2015	8:34:18 A	T02	
21/7/2015	8:34:19 A	T02	
21/7/2015	8:34:20 A	T02	
21/7/2015	8:34:21 A	T02	
21/7/2015	8:34:22 A	T02	
23/7/2015	10:28:08 A	T02	
23/7/2015	10:28:10 A	T02	
23/7/2015	10:28:11 A	T02	
23/7/2015	10:28:12 A	T02	
23/7/2015	10:28:13 A	T02	
25/7/2015	12:01:22 P	T07	
25/7/2015	12:01:23 P	T07	
25/7/2015	12:01:24 P	T07	
25/7/2015	12:01:25 P	T07	

Date	Time	Camera 1	Camera 2
25/7/2015	12:01:26 P	T07	
26/7/2015	8:28:56 A	T02	
26/7/2015	8:28:58 A	T02	
26/7/2015	8:28:59 A	T02	
26/7/2015	8:29:00 A	T02	
26/7/2015	8:29:01 A	T02	
26/7/2015	2:19:26 P	T09	
26/7/2015	2:19:27 P	T09	
26/7/2015	2:19:28 P	T09	
26/7/2015	2:19:29 P	T09	
26/7/2015	2:19:30 P	T09	
27/7/2015	7:24:29 A	T09	
27/7/2015	7:24:30 A	T09	
27/7/2015	7:24:31 A	T09	
27/7/2015	7:24:32 A	T09	
27/7/2015	7:24:33 A	T09	
29/7/2015	11:30:23 A	T07	
29/7/2015	11:30:24 A	T07	
29/7/2015	11:30:25 A	T07	
29/7/2015	11:30:26 A	T07	
29/7/2015	11:30:27 A	T07	
29/7/2015	11:31:55 A	T07	
29/7/2015	11:31:56 A	T07	
29/7/2015	11:31:57 A	T07	
29/7/2015	11:31:58 A	T07	
29/7/2015	11:31:59 A	T07	
30/7/2015	10:27:40 A	T02	
30/7/2015	10:27:42 A	T02	
30/7/2015	10:27:43 A	T02	
30/7/2015	10:27:44 A	T02	
30/7/2015	10:27:45 A	T02	
30/7/2015	10:28:08 A	T02	
30/7/2015	10:28:09 A	T02	
30/7/2015	10:28:10 A	T02	
30/7/2015	10:28:11 A	T02	
30/7/2015	10:28:12 A	T02	
1/8/2015	7:14:27 A	T07	
1/8/2015	7:14:28 A	T07	
1/8/2015	7:14:29 A	T07	

Date	Time	Camera 1	Camera 2
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1/8/2015	7:14:31 A	T07	
1/8/2015	3:55:33 P	T09	
1/8/2015	3:55:34 P	T09	
1/8/2015	3:55:35 P	T09	
1/8/2015	3:55:36 P	T09	
1/8/2015	3:55:37 P	T09	
1/8/2015	4:03:33 P	T02	
1/8/2015	4:03:35 P	T02	
1/8/2015	4:03:36 P	T02	
1/8/2015	4:03:37 P	T02	
1/8/2015	4:03:38 P	T02	
1/8/2015	4:03:56 P	T02	
1/8/2015	4:03:57 P	T02	
1/8/2015	4:03:58 P	T02	
1/8/2015	4:03:59 P	T02	
1/8/2015	4:04:00 P	T02	
1/8/2015	4:27:39 P	T07	
1/8/2015	4:27:40 P	T07	
1/8/2015	4:27:41 P	T07	
1/8/2015	4:27:42 P	T07	
1/8/2015	4:27:43 P	T07	
1/8/2015	5:13:42 P	T07	
1/8/2015	5:13:43 P	T07	
1/8/2015	5:13:44 P	T07	
1/8/2015	5:13:45 P	T07	
1/8/2015	5:13:46 P	T07	
4/8/2015	7:10:07 P	T07	
4/8/2015	7:10:08 P	T07	
4/8/2015	7:10:09 P	T07	
4/8/2015	7:10:10 P	T07	
4/8/2015	7:10:11 P	T07	
5/8/2015	7:06:37 P	T07	
5/8/2015	7:06:38 P	T07	
5/8/2015	7:06:39 P	T07	
5/8/2015	7:06:40 P	T07	
5/8/2015	7:06:41 P	T07	
6/8/2015	7:20:30 A	T02	
6/8/2015	7:20:31 A	T02	

Date	Time	Camera 1	Camera 2
6/8/2015	7:20:33 A	T02	
6/8/2015	7:20:34 A	T02	
6/8/2015	7:20:35 A	T02	
6/8/2015	3:17:30 P	T02	
6/8/2015	3:17:31 P	T02	
6/8/2015	3:17:32 P	T02	
6/8/2015	3:17:33 P	T02	
6/8/2015	3:17:34 P	T02	
7/8/2015	7:08:20 P	T07	
7/8/2015	7:08:22 P	T07	
7/8/2015	7:08:23 P	T07	
7/8/2015	7:08:24 P	T07	
7/8/2015	7:08:25 P	T07	
7/8/2015	7:10:45 P	T03	
7/8/2015	7:10:47 P	T03	
7/8/2015	7:10:48 P	T03	
7/8/2015	7:10:49 P	T03	
7/8/2015	7:10:50 P	T03	
7/8/2015	7:12:17 P	T07	
7/8/2015	7:12:19 P	T07	
7/8/2015	7:12:20 P	T07	
7/8/2015	7:12:21 P	T07	
7/8/2015	7:12:22 P	T07	
9/8/2015	7:06:45 A	T07	
9/8/2015	7:06:46 A	T07	
9/8/2015	7:06:47 A	T07	
9/8/2015	7:06:48 A	T07	
9/8/2015	7:06:49 A	T07	
9/8/2015	6:42:44 P	T07	
9/8/2015	6:42:45 P	T07	
9/8/2015	6:42:46 P	T07	
9/8/2015	6:42:47 P	T07	
9/8/2015	6:42:48 P	T07	
10/8/2015	2:13:58 P	T02	
10/8/2015	2:13:59 P	T02	
10/8/2015	2:14:00 P	T02	
10/8/2015	2:14:01 P	T02	
10/8/2015	2:14:02 P	T02	
12/8/2015	6:32:18 P	T07	

Date	Time	Camera 1	Camera 2
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12/8/2015	6:32:21 P	T07	
12/8/2015	6:32:22 P	T07	
12/8/2015	6:32:23 P	T07	
14/8/2015	6:59:13 A	T07	
14/8/2015	6:59:14 A	T07	
14/8/2015	6:59:15 A	T07	
14/8/2015	6:59:16 A	T07	
14/8/2015	6:59:17 A	T07	
18/8/2015	5:58:47 P	T03	
18/8/2015	5:58:49 P	T03	
18/8/2015	5:58:50 P	T03	
18/8/2015	5:58:51 P	T03	
18/8/2015	5:58:52 P	T03	
19/8/2015	8:34:42 A	T02	
19/8/2015	8:34:44 A	T02	
19/8/2015	8:34:45 A	T02	
19/8/2015	8:34:46 A	T02	
19/8/2015	8:34:47 A	T02	
19/8/2015	3:12:36 P	T03	
19/8/2015	3:12:37 P	T03	
19/8/2015	3:12:38 P	T03	
19/8/2015	3:12:39 P	T03	
19/8/2015	3:12:40 P	T03	
19/8/2015	4:06:14 P	T03	
19/8/2015	4:06:15 P	T03	
19/8/2015	4:06:16 P	T03	
19/8/2015	4:06:17 P	T03	
19/8/2015	4:06:18 P	T03	
20/8/2015	10:08:29 A	T02	
20/8/2015	10:08:31 A	T02	
20/8/2015	10:08:32 A	T02	
20/8/2015	10:08:33 A	T02	
20/8/2015	10:08:34 A	T02	
20/8/2015	11:50:32 A	T02	
20/8/2015	11:50:33 A	T02	
20/8/2015	11:50:34 A	T02	
20/8/2015	11:50:35 A	T02	
20/8/2015	11:50:36 A	T02	

Date	Time	Camera 1	Camera 2
22/8/2015	9:09:47 A	T02	
22/8/2015	9:09:49 A	T02	
22/8/2015	9:09:50 A	T02	
22/8/2015	9:09:51 A	T02	
22/8/2015	9:09:52 A	T02	
23/8/2015	5:31:15 P	T03	
23/8/2015	5:31:16 P	T03	
23/8/2015	5:31:17 P	T03	
23/8/2015	5:31:18 P	T03	
23/8/2015	5:31:19 P	T03	
24/8/2015	12:44:33 P	T03	
24/8/2015	12:44:34 P	T03	
24/8/2015	12:44:35 P	T03	
24/8/2015	12:44:36 P	T03	
24/8/2015	12:44:37 P	T03	
24/8/2015	3:51:22 P	T04	
24/8/2015	3:51:24 P	T04	
24/8/2015	3:51:25 P	T04	
24/8/2015	3:51:26 P	T04	
24/8/2015	3:51:27 P	T04	
25/8/2015	5:04:18 P	T02	
25/8/2015	5:04:19 P	T02	
25/8/2015	5:04:20 P	T02	
25/8/2015	5:04:21 P	T02	
25/8/2015	5:04:22 P	T02	
26/8/2015	10:06:09 A	T02	
26/8/2015	10:06:11 A	T02	
26/8/2015	10:06:12 A	T02	
26/8/2015	10:06:13 A	T02	
26/8/2015	10:06:14 A	T02	
26/8/2015	10:58:51 A	T02	
26/8/2015	10:58:52 A	T02	
26/8/2015	10:58:53 A	T02	
26/8/2015	10:58:54 A	T02	
26/8/2015	10:58:55 A	T02	
26/8/2015	12:17:55 P	T02	
26/8/2015	12:17:56 P	T02	
26/8/2015	12:17:57 P	T02	
26/8/2015	12:17:58 P	T02	

Date	Time	Camera 1	Camera 2
26/8/2015	12:17:59 P	T02	
27/8/2015	10:02:41 A	T02	
27/8/2015	10:02:43 A	T02	
27/8/2015	10:02:44 A	T02	
27/8/2015	10:02:45 A	T02	
27/8/2015	10:02:46 A	T02	
27/8/2015	11:06:24 A	T02	
27/8/2015	11:06:25 A	T02	
27/8/2015	11:06:27 A	T02	
27/8/2015	11:06:28 A	T02	
27/8/2015	11:06:29 A	T02	
27/8/2015	1:07:36 P	T03	
27/8/2015	1:07:37 P	T03	
27/8/2015	1:07:38 P	T03	
27/8/2015	1:07:39 P	T03	
27/8/2015	1:07:40 P	T03	
28/8/2015	12:39:48 P	T03	
28/8/2015	12:39:49 P	T03	
28/8/2015	12:39:50 P	T03	
28/8/2015	12:39:51 P	T03	
28/8/2015	12:39:52 P	T03	

Varanus nebulosus

26/6/2015	11:45:44 A	T07	
26/6/2015	11:45:45 A	T07	
26/6/2015	11:45:46 A	T07	
26/6/2015	11:45:47 A	T07	
26/6/2015	11:45:48 A	T07	
5/8/2015	10:19:44 A	T08	
5/8/2015	10:19:45 A	T08	
5/8/2015	10:19:47 A	T08	
5/8/2015	10:19:48 A	T08	
5/8/2015	10:19:49 A	T08	
10/8/2015	4:36:43 P	T03	
10/8/2015	4:36:44 P	T03	
10/8/2015	4:36:45 P	T03	
10/8/2015	4:36:46 P	T03	
10/8/2015	4:36:47 P	T03	

Date	Time	Camera 1	Camera 2
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14/8/2015	3:38:54 P	T03	
14/8/2015	3:38:55 P	T03	
14/8/2015	3:38:56 P	T03	
14/8/2015	3:38:57 P	T03	
15/8/2015	12:34:03 P	T07	
15/8/2015	12:34:04 P	T07	
15/8/2015	12:34:06 P	T07	
15/8/2015	12:34:07 P	T07	
15/8/2015	12:34:08 P	T07	
15/8/2015	1:11:45 P	T03	
15/8/2015	1:11:46 P	T03	
15/8/2015	1:11:47 P	T03	
15/8/2015	1:11:48 P	T03	
15/8/2015	1:11:49 P	T03	
22/9/2015	12:19:45 P	T06	
22/9/2015	12:19:47 P	T06	
22/9/2015	12:19:48 P	T06	
22/9/2015	12:19:49 P	T06	
22/9/2015	12:19:50 P	T06	

Varanus salvator

16/8/2015	12:58:26 P	T02	
16/8/2015	12:58:28 P	T02	
16/8/2015	12:58:29 P	T02	
16/8/2015	12:58:30 P	T02	
16/8/2015	12:58:31 P	T02	

T01


2015-08-04 7:51:14 PM M 1/5 25°C
T01
RECONYX

T02


2015-08-09 9:47:56 PM M 1/5 26°C
T02
RECONYX

T03


2015-08-23 5:31:15 PM M 1/5 28°C
T01A
RECONYX

T04


2015-08-26 5:44:16 PM M 1/5 26°C
T04
RECONYX

T05


2015-07-03 3:14:43 AM M 2/5
25°C
T04
RECONYX

T06


2015-08-21 10:27:48 PM M 3/5
26°C
T05
RECONYX

T07


2015-06-27 10:52:08 PM M 4/5
26°C
T06
RECONYX

T08


2015-07-04 2:02:39 PM M 2/5
25°C
T08
RECONYX

T09

Annex 14.4

Herpetofauna

Herpetofauna survey of the Mandai sectors
Serin Subaraj

Summary
This survey was carried out over a period of 6 months, from April to October 2015, to study and record the Herpetofauna in the Mandai Lake Road area. The results were combined with past records from the same area, giving a broader overview of the species found within the project area. A total of 57 Reptiles and 18 Amphibians were recorded from the project sectors. During the survey period of April to October 2015 a total of 36 Reptiles and 16 Amphibians were recorded.

Introduction
Herpetofauna of Singapore is composed of Anurans, Apodas, Squamates, Crocodilians and Chelonians. However there were no representatives of Apodas and Crocdilians recorded during the surveys or past records. Anurans are made up of Frogs and Toads, 16 frogs were recorded from the families: Megophryidae, Dicroglossidae, Ranidae, Rhacophoridae and Microhylidae while the toads represent the family Bufonidae. Squamates are made up of Lizards and Snakes, 18 lizards were recorded from the familes: Agamidae, Gekkonidae, Scincomorpha and Varanidae. 32 snakes were recorded from the families: Typhlopidae, Xenopeltidae, Pythonidae, Colubridae, Homalopsidae, Natricidae, Pareatidae, Elapidae and Viperidae. 6 Chelonians were recorded from the families: Geoemydidae, Trionychidae and Emydidae. However only 2 of the 6 Chelonians recorded are native.

Herpetofauna studies are difficult to carry out due to the sensitivity of the animals involved. Snakes for example are quick to escape from humans by feeling the vibrations the footsteps caused. As a result, past records came in useful to better understand the diversity within the sectors.

A total of 12 day surveys and 7 night surveys were conducted. Special focus was given to forest specialists and nationally and internationally threatened species. These species would indicate a more mature habitat and ecosystem. Each sector was surveyed twice in the day and once at night except for sector H. Each survey session lasted 3 hours. The survey was carried out by walking specific transects along the perimeter and through each sector. Slight deviations were made off trail to check streams, woodpiles or holes. Surveys were conducted using both visual sightings can vocalisation which is important for amphibians in particular. Species were identified by the surveyors and specimens collected usually found along the roads were given to the zoological collection of the Lee Kong Chian Natural History Museum for further studies.

Threats faced by the herpetofauna of the Mandai area

-Poaching (Illegal collection of animals by poachers)

Poaching can pose a significant threat to populations of herptiles within the Mandai area. The herptiles are mainly collected for either consumption or for the illegal pet trade. Such illegal collection remains unsustainable.
The remains of an unidentified Softshell turtle (Possibly *Amyda sp*) appears to have been caught in sector A and killed by fishermen for its meat.
Some examples of Native herpetofauna used in the illegal pet trade that were recorded from Mandai area: *Boiga dendrophila*, *Gonyosoma oxycephalum* (Locally EN), *Ahaetulla prasina* and *Nyctixalus pictus* (Locally EN).

-Collision with vehicles
Colliding with vehicles (Buggies, cars, bicycles) are usually fatal for most herptiles. Reptiles in particular are commonly seen as road kill, this is because reptiles may seek the warmth of the tarmac road in an attempt at thermoregulation. Some examples of herptile road kills are: *Coelognathus flavolineatus, Chrysopelea pelias, Xenepeltis unicolor, Oligodon octolineatus, Pareas margaritophorus and Ophiophagus hannah* (Locally EN)

-Pollution
Pollution poses a great threat towards herptiles, particularly amphibians. Amphibians require clean water sources to breed and lay eggs, tadpoles are extremely sensitive to slight changes in the water. Examples of sensitive forest dependent amphibians are: *Nyctixalus pictus* (Locally EN), *Hylarana laterimaculata*, *Hylarana labialis*, *Leptobrachium nigrops*
Abandoned fishing lines, nets and regular trash have the capability to trap unsuspecting animals, those animals die a slow death brought on by dehydration or starvation.

-Habitat degradation
Habitat degradation contributes significantly to habitat loss, as the forest degrades some sensitive animals that may require a specific microhabitat would also disappear as a consequence. Some examples of such species reliant on “good” forests are:
Gonyosoma oxycephalum (Locally EN), *Nyctixalus pictus* (Locally EN), *Eutropis rugifera* (Locally EN), *Lipinia vittigera* (Locally EN)

-Competition with introduced species
Introduced species can pose a threat to native herptiles as both introduced and native animals share similar niches within the tropical ecosystem. Several non-native herptiles have been recorded from the mandai area that may pose a threat to the native species in the area.
Examples of introduced herptiles recorded are: *Pareas margaritophorus, Gekko gecko, Calotes versicolor, Trachemys scripta, Orlitia borneensis* (Internationally EN), *Heosemys grandis* (Internationally VU)

Results of the findings

Zone A – Upper Seletar Peninsula (Central Catchment Nature Reserve) Transect

	Bold Print – Locally Threatened Underlined- Additional Species recorded during Bird surveys **Green-** Forest specialists	Bold Print & Capital Lettering – Internationally Threatened	**Herp Survey**	**Herp Survey**	**Night Survey**
No	**Common Names**	**Latin Names**	17/07/15	09/10/15	02/05/15
1	Brahminy Blind Snake	*Ramphotyphlops braminus*		1	
2	Oriental Whip Snake	*Ahaetulla prasina*		1	
3	Malayan Racer	*Coelognathus flavolineatus*			1
4	Striped Bronzeback	*Dendrelaphis caudolineatus*			1
5	Malayan Water Monior	*Varanus salvator*	2	1	
6	Common Sun Skink	*Eutropis multifasciatus*	2	2	
7	**Striped Sun Skink**	***Eutropis rugiferus***		1	
8	Spiny-tailed House Gecko	*Hemidactylus frenatus*	1		2
9	Black-bearded Flying Dragon	*Draco melanopogon*			
10	Changeable Lizard (Non Native)	*Calotes versicolor*			
11	Red-eared Slider (Non Native)	*Trachemys scripta*			
12	Malayan Box Terrapin	*Cuora amboinensis*			1
	Amphibians				
1	Black-eyed Litter Frog	*Leptobrachium nigrops*			7
2	Malayan Giant Frog	*Limnonectes blythii*			2
3	Malesian Frog	*Limnonectes malesianus*			1
4	**Spotted Tree Frog**	***Nyctixalus pictus***			2
5	Common Tree Frog	*Polypedates leucomystax*			2
6	**Golden-eared Rough-sided Frog**	***Hylarana baramica***			1
7	Copper-cheeked Frog	*Hylarana labialis*			3
8	**Lim Boo Liat's Sticky Frog**	***Kalophrynus limbooliati***		2	
9	Dark-sided Chorus Frog	*Microhyla heymonsi*			3

Zone B – Steven Lee Woods Transect

	Bold Print – Locally Threatened Underlined- Additional Species recorded during Bird surveys **Green-** Forest specialists	Bold Print & Capital Lettering – Internationally Threatened	**Herp Survey**	**Herp Survey**	**Night Survey**
No	**Common Names**	**Latin Names**	05/04/15	14/10/15	22/08/15
	Reptiles				
1	Reticulated Python	*Broghammerus reticulatus*	1		

2	Oriental Whip Snake	*Ahaetulla prasina*		1	1
3	**Red-necked Bronzeback**	***Dendrelaphis kopsteini***			
4	Painted Bronzeback	*Dendrelaphis pictus*			1
5	Striped Kukri	*Oligodon octolineatus*			1
6	Black-spitting Cobra	*Naja Sumatrana*		1	
7	Malayan Water Monior	*Varanus salvator*	1	2	
8	Clouded Monitor	*Varanus nebulosus*		1	
9	Spotted House Gecko	*Gekko monarchus*			3
10	Spiny-tailed House Gecko	*Hemidactylus frenatus*	1		4
11	Common Flying Dragon	*Draco sumatranus*		1	
12	Green-crested Lizard	*Bronchocela cristella*		1	1
13	Changeable Lizard (Non-Native)	*Calotes versicolor*	1	1	
14	Malayan Box Terrapin	*Cuora amboinensis*		1	
	Amphibians				
1	Asian Toad	*Duttaphrynus melanostictus*			1
2	Four-ridged Toad	*Ingerophrynus quadriporcatus*		2	
3	Black-eyed Litter Frog	*Leptobrachium nigrops*		2	
4	Field Frog	*Fejervarya limnocharis*			3
5	Malayan Giant Frog	*Limnonectes blythii*	1		2
6	Masked Rough-sided Frog	*Hylarana laterimaculata*			1
7	**Spotted Tree Frog**	***Nyctixalus pictus***	2		1
8	Common Tree Frog	*Polypedates leucomystax*			3
9	Painted Chorus Frog	*Microhyla butleri*	1		2
10	Dark-sided Chorus Frog	*Microhyla heymonsi*	3		10

Zone D – The Unnamed Road Along the Project Western Boundary Transect

	Bold Print – Locally Threatened Underlined- Additional Species recorded during Bird surveys **Green**- Forest specialists	Bold Print & Capital Lettering – Internationally Threatened	**Herp Survey**	**Herp Survey**	**Night Survey**
No	**Common Names**	**Latin Names**	26/04/15	08/08/15	26/06/15
	Reptiles				
1	Oriental Whip Snake	*Ahaetulla prasina*	1		
2	Painted Bronzeback	*Dendrelaphis pictus*	1	1	2
3	Malayan Water Monior	*Varanus salvator*		1	
4	Clouded Monitor	*Varanus nebulosus*	1		
5	Common Sun Skink	*Eutropis multifasciatus*	1	3	
6	Spotted House Gecko	*Gekko monarchus*			1
7	Spiny-tailed House Gecko	*Hemidactylus frenatus*		2	
8	**Lowland Dwarf Gecko**	***Hemiphyllodactylus typus***			1
9	Changeable Lizard (Non-Native)	*Calotes versicolor*	2		

	(Non-Native)				
10	Giant Asian Pond Terrapin (Non-Native)	*Heosemys grandis*			1
	Amphibians				
1	Field Frog	*Ferjervarya limnocharis*		2	2
2	Malayan Giant Frog	*Limnonectes blythii*		2	9
3	Common Tree Frog	*Polypedates leucomystax*	1		2
4	Common Greenback	*Hylarana erythraea*			
5	Copper-cheeked Frog	*Hylarana labialis*			1
6	**Lim Boo Liat's Sticky Frog**	***Kalophrynus limbooliati***	3		
7	Dark-sided Chorus Frog	*Microhyla heymonsi*			31

Zone E – Mandai Range Forest Transect

	Bold Print – Locally Threatened Underlined- Additional Species recorded during Bird surveys **Green-** Forest specialists	Bold Print & Capital Lettering – Internationally Threatened	**Herp Survey**	**Herp Survey**	**Night Survey**
No	**Common Names**	**Latin Names**	16/05/15	08/08/15	05/09/15
	Reptiles				
1	**Gold-ringed Cat Snake**	***Boiga dendrophila***	1		
2	Paradise Tree Snake	*Chrysopelea paradisi*			
3	Malayan Racer	*Coelognathus flavolineatus*	1		
4	Painted Bronzeback	*Dendrelaphis pictus*	1		
5	Malayan Water Monior	*Varanus salvator*	1		
6	Clouded Monitor	*Varanus nebulosus*		1	
7	Common Sun Skink	*Eutropis multifasciatus*		2	
8	Spotted House Gecko	*Gekko monarchus*			5
9	Spiny-tailed House Gecko	*Hemidactylus frenatus*		1	2
10	Common Flying Dragon	*Draco sumatranus*		1	
11	Changeable Lizard (Non-Native)	*Calotes versicolor*	2		1
	Amphibians				
1	Black-eyed Litter Frog	*Leptobrachium nigrops*			1
2	Field Frog	*Ferjervarya limnocharis*	21	1	
3	Malayan Giant Frog	*Limnonectes blythii*	3	2	4
4	**Spotted Tree Frog**	***Nyctixalus pictus***			2
5	Common Tree Frog	*Polypedates leucomystax*			4
6	Common Greenback	*Hylarana erythraea*	1		
7	**Lim Boo Liat's Sticky Frog**	***Kalophrynus limbooliati***		1	1
8	Dark-sided Chorus Frog	*Microhyla heymonsi*	4		6

Zone F – Singapore Zoo Transect

	Bold Print – Locally Threatened Underlined- Additional Species recorded during Bird surveys **Green-** Forest specialists	Bold Print & Capital Lettering – Internationally Threatened	**Herp Survey**	**Herp Survey**	**Night Survey**
No	**Common Names**	**Latin Names**	25/09/15	16/10/15	22/05/15
	Reptiles				
1	Reticulated Python	*Broghammerus reticulatus*			1
2	Oriental Whip Snake	*Ahaetulla prasina*		1	1
3	Malayan Water Monior	*Varanus salvator*	3	1	
4	Clouded Monitor	*Varanus nebulosus*	4	2	
5	**Yellow-striped Tree Skink**	*Lipinia vittigera*	1		
6	Common Sun Skink	*Eutropis multifasciatus*	2		
7	Spotted House Gecko	*Gekko monarchus*			5
8	Flat-tailed Gecko	*Hemidactylus platyurus*	2	8	5
9	Four-clawed Gecko	*Gehyra mutilata*		2	20
10	Spiny-tailed House Gecko	*Hemidactylus frenatus*	4	12	
11	Common Flying Dragon	*Draco sumatranus*	1	2	
12	Green-crested Lizard	*Bronchocela cristella*		1	4
13	Changeable Lizard (Non-Native)	*Calotes versicolor*		1	1
14	Tokay Gecko (Non-Native)	*Gekko gecko*			4
15	Red-eared Slider (Non-Native)	*Trachemys scripta*		1	
16	Bornean Giant River Terrapin (Non-native)	*Orlitia borneensis*	1		
	Amphibians				
1	Asian Toad	*Duttaphrynus melanostictus*			6
2	Malayan Giant Frog	*Limnonectes blythii*	2		4
3	Common Tree Frog	*Polypedates leucomystax*			1
4	Common Greenback	*Hylarana erythraea*	3		
5	Banded Bull Frog (Non-Native)	*Kaloula pulchra*			5

Zone G – Singapore Night Safari Transect

	Bold Print – Locally Threatened Underlined- Additional Species recorded during Bird surveys **Green-** Forest specialists	Bold Print & Capital Lettering – Internationally Threatened	**Herp Survey**	**Herp Survey**	**Night Survey**	**Night Survey**
No	**Common Names**	**Latin Names**	21/06/15	25/10/15	22/05/15	25/07/15
	Reptiles					
1	Sunbeam Snake	*Xenopeltis unicolor*				1
2	Paradise Tree Snake	*Chrysopelea paradisi*			1	
3	**Twin-barred Tree**	***Chrysopelea pelias***	1			

	Snake					
4	Painted Bronzeback	*Dendrelaphis pictus*				2
5	Striped Kukri	*Oligodon octolineatus*				1
6	White-spotted Slug Snake (Non-Native)	*Pareas margaritophorus*	1			
7	**Blue Coral Snake**	***Calliophis bivirgatus***	1			
8	Black Spitting Cobra	*Naja sumatrana*				
9	**King Cobra**	***Ophiophagus hannah***				
10	Malayan Water Monior	*Varanus salvator*	1	3		
11	Clouded Monitor	*Varanus nebulosus*		1		
12	Common Sun Skink	*Eutropis multifasciatus*				
13	Spotted House Gecko	*Gekko monarchus*	1		21	6
14	Flat-tailed Gecko	*Hemidactylus platyurus*		2	2	1
15	Four-clawed Gecko	*Gehyra mutilata*			5	
16	Spiny-tailed House Gecko	*Hemidactylus frenatus*		2	11	19
17	Maritime Gecko	*Lepidodactylus lugubris*		1		
18	Common Flying Dragon	*Draco sumatranus*	1			
19	Green-crested Lizard	*Bronchocela cristella*		2		3
20	Changeable Lizard (Non-Native)	*Calotes versicolor*		1		
21	Tokay Gecko (Non-Native)	*Gekko gecko*			2	4
22	Malayan Box Terrapin	*Cuora amboinensis*		1		
23	Bornean Giant River Terrapin (Non-native)	*Orlitia borneensis*				2
	Amphibians					
1	Asian Toad	*Duttaphrynus melanostictus*			2	2
2	Field Frog	*Ferjervarya limnocharis*			1	2
3	Malayan Giant Frog	*Limnonectes blythii*			5	8
4	Common Tree Frog	*Polypedates leucomystax*			8	3
5	Banded Bull Frog (Non-Native)	*Kaloula pulchra*			2	
6	**Lim Boo Liat's Sticky Frog**	***Kalophrynus limbooliati***			2	
7	Painted Chorus Frog	*Microhyla butleri*			2	3
8	Dark-sided Chorus Frog	*Microhyla heymonsi*			15	3

Total Herpetofauna List with past records

	Bold Print – Locally Threatened Underlined- Additional Species recorded during Bird surveys **Green-** Forest specialists	Bold Print & Capital Lettering – Internationally Threatened Yellow Highlight- Recorded during survey time frame No Highlight- Past records
No	**Common Names**	**Latin Names**
	Reptiles	
1	Brahminy Blind Snake	*Ramphotyphlops braminus*

2	**White-bellied Blind Snake**	***Typhlops muelleri***
3	Reticulated Python	*Malayopython reticulatus*
4	Sunbeam Snake	*Xenopeltis unicolor*
5	Oriental Whip Snake	*Ahaetulla prasina*
6	**Dog-toothed Cat Snake**	***Boiga cynodon***
7	**Gold-ringed Cat Snake**	***Boiga dendrophila***
8	**Jasper Cat Snake**	***Boiga jaspidae***
9	**Pink-headed Reed Snake**	***Calamaria schlegeli***
10	Golden Tree Snake (Non-Native)	*Chrysopelea ornata*
11	Paradise Tree Snake	*Chrysopelea paradisi*
12	**Twin-barred Tree Snake**	***Chrysopelea pelias***
13	**Malayan Racer**	***Coelognathus flavolineatus***
14	**Elegant Bronzeback**	***Dendrelaphis formosus***
15	Striped Bronzeback	*Dendrelaphis caudolineatus*
16	**Kopstein's Bronzeback**	***Dendrelaphis kopsteini***
17	Painted Bronzeback	*Dendrelaphis pictus*
18	**Red-tailed Racer**	***Gonyosoma oxycephalum***
19	Common Wolf Snake	*Lycodon capucinus*
20	Striped Kukri	*Oligodon octolineatus*
21	**Dwarf Reed Snake**	***Pseudorabdion longiceps***
22	Keeled Rat Snake	*Ptyas carinata*
23	**White-bellied Rat Snake**	***Ptyas fusca***
24	Indochinese Rat Snake	*Ptyas korros*
25	**Puff-faced Water Snake**	***Homalopsis buccata***
26	White-spotted Slug Snake (Non-Native)	*Pareas margaritophorus*
27	**Blue-necked Keelback**	***Macropisthodon rhodomelas***
28	**Blue Malayan Coral Snake**	***Calliophis bivirgatus***
29	**Banded Malayan Coral Snake**	***Calliophis intestinalis***
30	Black Spitting Cobra	*Naja sumatrana*
31	**King Cobra**	***Ophiophagus hannah***
32	**Wagler's Pit-viper**	***Tropidolaemus wagleri***
33	Malayan Water Monior	*Varanus salvator*
34	Clouded Monitor	*Varanus nebulosus*
35	Common Sun Skink	*Eutropis multifasciatus*
36	**Yellow-striped Tree Skink**	***Lipinia vittigera***
37	Garden Supple Skink	*Lygosoma bowringii*
38	**Striped Sun Skink**	***Eutropis rugiferus***
39	Spotted House Gecko	*Gekko monarchus*
40	Flat-tailed Gecko	*Hemidactylus platyurus*
41	**SINGAPORE BENT-TOED GECKO**	***Cyrtodactylus majulah***
42	Four-clawed Gecko	*Gehyra mutilata*
43	Spiny-tailed House Gecko	*Hemidactylus frenatus*
44	**Lowland Dwarf Gecko**	***Hemiphyllodactylus typus***
45	Maritime Gecko	*Lepidodactylus lugubris*
46	**Black-bearded Flying Dragon**	***Draco melanopogon***
47	Common Flying Dragon	*Draco sumatranus*
48	Green-crested Lizard	*Bronchocela cristella*

49	Changeable Lizard (Non-Native)	*Calotes versicolor*
50	Tokay Gecko (Non-Native)	*Gekko gecko*
51	Malayan Box Terrapin	*Cuora amboinensis*
52	**MALAYAN FLATSHELL TERRAPIN**	***Notochelys platynota***
53	Asian Softshell Turtle	*Amyda cartilaginea*
54	Black Marsh Terrapin (Non-Native)	*Siebenrockiella crassicollis*
55	Red-eared Slider (Non-Native)	*Trachemys scripta*
56	Giant Asian Pond Terrapin (Non-Native)	*Heosemys grandis*
57	Bornean Giant River Terrapin (Non-native)	*Orlitia borneensis*
	Amphibians	
1	Asian Toad	*Duttaphrynus melanostictus*
2	Four-ridged Toad	*Ingerophrynus quadriporcatus*
3	Black-eyed Litter Frog	*Leptobrachium nigrops*
4	Field Frog	*Ferjervarya limnocharis*
5	Malayan Giant Frog	*Limnonectes blythii*
6	Malesian Frog	*Limnonectes malesianus*
7	Yellow-bellied Puddle Frog	*Occidozyga sumatrana*
8	**Spotted Tree Frog**	***Nyctixalus pictus***
9	Common Tree Frog	*Polypedates leucomystax*
10	**Golden-eared Rough-sided Frog**	***Hylarana baramica***
11	Masked Rough-sided Frog	*Hylarana laterimaculata*
12	Common Greenback	*Hylarana erythraea*
13	Copper-cheeked Frog	*Hylarana labialis*
14	Banded Bull Frog (Non-Native)	*Kaloula pulchra*
15	**Lim Boo Liat's Sticky Frog**	***Kalophrynus limbooliati***
16	Painted Chorus Frog	*Microhyla butleri*
17	Dark-sided Chorus Frog	*Microhyla heymonsi*
18	**Manthey's Chorus Frog**	***Microhyla mantheyi***

Human Impact

Pareas margaritophorus (Roadkill)

Chrysopelea pelias (Roadkill)
(Forest specialist and Locally Threatened)

Ahaetulla prasina (Killed with intent)

Annex 14.5

Hymenoptera

Survey on Aculeate Hymenoptera (bees and wasps) of the Mandai area, April – October 2015

John X. Q. Lee

Summary

This survey was carried out over a period of 6 months, from April to October 2015, to record the bees and wasps in the Mandai Lake Road area. The results were combined with those of a short survey carried out on 2014, giving a broader overview of the species found within the survey locality and possible interpretations of the state of the habitat. A total of 114 distinct species from 9 families were recorded, a distinct increase from the 67 species recorded in the 2014 survey.

Introduction

The insects included in this survey were the Aculeate Hymenoptera (bees and wasps, excluding the ants). For the convenience of this survey, they can be divided broadly into four groups, namely social bees, solitary bees, social wasps and solitary wasps. There are in fact many different levels and classifications of sociality of bees and wasps, and some species may nest in close proximity to each other or gather in numbers to rest as dusk approaches, but there is no true social interaction and they are still considered solitary species. For the general purpose of this report, social species are defined as those which show some form of cooperation in building nests and rearing offspring. Most social species are capable of cooperative defence of their nests. However, in Singapore, the subfamily Stenogastrinae of the family Vespidae, commonly known as hover wasps, and the stingless bees (Apidae: Apinae, Meliponini) are generally non-aggressive and pose virtually no threat to humans.

The areas covered in this survey have been expanded as compared to the 2014 survey. A map provided by Mr Subaraj divides the survey area into eight zones, named from A to H, and these designations were followed in my survey.

A total of 35 survey sessions were carried out. Six zones were surveyed (Zone C and H were not included in the survey), and each zone was surveyed six times except for Zone G, which was surveyed five times. Each survey session lasted a minimum of two and a half hours. Surveys were carried out in the day, except for one night survey in Zone G. The surveys were done by walking round the perimeter of each plot as well as entering the vegetation and forested areas and walking along specific transects, as shown in the map attached. Visual sightings of species observed were recorded. Specimens were taken where identification through sightings or photos alone were not possible. Some species will be sent to experts in the respective groups for identification, while any I can identify myself will be deposited in the zoological collection of the Lee Kong Chian Natural History Museum (LKCNHM) once identified and having the details recorded. Some species which

were not identified in the 2014 survey have since been identified, adding on to the total list of species found in the area thus far.

Summary of findings

The survey area comprises of a wide range of habitats, including secondary forest, secondary swamp forest, abandoned plant nurseries and fruit tree plantations, grassland, scrub habitat and roadside vegetation, as well as man-made habitats and cultivated vegetation within the managed areas within the Singapore Zoological Gardens, River Safari and Night Safari.

As in the previous survey in 2014 and in line with all past personal observations, bees and wasps were generally more abundant in open areas and at the forest edge in each of the various zones, where there was considerable presence of flowering plants, and less commonly seen inside forest. This does not indicate that bees and wasps are not present in the forest, but simply that they are more easily seen and recorded when feeding on nectar or collecting pollen (in the case of bees) at flowers.

Zone A consists largely of forest bordered by Mandai Road to the north. Perhaps due to the large overall area, this zone proved to be fairly rich in diversity, with 57 species recorded altogether. This zone was also where the largest number of wasps, both social (13 species) and solitary (27 species), were found. Of particular interest is the fact that some less common Stenogastrinae (hover wasps) were found only in this area, and two species, *Metischnogaster drewseni* and *Parischnogaster unicuspata*, were only found in 2014 but were not recorded throughout the 2015 survey. While recorded from Singapore, I have also never seen *Metischnogaster drewseni* anywhere else in Singapore, nor are specimens present in the former RMBR (now LKCNHM) zoological reference collection to the best of my knowledge. Other interesting species recorded in this area include *Amegilla (Glossamegilla) insularis*, a relatively rare bee only found in or around healthy mature forest in Singapore, and another Stenogastrine wasp *Eustenogaster hauxwelli*. Most of the species were recorded at the forest edge, especially near the edge of the water, on plants such as *Melastoma malabathricum*, *Leea indica* and *Mussaenda frondosa*, as well as on cultivated roadside vegetation, with vegetation such as *Vitex trifolia*, *Leea rubra* and *Tabernaemontana sp*.

Zone B comprises of forest habitat similar to Zone A, as well as an abundance of durian and starfruit trees indicating abandoned fruit orchards, and scattered growth of plants such as various Heliconias (a favoured nectar plant for many species) and *Dracaena fragrans* (a preferred nesting site for some social wasps), possibly left behind following the abandonment of horticultural farms or nurseries. 35 species were recorded from this area. Species only recorded from this area were *Ceratina perforatrix*, the largest local member of the dwarf carpenter bee genus *Ceratina*; *Xylocopa caerulea*, a large carpenter bee with a distinctive blue coat of hairs on the thorax which is fairly widespread in forested areas but wasn't recorded in the 2014 survey; *Megachile stulta*, a leaf-cutter bee (note that some species in this diverse genus do not use leaves in their nests, but choose mud or resin instead) found on flowers of a *Syzygium sp*. tree along the roadside in October 2015, and *Polistes meadeanus*, a locally rare and apparently forest-dependent paper wasp.

Zone D comprises of varied habitat, ranging from forest to open sandy areas and grassland. The most species were recorded in this area (61). Among these, 24 species of solitary bees were recorded, the greatest number out of all six zones surveyed. Many of the bees and wasps recorded in this area were found feeding on flowers of *Bidens pilosa, Dillenia suffruticosa, Sphagneticola trilobata* and *Mimosa sp.* Numerous Rambutan trees were also present in this area, and attracted many species during their flowering period. The most significant find in this area was *Xylocopa dejeani* (Apidae: Apinae, Xylocopinae), one of the large carpenter bees which is exceedingly rare in Singapore. Unfortunately only one sighting was made, and an attempt to collect the specimen failed. Zone D was also home to four species of *Sphex sp*. digger wasps (Sphecidae: Sphecinae), including *Sphex argentatus*, a very rare species locally, with the only recent records being from Pulau Semakau.

Zone E consists mainly of forest, with fewer flowering plants, apart from along the main road and scattered areas bordering Zone D. This might be one reason why the fewest number of species (31) were recorded in this area. Also, only one species of social bee, the common honeybee *Apis cerana*, was found here. Nevertheless, two bees, *Ceratina lieftincki* and *Nomia* (*Hoplonomia*) *incerta*, were only found in this area throughout the duration of the survey, and it was also the only zone where a ground wasp of the genus *Scolia* (Scoliidae) was found.

Zone F consists of some forest bordering the reservoir and roadside vegetation, as well as the Singapore Zoological Gardens (hereafter referred to as the zoo) and the River Safari. A total of 39 species were recorded in this area. Five species of social bees were recorded, the highest number among all six zones. Bee and wasp activity was high within the managed parks, with many of the solitary species building nests in and around various man-made structures such as roofs and ledges of pavilions and shelters, while cultivated flowering plants such as *Cuphea hyssopifolia*, *Antigonon leptopus*, *Hamelia patens* and *Tabernaemontana sp*. attracted a large number of bees and wasps. A large species of paper wasp, *Polistes sagittarius*, was only found within the Zoo and River Safari grounds throughout the duration of the survey, and was not recorded in the 2014 survey either, even though it is a common species found in a wide range of habitats, including urban environments.

Zone G consists of some forested area on the opposite side of the road from Zone F, along with the grounds of the Night Safari. 32 species were recorded from this area, the second lowest out of the six zones surveyed, and the number of bees recorded here was unusually low (6 species altogether, 4 social and 2 solitary). However, this might be due to the fact that the weather was unfavourable to bee and wasp activity (overcast, raining or hazy) on three out of five survey sessions. As with Zone F, many species of solitary wasps such as the potter wasps (Vespidae: Eumeninae) and mud dauber wasps (Sphecidae: Sceliphrinae) were nesting in and around various man-made structures. Males of *Campsomeris sp*. (Scoliidae) were abundant here too.

As a follow-up to the short survey carried out in 2014, this survey proves that overall diversity of bees and wasps in the Mandai area is fairly rich and generally what can be expected for such habitats. Many species not found in the 2014 survey were found this year, bringing the total number of species recorded from 67 to 114. This is almost certainly the result of a longer survey period and an extended survey area. At least five species can be considered extremely rare species in Singapore, and I have not recorded these anywhere else locally. The number of species recorded is by no means exhaustive, and it is highly possible that even more species are present in the area.

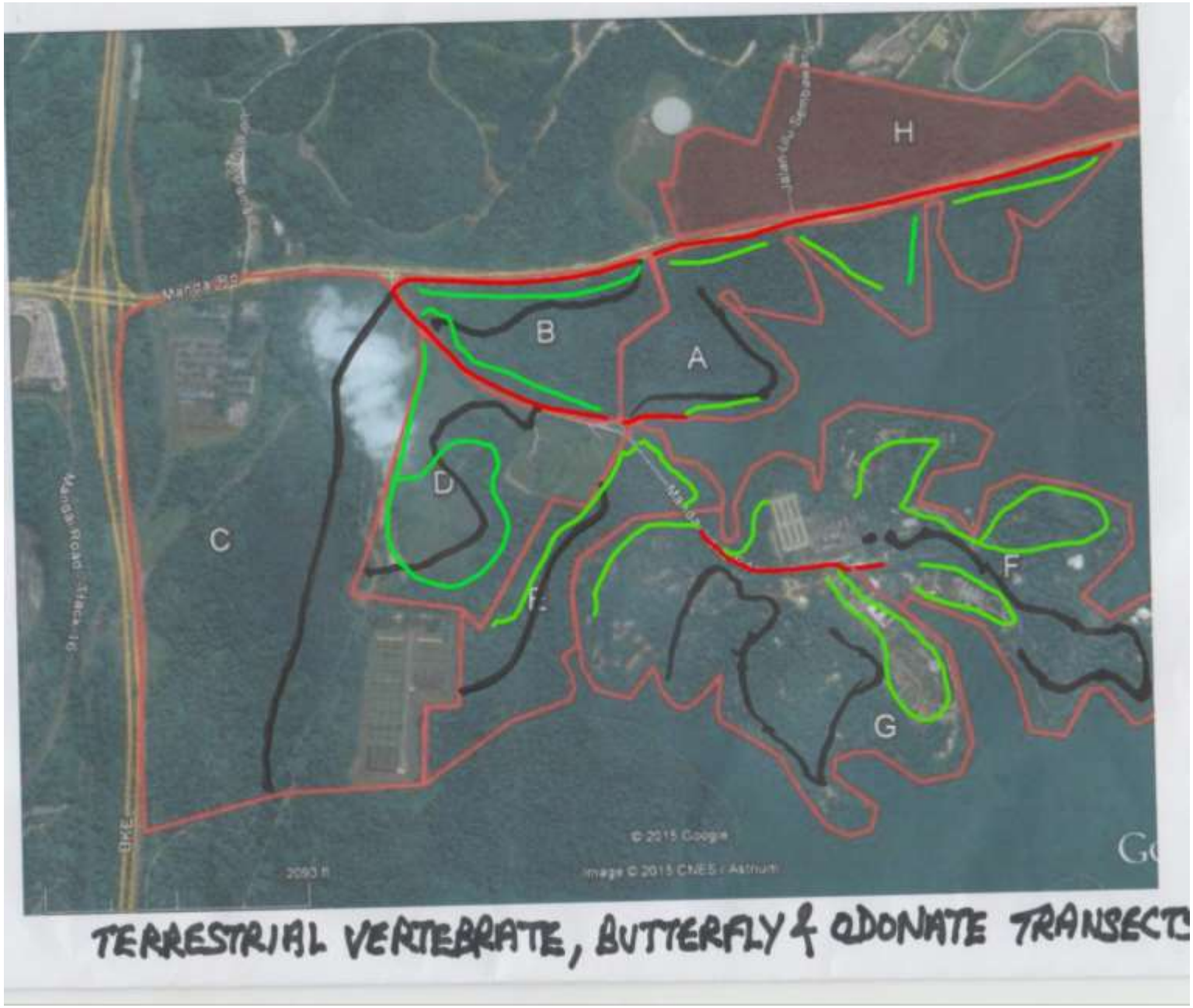
Despite being managed zoological parks, the Zoo, River Safari and Night Safari are home to a wide diversity of bees and wasps. Plants cultivated within the parks are mostly different from those in or at the edge of forests, but nevertheless attracted many species. Nests of solitary species were common throughout, and nests of social species were also found. The vast majority of nests of social species within the parks were of harmless species such as the stingless bees and hover wasps (Stenogastrinae). The presence of all these insects should be regarded as positive and they should not be destroyed unnecessarily.

Two observations might provide some insight on the health of the forest and the biodiversity around it. Firstly, the small paper wasp *Ropalidia sumatrae* was not recorded in the 2014 survey, and was seen this year, but only isolated sightings were made and the species was never abundant. In my experience, *Ropalidia sumatrae* colonies are very large and the wasps are very common locally in areas with primary forest or healthy, mature secondary forest, or parks with very tall and very old trees. This species is generally not found out of such environments. It is in fact very common in Upper Seletar Reservoir and forest bordering Upper Thomson Road, both of which are fairly near to the Mandai area. Thus, the relative lack of abundance of this species might indicate a certain level of disturbance or a lack of trees which are large or mature enough for colonies to nest in. The felling of thousands of trees in a large section of the forest along the main road (Grace Chua, 19 Feb 2011 - Storm flattens section of Mandai forest. *The Straits Times*) could also have been one of the factors for this. This is just a hypothesis at best but is worth looking into.

Secondly, the relative scarcity of the Scoliidae (commonly known as ground wasps) is also interesting to note. Various *Campsomeris*, *Megascolia* and *Scolia* species are often seen in similar environments. However, no members of the family Scoliidae (ground wasps) were recorded at all in the 2014 survey, while only a single individual of a *Scolia* sp. was found within the natural areas during this survey, though *Campsomeris sp*. was present in the Night Safari. The scarcity of these wasps in the Mandai area is rather noticeable and remarkable. As these wasps prey on the larvae of scarab beetles underground, their presence may be an indicator of the abundance of such beetles in a given area, which in turn might be an indicator of the health and biodiversity of the given locality. The presence of large number of *Campsomeris* in the Night Safari might be due to an abundance of suitable prey in the soil used for the plants cultivated throughout the park.

Despite the above two observations, the number of species recorded in the Mandai area during this survey and the fact that some rare species not recorded elsewhere can be found there indicate that the area is rich in biodiversity, and care should be taken to minimize the impact to the environment in all future developments.

In the attached statistics and species list, it may be noted that many of the species are not identified to species, or in some cases, even to genus. The taxonomy of many groups, particularly the Pompilidae (spider-hunting wasps) and Vespidae; Eumeninae (potter wasps), is still poorly understood and few revisions have been done, especially on species in the Southeast Asian region. Also, references for identification of many species are not accessible at this time. Some of the specimens collected in this survey will be sent to experts in the respective groups for identification, but in such cases, an answer might only be obtained after several months. Some species not identified in the 2014 survey have since been identified and the list has been updated.



TERRESTRIAL VERTEBRATE, BUTTERFLY & ODONATE TRANSECTS

This is a list of plants which attracted more than five spe
be considered important plants for these insects.

Family	Species
Acanthaceae	Asystasia gangetica
Apocynaceae	Tabarnaemontana sp.
Asteraceae	Bidens pilosa
Asteraceae	Mikania micrantha
Asteraceae	Sphagneticola trilobata
Asteraceae	Tridax procumbens
Costaceae	Costus lucanusianus
Dilleniaceae	Dillenia suffruticosa
Fabaceae	Mimosa sp.
Lamiaceae	Vitex trifolia
Lythraceae	Cuphea hyssopifolia
Malvaceae	Malvaviscus arboreus
Melastomataceae	Melastoma malabathricum
Myrtaceae	Syzygium sp.
Polygonaceae	Antigonon leptopus
Rubiaceae	Hamelia patens
Rubiaceae	Mussaenda frondosa
Sapindaceae	Nephelium lappaceum
Vitaceae	Leea indica
Vitaceae	Leea rubra

ecies of bees or wasps during the survey period, and thus can

Status in Mandai
Wild
Cultivated - roadside and in parks
Wild
Wild
Wild
Wild
Wild
Wild
Wild
Cultivated - roadside
Cultivated - in parks
Cultivated - in parks
Wild. Also cultivated along roadside
Wild
Cultivated - in parks
Cultivated - in parks
Wild
Growing wild, left behind from abandoned plantations
Wild
Cultivated - roadside

Family	Subfamily and tribe (if applicable)	Species	Year(s) recorded in	Zone	Remarks
Apidae	Apinae; Anthoporini	Amegilla (Glossamegilla) insularis	2015	A	
Apidae	Apinae; Anthoporini	Amegilla (Zonamegilla) andrewsi	2014, 2015	A, D	
Apidae	Apinae; Anthoporini	Amegilla (Zonamegilla) korotonensis	2015	A	
Apidae	Apinae; Apini	Apis andreniformis	2015	A, B, F, G	
Apidae	Apinae; Apini	Apis cerana	2014, 2015	A, B, D, E, F, G	
Apidae	Apinae; Apini	Apis dorsata	2015	D, F	
Apidae	Apinae; Melectini	Thyreus ceylonicus	2015	A, D, F	
Apidae	Apinae; Melectini	Thyreus himalayensis	2015	D	
Apidae	Apinae; Meliponini	Heterotrigona itama	2015	D, F, G	
Apidae	Apinae; Meliponini	Tetragonula laeviceps	2014, 2015	A, B, F, G	
Apidae	Xylocopinae: Allodapini	Braunsapis cupulifera	2015	B, D, F	
Apidae	Xylocopinae: Allodapini	Braunsapis sp.	2015	A	
Apidae	Xylocopinae; Ceratinini	Ceratina collusor	2014, 2015	D, E, F	
Apidae	Xylocopinae; Ceratinini	Ceratina lieftincki	2015	E	
Apidae	Xylocopinae; Ceratinini	Ceratina nigrolateralis	2014, 2015	A, B, D, E, F	
Apidae	Xylocopinae; Ceratinini	Ceratina perforatrix	2015	B	
Apidae	Xylocopinae; Ceratinini	Ceratina ridleyi	2015	B	
Apidae	Xylocopinae; Ceratinini	Ceratina unimaculata	2014, 2015	D, E	
Apidae	Xylocopinae; Xylocopini	Xylocopa aestuans	2015	D, E, F	
Apidae	Xylocopinae; Xylocopini	Xylocopa caerulea	2015	B	
Apidae	Xylocopinae; Xylocopini	Xylocopa dejeani	2015	D	
Apidae	Xylocopinae; Xylocopini	Xylocopa flavonigrescens	2015	D, E, F	
Apidae	Xylocopinae; Xylocopini	Xylocopa latipes	2014, 2015	A, B, D, E, F, G	
Colletidae		Hylaeus sp.	2014, 2015	A, B	Just one species recorded thus far, but there might be more
Halictidae	Halictinae	Lasioglossum albescens	2014	D	
Halictidae	Halictinae	Patellapis (Pachyhalictus) sp.	2014	A	
Halictidae	Halictinae	Halictidae undet. 1	2015	B	
Halictidae	Nomiinae	Nomia (Acunomia) iridescens	2015	D, E	
Halictidae	Nomiinae	Nomia (Acunomia) strigata	2014, 2015	A, B, D, E, F, G	
Halictidae	Nomiinae	Nomia (Hoplonomia) incerta	2015	E	
Halictidae	Nomiinae	Nomia (Maculonomia) apicalis	2014, 2015	A, D, E	
Halictidae	Nomiinae	Nomia (Maculonomia) terminata	2014, 2015	A, B, D, F	
Halictidae	Nomiinae	Lipotriches ceratina	2014, 2015	A, D, E	
Halictidae	Nomiinae	Pseudapis siamensis	2015	D	
Megachilidae		Coelioxys confusa	2014, 2015	D	
Megachilidae		Heriades sp.	2014, 2015	D, F	
Megachilidae		Megachile atrata	2015	D	
Megachilidae		Megachile disjuncta	2014, 2015	D, E	
Megachilidae		Megachile laticeps	2014, 2015	D, E	
Megachilidae		Megachile stulta	2015	B	
Megachilidae		Megachile subrixator	2014, 2015	A, D	
Crabronidae	Bembicinae (Stizini)	Bembicinus sp.	2015	D	
Crabronidae	Crabroninae; Trypoxylini	Trypoxylon "sp. 1"	2014, 2015	A, B, D, E, G	Possibly T. petiolatum; awaiting further confirmation
Crabronidae	Crabroninae; Trypoxylini	Trypoxylon "sp. 2"	2014, 2015	A	Much larger
Crabronidae	Crabroninae; Crabronini	Crabronidae undet.	2014	A	
Crabronidae	Larrinae	Larrinae sp. 1	2014	A	Liris sp.
Crabronidae	Larrinae	Larrinae sp. 2	2014, 2015	D	Liris sp.
Crabronidae	Larrinae	Larrinae sp. 3	2015	D	
Crabronidae	Larrinae	Larrinae sp. 4	2015	G	
Crabronidae	Larrinae	Larrinae sp. 5	2015	G	
Crabronidae	Larrinae	Larrinae sp. 6	2015	G	
Crabronidae	Larrinae	Larrinae sp. 7	2015	G	
Crabronidae	Larrinae	Larrinae sp. 8	2015	G	
Pompilidae		Auplopus "sp. 1"	2014, 2015	A, G	
Pompilidae		Tachypompilus analis	2014	D	
Pompilidae		Pompilidae "sp. 1"	2014, 2015	A, D	
Pompilidae		Pompilidae "sp. 2"	2014, 2015	A, F	
Pompilidae		Pompilidae "sp. 3"	2014, 2015	A, F	
Pompilidae		Pompilidae "sp. 4"	2014, 2015	A, B, D, F, G	
Pompilidae		Pompilidae "sp. 5"	2014	A	
Pompilidae		Pompilidae "sp. 6"	2014	A	
Pompilidae		Pompilidae "sp. 7"	2014	D	
Pompilidae		Pompilidae "sp. 8"	2014	D	Found only in forest off track in Area D to date. Possibly Cryptocheilus sp.
Scoliidae		Campsomeris sp.	2015	G	
Scoliidae		Scolia sp.	2015	E	
Sphecidae	Sceliphrinae	Chalybion sp. nr. bengalense	2015	F, G	
Sphecidae	Sceliphrinae	Chalybion (Hemichalybion) sumatranum	2015	F	
Sphecidae	Sceliphrinae	Sceliphron javanum	2014, 2015	A, F, G	
Sphecidae	Sceliphrinae	Sceliphron madraspatanum	2014, 2015	D	
Sphecidae	Sphecinae	Isodontia sp. nr. diodon	2014, 2015	A, B, D, F	
Sphecidae	Sphecinae	Isodontia sp.	2014, 2015	A, E	
Sphecidae	Sphecinae	Sphex argentatus	2015	D	Observed only once but couldn't be collected; very likely to be this species
Sphecidae	Sphecinae	Sphex sp. nr. diabolicus	2015	D	
Sphecidae	Sphecinae	Sphex sericeus	2014, 2015	B, D, E	
Sphecidae	Sphecinae	Sphex subtruncatus	2015	D	
Vespidae	Eumeninae	Allorhynchium argentatum	2014, 2015	A, B, D, E, G	
Vespidae	Eumeninae	Delta pyriforme	2014, 2015	A, B, D, E, F, G	
Vespidae	Eumeninae	Phimenes flavopictus	2015	A	
Vespidae	Eumeninae	Phimenes sp.	2014	D	Like typical Phimenes flavopictus, but with black thorax
Vespidae	Eumeninae	Rhynchium haemorrhoidale	2014, 2015	E, F, G	
Vespidae	Eumeninae	Eumeninae "sp. 1"	2014, 2015	A, B, D, E, F, G	
Vespidae	Eumeninae	Eumeninae "sp. 2"	2014, 2015	F	
Vespidae	Eumeninae	Eumeninae "sp. 3"	2014, 2015	A, G	
Vespidae	Eumeninae	Eumeninae "sp. 4"	2014, 2015	A, B, D, F, G	
Vespidae	Eumeninae	Eumeninae "sp. 5"	2014, 2015	B	
Vespidae	Eumeninae	Eumeninae "sp. 6"	2014, 2015	A, D	
Vespidae	Eumeninae	Eumeninae "sp. 7"	2014, 2015	A	
Vespidae	Eumeninae	Eumeninae "sp. 8"	2015	A	
Vespidae	Eumeninae	Eumeninae "sp. 9"	2015	A, D	
Vespidae	Eumeninae	Eumeninae "sp. 10"	2014, 2015	A, D	
Vespidae	Eumeninae	Eumenes "sp. 1"	2014, 2015	A, B, D, E, F, G	
Vespidae	Eumeninae	Eumenes "sp. 2"	2014, 2015	A, B, D, E, F, G	
Vespidae	Polistinae	Polistes meadeanus	2014	B	
Vespidae	Polistinae	Polistes sagittarius	2015	F	
Vespidae	Polistinae	Polistes stigma	2014, 2015	A, B, F	
Vespidae	Polistinae	Polistes sp. nr. stigma	2014, 2015	A, F	A presently unidentified species very similar to P. stigma
Vespidae	Polistinae	Ropalidia erythrospila	2014, 2015	A, B, G	
Vespidae	Polistinae	Ropalidia flavopicta	2015	F	
Vespidae	Polistinae	Ropalidia marginata	2014, 2015	D, E	
Vespidae	Polistinae	Ropalidia stigma	2014, 2015	A, B, D, E, F, G	
Vespidae	Polistinae	Ropalidia sumatrae	2015	B, E, G	
Vespidae	Polistinae	Ropalidia timida	2015	D, G	
Vespidae	Polistinae	Ropalidia "sp. 2"	2014, 2015	D	
Vespidae	Stenogastrinae	Eustenogaster hauxwelli	2014, 2015	A	
Vespidae	Stenogastrinae	Eustenogaster micans	2014, 2015	A, B, D	
Vespidae	Stenogastrinae	Liostenogaster nitidipennis	2014, 2015	A, G	
Vespidae	Stenogastrinae	Liostenogaster varipicta	2015	A, G	
Vespidae	Stenogastrinae	Metischnogaster drewseni	2014	A	
Vespidae	Stenogastrinae	Parischnogaster mellyi	2014, 2015	A, B, D, E, F, G	
Vespidae	Stenogastrinae	Parischnogaster nigricans	2014, 2015	A, B, F	
Vespidae	Stenogastrinae	Parischnogaster unicuspata	2014	A	
Vespidae	Vespinae	Vespa affinis	2015	B, D, E, F	
Vespidae	Vespinae	Vespa analis	2014, 2015	D, F	
Vespidae	Vespinae	Vespa tropica	2014, 2015	A, B, D, E, F	

#	Overall number of species
1	Amegilla (Glossamegilla) insularis
2	Amegilla (Zonamegilla) andrewsi
3	Amegilla (Zonamegilla) korotonensis
4	Apis andreniformis
5	Apis cerana
6	Thyreus ceylonicus
7	Tetragonula laeviceps
8	Braunsapis sp.
9	Ceratina nigrolateralis
10	Xylocopa latipes
11	Hylaeus sp.
12	Patellapis (Pachyhalictus) sp.
13	Nomia (Acunomia) strigata
14	Nomia (Maculonomia) apicalis
15	Nomia (Maculonomia) terminata
16	Lipotriches ceratina
17	Megachile subrixator
18	Trypoxylon "sp. 1"
19	Trypoxylon "sp. 2"
20	Crabronidae undet.
21	Larrinae sp. 1
22	Auplopus "sp. 1"
23	Pompilidae "sp. 1"
24	Pompilidae "sp. 2"
25	Pompilidae "sp. 3"
26	Pompilidae "sp. 4"
27	Pompilidae "sp. 5"
28	Pompilidae "sp. 6"
29	Sceliphron javanum
30	Isodontia sp. nr. diodon
31	Isodontia sp.
32	Allorhynchium argentatum
33	Delta pyriforme
34	Phimenes flavopictus
35	Eumeninae "sp. 1"
36	Eumeninae "sp. 3"
37	Eumeninae "sp. 4"
38	Eumeninae "sp. 6"
39	Eumeninae "sp. 7"
40	Eumeninae "sp. 8"
41	Eumeninae "sp. 9"
42	Eumeninae "sp. 10"
43	Eumenes "sp. 1"
44	Eumenes "sp. 2"
45	Polistes stigma
46	Polistes sp. nr. stigma
47	Ropalidia erythrospila
48	Ropalidia stigma
49	Eustenogaster hauxwelli

50	Eustenogaster micans
51	Liostenogaster nitidipennis
52	Liostenogaster varipicta
53	Metischnogaster drewseni
54	Parischnogaster mellyi
55	Parischnogaster nigricans
56	Parischnogaster uniscupata
57	Vespa tropica

Social bees

1	Apis andreniformis
2	Apis cerana
3	Tetragonula laeviceps

Solitary bees

1	Amegilla (Glossamegilla) insularis
2	Amegilla (Zonamegilla) andrewsi
3	Amegilla (Zonamegilla) korotonensis
4	Thyreus ceylonicus
5	Braunsapis sp.
6	Ceratina nigrolateralis
7	Xylocopa latipes
8	Hylaeus sp.
9	Patellapis (Pachyhalictus) sp.
10	Nomia (Acunomia) strigata
11	Nomia (Maculonomia) apicalis
12	Nomia (Maculonomia) terminata
13	Lipotriches ceratina
14	Megachile subrixator

Social wasps

1	Polistes stigma
2	Polistes sp. nr. stigma
3	Ropalidia erythrospila
4	Ropalidia stigma
5	Eustenogaster hauxwelli
6	Eustenogaster micans
7	Liostenogaster nitidipennis
8	Liostenogaster varipicta
9	Metischnogaster drewseni
10	Parischnogaster mellyi
11	Parischnogaster nigricans
12	Parischnogaster unicuspata
13	Vespa tropica

Solitary wasps

1	Trypoxylon "sp. 1"
2	Trypoxylon "sp. 2"
3	Crabronidae undet.
4	Larrinae sp. 1

5	Auplopus "sp. 1"
6	Pompilidae "sp. 1"
7	Pompilidae "sp. 2"
8	Pompilidae "sp. 3"
9	Pompilidae "sp. 4"
10	Pompilidae "sp. 5"
11	Pompilidae "sp. 6"
12	Sceliphron javanum
13	Isodontia sp. nr. diodon
14	Isodontia sp.
15	Allorhynchium argentatum
16	Delta pyriforme
17	Phimenes flavopictus
18	Eumeninae "sp. 1"
19	Eumeninae "sp. 3"
20	Eumeninae "sp. 4"
21	Eumeninae "sp. 6"
22	Eumeninae "sp. 7"
23	Eumeninae "sp. 8"
24	Eumeninae "sp. 9"
25	Eumeninae "sp. 10"
26	Eumenes "sp. 1"
27	Eumenes "sp. 2"

#	Overall number of species
1	Apis andreniformis
2	Apis cerana
3	Tetragonula laeviceps
4	Braunsapis cupulifera
5	Ceratina nigrolateralis
6	Ceratina perforatrix
7	Ceratina ridleyi
8	Xylocopa caerulea
9	Xylocopa latipes
10	Hylaeus sp.
11	Halictidae undet. 1
12	Nomia (Acunomia) strigata
13	Nomia (Maculonomia) terminata
14	Megachile stulta
15	Trypoxylon "sp. 1"
16	Pompilidae "sp. 4"
17	Isodontia sp. nr. diodon
18	Sphex sericeus
19	Allorhynchium argentatum
20	Delta pyriforme
21	Eumeninae "sp. 1"
22	Eumeninae "sp. 4"
23	Eumeninae "sp. 5"
24	Eumenes "sp. 1"
25	Eumenes "sp. 2"
26	Polistes meadeanus
27	Polistes stigma
28	Ropalidia erythrospila
29	Ropalidia stigma
30	Ropalidia sumatrae
31	Eustenogaster micans
32	Parischnogaster mellyi
33	Parischnogaster nigricans
34	Vespa affinis
35	Vespa tropica

	Social bees
1	Apis andreniformis
2	Apis cerana
3	Tetragonula laeviceps

	Solitary bees
1	Braunsapis cupulifera
2	Ceratina nigrolateralis
3	Ceratina perforatrix
4	Ceratina ridleyi
5	Xylocopa caerulea
6	Xylocopa latipes

7 Hylaeus sp.
8 Halictidae undet. 1
9 Nomia (Acunomia) strigata
10 Nomia (Maculonomia) terminata
11 Megachile stulta

Social wasps

1 Polistes meadeanus
2 Polistes stigma
3 Ropalidia erythrospila
4 Ropalidia stigma
5 Ropalidia sumatrae
6 Eustenogaster micans
7 Parischnogaster mellyi
8 Parischnogaster nigricans
9 Vespa affinis
10 Vespa tropica

Solitary wasps

1 Trypoxylon "sp. 1"
2 Pompilidae "sp. 4"
3 Isodontia sp. nr. diodon
4 Sphex sericeus
5 Allorhynchium argentatum
6 Delta pyriforme
7 Eumeninae "sp. 1"
8 Eumeninae "sp. 4"
9 Eumeninae "sp. 5"
10 Eumenes "sp. 1"
11 Eumenes "sp. 2"

#	Overall number of species	Area
1	Amegilla (Zonamegilla) andrewsi	A, D
2	Apis cerana	A, B, D, E, F
3	Apis dorsata	D, F
4	Thyreus ceylonicus	A, D, F
5	Thyreus himalayensis	D
6	Heterotrigona itama	D, F
7	Braunsapis cupulifera	B, D, F
8	Ceratina collusor	D, E, F
9	Ceratina nigrolateralis	A, B, D, E, F
10	Ceratina unimaculata	D, E
11	Xylocopa aestuans	D, E, F
12	Xylocopa dejeani	D
13	Xylocopa flavonigrescens	D, E, F
14	Xylocopa latipes	A, B, D, E, F, G
15	Lasioglossum albescens	D
16	Nomia (Acunomia) iridescens	D, E
17	Nomia (Acunomia) strigata	A, B, D, E, F, G
18	Nomia (Maculonomia) apicalis	A, D, E
19	Nomia (Maculonomia) terminata	A, B, D, F
20	Lipotriches ceratina	A, D, E
21	Pseudapis siamensis	D
22	Coelioxys confusa	D
23	Heriades sp.	D, F
24	Megachile atrata	D
25	Megachile disjuncta	D, E
26	Megachile laticeps	D, E
27	Megachile subrixator	A, D
28	Bembicinus sp.	D
29	Trypoxylon "sp. 1"	A, B, D, E, G
30	Larrinae sp. 2	D
31	Larrinae sp. 3	D
32	Tachypompilus analis	D
33	Pompilidae "sp. 1"	A, D
34	Pompilidae "sp. 4"	A, B, D, F, G
35	Pompilidae "sp. 7"	D
36	Pompilidae "sp. 8"	D
37	Sceliphron madraspatanum	D
38	Isodontia sp. nr. diodon	A, B, D, F
39	Sphex argentatus	D
40	Sphex sp. nr. diabolicus	D
41	Sphex sericeus	
42	Sphex subtruncatus	D
43	Allorhynchium argentatum	A, B, D, E, G
44	Delta pyriforme	A, B, D, E, F, G
45	Phimenes sp.	D
46	Eumeninae "sp. 1"	A, B, D, E, F, G
47	Eumeninae "sp. 4"	A, B, D, F, G
48	Eumeninae "sp. 6"	A, D
49	Eumeninae "sp. 9"	A, D

50	Eumeninae "sp. 10"	A, D
51	Eumenes "sp. 1"	A, B, D, E, F, G
52	Eumenes "sp. 2"	A, B, D, E, F, G
53	Ropalidia marginata	D, E
54	Ropalidia stigma	A, B, D, E, F, G
55	Ropalidia timida	D, G
56	Ropalidia "sp. 2"	D
57	Eustenogaster micans	A, B, D
58	Parischnogaster mellyi	A, B, D, E, F, G
59	Vespa affinis	B, D, E, F
60	Vespa analis	D, F
61	Vespa tropica	A, B, D, E, F

Social bees

1 Apis cerana
2 Apis dorsata
3 Heterotrigona itama

Solitary bees

1 Amegilla (Zonamegilla) andrewsi
2 Thyreus ceylonicus
3 Thyreus himalayensis
4 Braunsapis cupulifera
5 Ceratina collusor
6 Ceratina nigrolateralis
7 Ceratina unimaculata
8 Xylocopa aestuans
9 Xylocopa dejeani
10 Xylocopa flavonigrescens
11 Xylocopa latipes
12 Lasioglossum albescens
13 Nomia (Acunomia) iridescens
14 Nomia (Acunomia) strigata
15 Nomia (Maculonomia) apicalis
16 Nomia (Maculonomia) terminata
17 Lipotriches ceratina
18 Pseudapis siamensis
19 Coelioxys confusa
20 Heriades sp.
21 Megachile atrata
22 Megachile disjuncta
23 Megachile laticeps
24 Megachile subrixator

Social wasps

1 Ropalidia marginata
2 Ropalidia stigma
3 Ropalidia timida
4 Ropalidia "sp. 2"
5 Eustenogaster micans

6 Parischnogaster mellyi
7 Vespa affinis
8 Vespa analis
9 Vespa tropica

Solitary wasps

1 Bembicinus sp.
2 Trypoxylon "sp. 1"
3 Larrinae sp. 2
4 Larrinae sp. 3
5 Tachypompilus analis
6 Pompilidae "sp. 1"
7 Pompilidae "sp. 4"
8 Pompilidae "sp. 7"
9 Pompilidae "sp. 8"
10 Sceliphron madraspatanum
11 Isodontia sp. nr. diodon
12 Sphex argentatus
13 Sphex sp. nr. diabolicus
14 Sphex sericeus
15 Sphex subtruncatus
16 Allorhynchium argentatum
17 Delta pyriforme
18 Phimenes sp.
19 Eumeninae "sp. 1"
20 Eumeninae "sp. 4"
21 Eumeninae "sp. 6"
22 Eumeninae "sp. 9"
23 Eumeninae "sp. 10"
24 Eumenes "sp. 1"
25 Eumenes "sp. 2"

#	Overall number of species
1	Apis cerana
2	Ceratina collusor
3	Ceratina lieftincki
4	Ceratina nigrolateralis
5	Ceratina unimaculata
6	Xylocopa aestuans
7	Xylocopa flavonigrescens
8	Xylocopa latipes
9	Nomia (Acunomia) iridescens
10	Nomia (Acunomia) strigata
11	Nomia (Hoplonomia) incerta
12	Nomia (Maculonomia) apicalis
13	Lipotriches ceratina
14	Megachile disjuncta
15	Megachile laticeps
16	Trypoxylon "sp. 1"
17	Scolia sp.
18	Isodontia sp.
19	Sphex sericeus
20	Allorhynchium argentatum
21	Delta pyriforme
22	Rhynchium haemorrhoidale
23	Eumeninae "sp. 1"
24	Eumenes "sp. 1"
25	Eumenes "sp. 2"
26	Ropalidia marginata
27	Ropalidia stigma
28	Ropalidia sumatrae
29	Parischnogaster mellyi
30	Vespa affinis
31	Vespa tropica

	Social bees
1	Apis cerana

	Solitary bees
1	Ceratina collusor
2	Ceratina lieftincki
3	Ceratina nigrolateralis
4	Ceratina unimaculata
5	Xylocopa aestuans
6	Xylocopa flavonigrescens
7	Xylocopa latipes
8	Nomia (Acunomia) iridescens
9	Nomia (Acunomia) strigata
10	Nomia (Hoplonomia) incerta
11	Nomia (Maculonomia) apicalis
12	Lipotriches ceratina
13	Megachile disjuncta

14 Megachile laticeps

Social wasps

1 Ropalidia marginata
2 Ropalidia stigma
3 Ropalidia sumatrae
4 Parischnogaster mellyi
5 Vespa affinis
6 Vespa tropica

Solitary wasps

1 Trypoxylon "sp. 1"
2 Scolia sp.
3 Isodontia sp.
4 Sphex sericeus
5 Allorhynchium argentatum
6 Delta pyriforme
7 Rhynchium haemorrhoidale
8 Eumeninae "sp. 1"
9 Eumenes "sp. 1"
10 Eumenes "sp. 2"

#	Overall number of species
1	Apis andreniformis
2	Apis cerana
3	Apis dorsata
4	Thyreus ceylonicus
5	Heterotrigona itama
6	Tetragonula laeviceps
7	Braunsapis cupulifera
8	Ceratina collusor
9	Ceratina nigrolateralis
10	Xylocopa aestuans
11	Xylocopa flavonigrescens
12	Xylocopa latipes
13	Nomia (Acunomia) strigata
14	Nomia (Maculonomia) terminata
15	Heriades sp.
16	Pompilidae "sp. 2"
17	Pompilidae "sp. 3"
18	Pompilidae "sp. 4"
19	Chalybion sp. nr. bengalense
20	Chalybion (Hemichalybion) sumatranum
21	Sceliphron javanum
22	Isodontia sp. nr. diodon
23	Delta pyriforme
24	Rhynchium haemorrhoidale
25	Eumeninae "sp. 1"
26	Eumeninae "sp. 2"
27	Eumeninae "sp. 4"
28	Eumenes "sp. 1"
29	Eumenes "sp. 2"
30	Polistes sagittarius
31	Polistes stigma
32	Polistes sp. nr. stigma
33	Ropalidia flavopicta
34	Ropalidia stigma
35	Parischnogaster mellyi
36	Parischnogaster nigricans
37	Vespa affinis
38	Vespa analis
39	Vespa tropica

	Social bees
1	Apis andreniformis
2	Apis cerana
3	Apis dorsata
4	Heterotrigona itama
5	Tetragonula laeviceps

Solitary bees

1 Thyreus ceylonicus
2 Braunsapis cupulifera
3 Ceratina collusor
4 Ceratina nigrolateralis
5 Xylocopa aestuans
6 Xylocopa flavonigrescens
7 Xylocopa latipes
8 Nomia (Acunomia) strigata
9 Nomia (Maculonomia) terminata
10 Heriades sp.

Social wasps

1 Polistes sagittarius
2 Polistes stigma
3 Polistes sp. nr. stigma
4 Ropalidia flavopicta
5 Ropalidia stigma
6 Parischnogaster mellyi
7 Parischnogaster nigricans
8 Vespa affinis
9 Vespa analis
10 Vespa tropica

Solitary wasps

1 Pompilidae "sp. 2"
2 Pompilidae "sp. 3"
3 Pompilidae "sp. 4"
4 Chalybion sp. nr. bengalense
5 Chalybion (Hemichalybion) sumatranum
6 Sceliphron javanum
7 Isodontia sp. nr. diodon
8 Delta pyriforme
9 Rhynchium haemorrhoidale
10 Eumeninae "sp. 1"
11 Eumeninae "sp. 2"
12 Eumeninae "sp. 4"
13 Eumenes "sp. 1"
14 Eumenes "sp. 2"

#	Overall number of species
1	Apis andreniformis
2	Apis cerana
3	Heterotrigona itama
4	Tetragonula laeviceps
5	Xylocopa latipes
6	Nomia (Acunomia) strigata
7	Trypoxylon "sp. 1"
8	Larrinae sp. 4
9	Larrinae sp. 5
10	Larrinae sp. 6
11	Larrinae sp. 7
12	Larrinae sp. 8
13	Auplopus "sp. 1"
14	Pompilidae "sp. 4"
15	Campsomeris sp.
16	Chalybion sp. nr. bengalense
17	Sceliphron javanum
18	Allorhynchium argentatum
19	Delta pyriforme
20	Rhynchium haemorrhoidale
21	Eumeninae "sp. 1"
22	Eumeninae "sp. 3"
23	Eumeninae "sp. 4"
24	Eumenes "sp. 1"
25	Eumenes "sp. 2"
26	Ropalidia erythrospila
27	Ropalidia stigma
28	Ropalidia sumatrae
29	Ropalidia timida
30	Liostenogaster nitidipennis
31	Liostenogaster varipicta
32	Parischnogaster mellyi

	Social bees
1	Apis andreniformis
2	Apis cerana
3	Heterotrigona itama
4	Tetragonula laeviceps

	Solitary bees
1	Xylocopa latipes
2	Nomia (Acunomia) strigata

	Social wasps
1	Ropalidia erythrospila
2	Ropalidia stigma
3	Ropalidia sumatrae
4	Ropalidia timida
5	Liostenogaster nitidipennis

6 Liostenogaster varipicta
7 Parischnogaster mellyi

Solitary wasps

1 Trypoxylon "sp. 1"
2 Larrinae sp. 4
3 Larrinae sp. 5
4 Larrinae sp. 6
5 Larrinae sp. 7
6 Larrinae sp. 8
7 Auplopus "sp. 1"
8 Pompilidae "sp. 4"
9 Campsomeris sp.
10 Chalybion sp. nr. bengalense
11 Sceliphron javanum
12 Allorhynchium argentatum
13 Delta pyriforme
14 Rhynchium haemorrhoidale
15 Eumeninae "sp. 1"
16 Eumeninae "sp. 3"
17 Eumeninae "sp. 4"
18 Eumenes "sp. 1"
19 Eumenes "sp. 2"

Highest number of social bees recorded:
Lowest number of social bees recorded:
Highest number of solitary bees recorded:
Lowest number of solitary bees recorded:
Highest number of social wasps recorded:
Lowest number of social wasps recorded:
Highest number of solitary wasps recorded:
Lowest number of solitary wasps recorded:

Greatest total number of species recorded:
Fewest total species recorded:

Total breakdown of groups

Social bees	5 species
Solitary bees	36 species
Social wasps	51 species
Solitary wasps	22 species

Survey dates

Zone A	7 May 2015	16 July 2015	19 September 2015
Zone B	7 May 2015	21 July 2015	14 August 2015
Zone D	19 April 2015	26 April 2015	31 May 2015
Zone E	29 April 2015	19 July 2015	2 August 2015
Zone F	10 May 2015	22 July 2015	23 July 2015
Zone G	10 May 2015	24 July 2015	11 August 2015

Zone F (5)
Zone E (1)
Zone D (24)
Zone G (2)
Zone A (13)
Zone E (6)
Zone A (27)
Zone B and E (10)

Zone D (61 species)
Zone E (31 species)

29 September 2015	30 September 2015	13 October 2015
29 September 2015	30 September 2015	13 October 2015
21 June 2015	9 August 2015	27 September 2015
23 August 2015	12 September 2015	20 September 2015
30 July 2015	17 August 2015	23 September 2015
24 August 2015	28 September 2015	

Family	Subfamily and tribe (if applicable)	Species	Year(s) recorded in	Zone	Remarks
Apidae	Apinae; Anthoporini	Amegilla (Glossamegilla) insularis	2015	A	Uncommon species. Forest dweller, found only in primary and mature secondary or mangrove forest. Observed only once, feeding on flowers of Dillenia suffruticosa at forest edge.
Apidae	Apinae; Anthoporini	Amegilla (Zonamegilla) andrewsi	2014, 2015	A, D	Common species, found in both urban and natural habitats. Found feeding on a wide range of flowers throughout the survey.
Apidae	Apinae; Anthoporini	Amegilla (Zonamegilla) korotonensis	2015	A	Fairly common species, found in a wide range of habitats and feeding on wide range of flowers
Apidae	Apinae; Apini	Apis andreniformis	2015	A, B, F, G	Common species in urban areas in Singapore. Found mostly on cultivated or roadside flowers in this survey
Apidae	Apinae; Apini	Apis cerana	2014, 2015	A, B, D, E, F, G	Common species in all habitats in Singapore.
Apidae	Apinae; Apini	Apis dorsata	2015	D, F	Common species in Singapore, nests more commonly found in forest or wasteland.
Apidae	Apinae; Melectini	Thyreus ceylonicus	2015	A, D, F	Common species in Singapore. Found mainly in scrubland or at forest edge.
Apidae	Apinae; Melectini	Thyreus himalayensis	2015	D	Common species in Singapore. Found mainly in scrubland or at forest edge.
Apidae	Apinae; Meliponini	Heterotrigona itama	2015	D, F, G	Moderately common in Singapore. Found mainly on roadside and cultivated vegetation in this survey.
Apidae	Apinae; Meliponini	Tetragonula laeviceps	2014, 2015	A, B, F, G	Common and widespread species in Singapore. Might prove to be a complex of closely related species. In this survey, observed at roadside and cultivated flowers
Apidae	Xylocopinae: Allodapini	Braunsapis cupulifera	2015	B, D, F	Occasionally found in both urban and natural habitats. May be more common than thought, just often overlooked due to small size.
Apidae	Xylocopinae: Allodapini	Braunsapis sp.	2015	A	Species identification still pending
Apidae	Xylocopinae; Ceratinini	Ceratina collusor	2014, 2015	D, E, F	Fairly common species, mainly found in secondary forest habitat. Also found on cultivated flowers within the Zoo and River Safari in this survey.
Apidae	Xylocopinae; Ceratinini	Ceratina lieftincki	2015	E	Generally common species in parks and gardens, but found to be uncommon in the Mandai area throughout the survey period.
Apidae	Xylocopinae; Ceratinini	Ceratina nigrolateralis	2014, 2015	A, B, D, E, F	The most common species of its genus in this survey, found in forest, scrubland and managed habitats
Apidae	Xylocopinae; Ceratinini	Ceratina perforatrix	2015	B	Uncommon species in Singapore, restricted to forest throughout most of its range, though also found in parks and gardens in Singapore. In this survey, found at forest edge feeding on flowers of Costus lucanusianus
Apidae	Xylocopinae; Ceratinini	Ceratina ridleyi	2015	B	Rare species only found in primary and mature secondary forests. Observed at forest edge feeding on flowers of Syzygium sp.
Apidae	Xylocopinae; Ceratinini	Ceratina unimaculata	2014, 2015	D, E	Moderately common in scrubland habitat.
Apidae	Xylocopinae; Xylocopini	Xylocopa aestuans	2015	D, E, F	Common species in Singapore. Found mainly in scrubland and inside WRS parks during this survey
Apidae	Xylocopinae; Xylocopini	Xylocopa caerulea	2015	B	Moderately common species in forest habitats, less common in urban areas.
Apidae	Xylocopinae; Xylocopini	Xylocopa dejeani	2015	D	Extremely rare species, few recent records. Only one individual sighted at flowers of Bidens pilosa and Dillenia suffruticosa but failed to collect specimen
Apidae	Xylocopinae; Xylocopini	Xylocopa flavonigrescens	2015	D, E, F	Common species in Singapore. Found mainly in scrubland and inside WRS parks during this survey
Apidae	Xylocopinae; Xylocopini	Xylocopa latipes	2014, 2015	A, B, D, E, F, G	Common species throughout all urban and forest habitat in Singapore
Colletidae		Hylaeus sp.	2014, 2015	A, B	Just one species recorded during this survey, but there might be more. This appears to be the most common species, widely distributed in various habitats in Singapore
Halictidae	Halictinae	Lasioglossum albescens	2014	D	Uncommon but not rare or restricted in distribution in Singapore. Only one specimen taken during the 2014 survey.
Halictidae	Halictinae	Patellapis (Pachyhalictus) sp.	2014	A	Only seen during the 2014 survey period. May be more common than thought, as often overlooked due to small and inconspicuous appearance.
Halictidae	Halictinae	Halictidae undet. 1	2015	B	
Halictidae	Nominae	Nomia (Acunomia) iridescens	2015	D, E	Less common species, confined to habitats in and around forest.
Halictidae	Nominae	Nomia (Acunomia) strigata	2014, 2015	A, B, D, E, F, G	Most common species of its genus in Singapore, found in wide range of habitats
Halictidae	Nominae	Nomia (Hoplonomia) incerta	2015	E	Fairly common species in parks, managed gardens and forests in Singapore
Halictidae	Nominae	Nomia (Maculonomia) apicalis	2014, 2015	A, D, E	Common species in secondary forest and scrubland adjacent to forest.
Halictidae	Nominae	Nomia (Maculonomia) terminata	2014, 2015	A, B, D, F	Less common than above species. More forest dependent and more restricted to Central Catchment Area, though both species were found together in this survey.
Halictidae	Nominae	Lipotriches ceratina	2014, 2015	A, D, E	Not an uncommon species. Found predominantly in grassy areas in Singapore.
Halictidae	Nominae	Pseudapis siamensis	2015	D	Not common, but widely distributed in Singapore. Found in scrubland habitats.
Megachilidae		Coelioxys confusa	2014, 2015	D	Common species found over a wide range of habitats in Singapore. In this survey, found mainly in scrubland and attracted to flowers of Bidens pilosa.
Megachilidae		Heriades sp.	2014, 2015	D, F	Common species in scrubland and managed gardens.
Megachilidae		Megachile atrata	2015	D	Found mainly in mature secondary and mangrove forests. Only recorded on one occasion in this survey.
Megachilidae		Megachile disjuncta	2014, 2015	D, E	Common and widespread species in Singapore, more commonly associated with scrubland and urban environments.
Megachilidae		Megachile laticeps	2014, 2015	D, E	Common species in forest edge, scrubland and parks in Singapore
Megachilidae		Megachile stulta	2015	B	Rare species dependent on primary and mature secondary forest. Only observed once during this survey, feeding on flowers of Syzygium sp. at the edge of forest.
Megachilidae		Megachile subnixator	2014, 2015	A, D	Fairly common species in scrubland and managed gardens.
Crabronidae	Bembicinae (Stizini)	Bembicinus sp.	2015	D	Common species near seaside habitats, less common inland. Only observed once during this survey, digging burrow in soil in open, exposed area
Crabronidae	Crabroninae; Trypoxylini	Trypoxylon "sp. 1"	2014, 2015	A, B, D, E, G	Possibly T. petiolatum; awaiting further confirmation. Common and widespread throughout Singapore.
Crabronidae	Crabroninae; Trypoxylini	Trypoxylon "sp. 2"	2014, 2015	A	Much larger individuals. Awaiting further examination to determine if they are just exceptionally large individuals of the more common species listed above.
Crabronidae	Crabroninae; Crabronini	Crabronidae undet.	2014	A	Possibly Dasyproctus sp. Found only in 2014 survey on forest vegetation
Crabronidae	Larrinae	Larrinae sp. 1	2014	A	Probably Liris sp. Very large, black species. Rare, recorded only from the Mandai area. Recorded only once in 2014, foraging on Mussaenda frondosa and Melastoma malabathricum
Crabronidae	Larrinae	Larrinae sp. 2	2014, 2015	D	Liris sp. Common species throughout most habitats in Singapore.
Crabronidae	Larrinae	Larrinae sp. 3	2015	D	Information on distribution and abundance lacking, need to compare with a wider pool of specimens to determine this in Singapore
Crabronidae	Larrinae	Larrinae sp. 4	2015	G	Information on distribution and abundance lacking, need to compare with a wider pool of specimens to determine this in Singapore
Crabronidae	Larrinae	Larrinae sp. 5	2015	G	Information on distribution and abundance lacking, need to compare with a wider pool of specimens to determine this in Singapore
Crabronidae	Larrinae	Larrinae sp. 6	2015	G	Information on distribution and abundance lacking, need to compare with a wider pool of specimens to determine this in Singapore
Crabronidae	Larrinae	Larrinae sp. 7	2015	G	Information on distribution and abundance lacking, need to compare with a wider pool of specimens to determine this in Singapore
Crabronidae	Larrinae	Larrinae sp. 8	2015	G	Information on distribution and abundance lacking, need to compare with a wider pool of specimens to determine this in Singapore
Pompilidae		Auplopus "sp. 1"	2014, 2015	A, G	Fairly common in forest and managed gardens.
Pompilidae		Tachypompilus analis	2014	D	Not abundant, usually found in forest habitats or near the sea.
Pompilidae		Pompilidae "sp. 1"	2014, 2015	A, D	Common species in forest and open areas adjacent to forest in Singapore
Pompilidae		Pompilidae "sp. 2"	2014, 2015	A, F	Common species in both forest and managed environments in Singapore
Pompilidae		Pompilidae "sp. 3"	2014, 2015	A, F	Common species in both forest and managed environments in Singapore
Pompilidae		Pompilidae "sp. 4"	2014, 2015	A, B, D, F, G	Common species in both forest and managed environments in Singapore
Pompilidae		Pompilidae "sp. 5"	2014	A	Rare species, only recorded in Mandai area to date. Found foraging among vegetation at forest edge.
Pompilidae		Pompilidae "sp. 6"	2014	A	Common species in and near forest in Singapore
Pompilidae		Pompilidae "sp. 7"	2014	D	Common species in and near forest in Singapore
Pompilidae		Pompilidae "sp. 8"	2014	D	Not abundant but found throughout forested areas in Central Catchment Area. Found only in forest off track in Area D in this survey. Possibly Cryptocheilus sp.
Scoliidae		Campsomeris sp.	2015	G	Widespread and abundant in gardens and scrubland in Singapore. Only observed within the Night Safari during this survey.
Scoliidae		Scolia sp.	2015	E	Common species in forest, scrubland and mangrove in Singapore. Only observed once during this survey.
Sphecidae	Sceliphrinae	Chalybion sp. nr. bengalense	2015	F, G	Common and widespread species generally associated with man-made structures.
Sphecidae	Sceliphrinae	Chalybion (Hemichalybion) sumatranum	2015	F	Common species, often found nesting on man-made structures.
Sphecidae	Sceliphrinae	Sceliphron javanum	2014, 2015	A, F, G	Common species, often found nesting on man-made structures.
Sphecidae	Sceliphrinae	Sceliphron madraspatanum	2014, 2015	D	Less common species, generally found in grassland or scrubland habitats.
Sphecidae	Sphecinae	Isodontia sp. nr. diodon	2014, 2015	A, B, D, F	Common and widespread species in scrubland and managed parks and gardens.
Sphecidae	Sphecinae	Isodontia sp.	2014, 2015	A, E	Less common than above species.
Sphecidae	Sphecinae	Sphex argentatus	2015	D	Observed only once but couldn't be collected; very likely to be this species. Rare species in Singapore, only recorded from two localities
Sphecidae	Sphecinae	Sphex sp. nr. diabolicus	2015	D	Fairly common species, usually found in shaded areas of secondary forest or beaches.
Sphecidae	Sphecinae	Sphex sericeus	2014, 2015	B, D, E	Common species in all habitats in Singapore.
Sphecidae	Sphecinae	Sphex subtruncatus	2015	D	Less common than above two species. Found predominantly in forest and scrubland.
Vespidae	Eumeninae	Allorhynchium argentatum	2014, 2015	A, B, D, E, G	Common species throughout urban and natural habitats in Singapore
Vespidae	Eumeninae	Delta pyriforme	2014, 2015	A, B, D, E, F, G	Very common species in Singapore. Found in forest but more commonly in urban environments and parks
Vespidae	Eumeninae	Phimenes flavopictus	2015	A	Moderately common and widely distributed in Singapore. Most common in parks with mature vegetation and secondary forest
Vespidae	Eumeninae	Phimenes sp.	2014	D	Like typical Phimenes flavopictus, but with black thorax. Failed to collect specimen, thus cannot be identified to species. Rare in Singapore, only observed at Mandai and Fort Canning to date.
Vespidae	Eumeninae	Rhynchium haemorrhoidale	2014, 2015	E, F, G	Common species in parks, gardens and urban environments. Often nests on man-made structures
Vespidae	Eumeninae	Eumeninae "sp. 1"	2014, 2015	A, B, D, E, F, G	Very common and widespread in urban and natural habitats
Vespidae	Eumeninae	Eumeninae "sp. 2"	2014, 2015	F	Very similar to above species with differences in wing venation and pattern. Much less common than above species.
Vespidae	Eumeninae	Eumeninae "sp. 3"	2014, 2015	A, G	Very common and widespread in urban and natural habitats
Vespidae	Eumeninae	Eumeninae "sp. 4"	2014, 2015	A, B, D, F, G	Common and widespread. More abundant in forest habitats but also in parks and gardens.
Vespidae	Eumeninae	Eumeninae "sp. 5"	2014, 2015	B	Not uncommon, usually found in mature secondary forest.
Vespidae	Eumeninae	Eumeninae "sp. 6"	2014, 2015	A, D	Less common species, usually found in mature secondary and mangrove forest.
Vespidae	Eumeninae	Eumeninae "sp. 7"	2014, 2015	A	Uncommon species, usually found in mature secondary and mangrove forest.
Vespidae	Eumeninae	Eumeninae "sp. 8"	2015	A	Uncommon species, usually found in mature secondary and mangrove forest.
Vespidae	Eumeninae	Eumeninae "sp. 9"	2015	A, D	Common in forest and scrubland
Vespidae	Eumeninae	Eumeninae "sp. 10"	2014, 2015	A, D	Less common species, found in forest, scrubland and mangrove
Vespidae	Eumeninae	Eumenes "sp. 1"	2014, 2015	A, B, D, E, F, G	Very common in scrubland and managed parks and gardens
Vespidae	Eumeninae	Eumenes "sp. 2"	2014, 2015	A, B, D, E, F, G	Common in scrubland and managed parks and gardens
Vespidae	Polistinae	Polistes meadeanus	2014	B	Uncommon, found throughout Central Catchment Area and Bukit Timah Nature Reserve. Found only in primary or mature secondary forest.
Vespidae	Polistinae	Polistes sagittarius	2015	F	Common species in urban areas in Singapore. Only observed within the Zoo in this survey.
Vespidae	Polistinae	Polistes stigma	2014, 2015	A, B, F	Common and widespread in secondary forest and mangrove habitats, occasionally in managed gardens.
Vespidae	Polistinae	Polistes sp. nr. stigma	2014, 2015	A, F	A presently undescribed species very similar to P. stigma. Description of this species in conjunction with specialists in this group pending.
Vespidae	Polistinae	Ropalidia erythrospila	2014, 2015	A, B, G	Widely distributed in Singapore, found in habitats inside or at the edge of forests.
Vespidae	Polistinae	Ropalidia flavopicta	2015	F	Uncommon species in Singapore, known from only a few localities thus far. Found nesting in the Zoo. Only found within the zoo during this survey.
Vespidae	Polistinae	Ropalidia marginata	2014, 2015	D, E	Rare species in Singapore, few past records. Personally recorded only from Mandai.
Vespidae	Polistinae	Ropalidia stigma	2014, 2015	A, B, D, E, F, G	Very common and widespread in Singapore. Most common in secondary forest, but also in mangroves, seaside vegetation and parks.
Vespidae	Polistinae	Ropalidia sumatrae	2015	B, E, G	Very common in Sinaaore. but not abundant in the Mandai area throughout survey period. Possibly an indicator of forest health as most commonly found in good mature forest.
Vespidae	Polistinae	Ropalidia timida	2015	D, G	Not particularly common but widely distributed in Singapore. Found in secondary forest and parks with more mature vegetation
Vespidae	Polistinae	Ropalidia "sp. 2"	2014, 2015	D	Probably Ropalidia jacobsoni. Very common species in Singapore, more common in urban areas and grassland.
Vespidae	Stenogastrinae	Eustenogaster hauxwelli	2014, 2015	A	Dwells in mangrove, primary and mature secondary forest. Rarer than Eustenogaster micans. Personal records only from Mandai, Central Catchment Area and Pulau Ubin.
Vespidae	Stenogastrinae	Eustenogaster micans	2014, 2015	A, B, D	Found in same habitats as Eustenogaster hauxwelli, but much more abundant.
Vespidae	Stenogastrinae	Liostenogaster nitidipennis	2014, 2015	A, G	Common in forest habitats. Found nesting on ornamental plants in Night Safari.
Vespidae	Stenogastrinae	Liostenogaster varipicta	2015	A, G	Common in forest habitats. Found nesting on ornamental plants in Night Safari.
Vespidae	Stenogastrinae	Metischnogaster drewseni	2014	A	Very rare, only recorded in Mandai area thus far.
Vespidae	Stenogastrinae	Parischnogaster mellyi	2014, 2015	A, B, D, E, F, G	Most common species of its subfamily in Singapore, found in wide range of habitats.
Vespidae	Stenogastrinae	Parischnogaster nigricans	2014, 2015	A, B, F	Common species, found in both urban and natural environments.
Vespidae	Stenogastrinae	Parischnogaster unicuspata	2014	A	Rare species, only recorded from two localities. Only one record throughout this survey.
Vespidae	Vespinae	Vespa affinis	2015	B, D, E, F	Most common hornet species in Singapore, found in a wide range of habitats.
Vespidae	Vespinae	Vespa analis	2014, 2015	D, F	Common species in parks and gardens.
Vespidae	Vespinae	Vespa tropica	2014, 2015	A, B, D, E, F	Common species found in a wide range of habitats, but more common in forest.

COMPARATIVE ANALYSIS BETWEEN ZONES IN TE

Zone

A

B

D
E
F
G

Survey dates and times

Zone A
Zone B
Zone D
Zone E
Zone F
Zone G

RMS OF HABITAT AND SPECIES DIVERSITY

Type of habitat	
Forest, cultivated roadside vegetation	
Forest, cultivated roadside vegetation, abandoned fruit orchards	
Forest, grassland/scrubland, open sandy areas, patches of abandoned fruit orchard	
Predominantly forest, few flowering plants	
Forest, roadside vegetation, managed zoological parks	
Forest, roadside vegetation, managed zoological park	

	7 May 2015, 10:50am - 12:40pm (Interrupted by rain)
	7 May 2015, 3:30pm - 6:00pm
	19 April 2015, 1:00pm - 3:30pm
	29 April 201, 11:30am - 2:30pm
	10 May 2015, 11:50am - 2:30pm
	10 May 2015, 2:50pm - 5:20pm

Total number of species recorded

57

35

61
31
39
32

16 July 2015, 2:40pm - 5:20pm
21 July 2015, 1:35pm - 4:10pm
26 April 2015, 1:30pm - 4:00pm
19 July 2015, 3:10pm - 5:45pm
22 July 2015, 11:40am - 1:00pm and 2:00pm - 4:10pm
25 July 2015, 12:15am - 3:10am

19 September 2015, 3:30pm - 6:00pm
14 August 2015, 1:00pm - 3:30pm
31 May 2015, 3:00pm - 5:30pm
2 August 2015, 1:00pm - 4:00pm
23 July 2015, 1:50pm - 4:20pm
11 August 2015, 1:30pm - 4:30pm

29 September 2015, 2:30pm - 5:00pm
29 September 2015, 10:50am -1:30pm
21 June 2015, 3:30pm - 6:00pm
23 August 2015, 2:30pm - 5:00pm
30 July 2015, 12:30pm - 1:30 pm and 2:00pm - 4:00pm
24 August 2015, 9:50am - 12:20pm

30 September 2015, 2:20pm - 5:00pm
30 September 2015, 11:10am - 2:00pm
9 August 2015, 4:15pm - 6:45pm
12 September 2015, 3:00pm - 5:00pm (shortened survey duration due to haze)
17 August 2015, 2:00pm - 4:30pm
28 September 2015, 2:00pm - 4:30pm

13 October 2015, 4:00pm - 7:00pm
13 October 2015, 1:00pm - 3:45pm
27 September 2015, 11:00am - 1:00pm (shortened survey duration due to haze)
20 September 2015, 1:30pm - 4:00pm
23 September 2015, 12:20pm - 3:00pm

Species of

Family (subfamily and tribe if applicable)	Species
Apidae: Apinae; Anthoporini	Amegilla (Glossamegilla) insularis
Apidae: Xylocopinae; Xylocopini	Xylocopa dejeani
Megachilidae	Megachile stulta
Crabronidae: Larrinae	Probably Liris sp.
Pompilidae	Pompilidae "sp. 5"
Sphecidae: Sphecinae	Sphex argentatus
Vespidae: Polistinae	Polistes meadeanus
Vespidae: Polistinae	Ropalidia marginata
Vespidae: Stenogastrinae	Metischnogaster drewseni
Vespidae: Stenogastrinae	Parischnogaster unicuspata

conservation significance

Zone/habitat found	Remarks
A; Forest edge	Forest dweller, found only in primary and mature secondary or mangrove forest. Nesting habits not known at present, but presumably requires healthy forest with good soil as it is probably a ground dweller, like most members of its genus
D; Open clearing at edge of forest	Extremely rare in Singapore, despite being common throughout other parts of its range like Hong Kong. Nests in fallen tree trunks. Habitat availability does not seem a problem, thus reason for its local rarity not known
B; Edge of forest	Forest-dependent species. Nesting habits unknown.
A; Forest edge	First personal record of this species in Singapore. May be restricted to the Mandai area or at least to habitats near healthy forest.
A; Forest edge	First personal record of this species in Singapore. May be restricted to the Mandai area or at least to habitats near healthy forest.
D; grassland	Digs burrows in sandy soil. Rare species only known from two localities in Singapore.
B; Inside forest	Forest-dependent species. Nests built on underside of leaves of trees, usually 1 to 3 metres above ground.
D; grassland	Recorded only from Mandai so far. Usually confined to small areas of tall grass. Nesting behaviour in Singapore unknown.
A; Forest edge	Extremely rare species in Singapore, nests not found locally. Known to nest in dark, humid parts of forests and on structures such as aerial rootlets of trees
A; Inside forest	Rarest among the three species of this genus found in Singapore. Seems restricted to forest and mangroves. Nesting behaviour in Singapore currently unknown.

Annex 14.6

Odonata

Odonata (Dragonflies and Damselflies) Survey at Mandai From April 2015 to October 2015

Yeo Suay Hwee

Introduction:

The Insect Order Odonata subdivided to sub-orders Zygoptera-Damselflies and Anisoptera-Dragonflies. Damselflies appear to be more fragile, slender and smaller as compared to the muscular, stockier and bigger Dragonflies. Both are aerial predators would prey on other animals (mainly insects) on wings.

Odonata differs from most other insects by spending their larva stage underwater. Their larvae also prey on other aquatic animals such as small fishes, tadpole, aquatic insects (including their own kind) and worms.

Method of Survey:

The area is further divide into eight sectors from Zone A to Zone H. Only three surveys are carried out for Zone H as this sector only added in June 2015. A total of 39 day surveys were carried out with one day survey per sector each month.

The Day Surveys were done by observation when walking in the specific transects of the zone in the morning. Visual sightings of species were recorded with the aids of photography if field identification is difficult or impossible. No collection of specimen is involved in this survey. We made no attempt to collect the larvae as identification of individual species is time consuming and inefficient as many species would spend months if not years underwater before transforming themselves to adulthood.

Findings:

Following table shows the occurrences of species by zones.

		Dragonflies Survey								
	Mandai Area	**(Apr.--Oct. 2015)**	A	B	D	E	F	G	H	Remarks
	Species									
1	Common Flashwing	*Vestalis amethystina*			2					F
2	Ornate Coraltail	*Ceriagrion cerinorubellum*	1		3		1		7	
3	**Fiery Coraltail**	***Ceriagrion chaoi***							5	
4	Common Blue Sprite	*Pseudagrion microcephalum*	2		7	6	18	3	1	
5	**Grey Sprite**	***Pseudagrion pruinosum***			8				1	F
6	**Telephone Sylvan**	***Coeliccia octogesima***	9							F, R
7	Yellow Featherlegs	*Copera marginipes*			8					
8	**Orange-striped Threadtail**	***Prodasineura humeralis***	148		23	12	16	2		F
9	**Spoon-tailed Duskhawker**	***Gynacantha basiguttata***		1						F, R
10	Common Flangetail	*Ictinogomphus decoratus*	21		3		2	1	1	
11	**Forktail**	***Macrogomphus quadratus***							1	F
12	Pond Adjutant	*Aethriamanta gracilis*							12	
13	Trumpet Tail	*Acisoma panorpoides*			1					
14	Pond Cruiser	*Epophthalmia vittigera*						1		
15	Grenadier	*Agrioptera insignis*		1	1	4	3	4		
16	**Handsome Grenadier**	***Agrionoptera sexlineata***		4		10	3			F

17	Blue Dasher	*Brachydiplax chalybea*			3	5	8	5	1	
18	**Sultan**	***Camacinia gigantea***					1	1		R
19	**Variable Sentinel**	***Orchithemis Pulcherrima***							3	F
20	Dark-tipped Forest-skimmer	*Cratilla metallica*	1	16		15	3	3		F
21	Common Scarlet	*Crocothemis servilia*			2			1		
22	Chalky Percher	*Diplacodes trivialis*						1		
23	Water Monarch	*Hydrobasileus croceus*						3	4	
24	Scarlet Grenadier	*Lathrecista asiatica*	2	3	8			1		
25	Coastal Glider	*Macrodiplax cora*			3		40	3		
26	Scarlet Pygmy	*Nannophya pygmaea*							6	
27	Common Parasol	*Neurothemis fluctuans*	1	11	47	75	34	29	2	
28	Spine-tufted Skimmer	*Orthetrum chrysis*	2	1	22	9	6	10	4	
29	Common Blue Skimmer	*Orthetrum glaucum*		3	1	6	8			
30	Slender Blue Skimmer	*Orthetrum luzonicum*			31					
31	Variegated Green Skimmer	*Orthetrum sabina*				10	18	47		
32	Scarlet Skimmer	*Orthetrum testaceum*		5	9	8	21	21	2	
33	Wandering Glider	*Pantala flavescens*		25	17	23	12	8		
34	Common Chaser	*Potamacha congener*						2		
35	**Banded Skimmer**	***Pseudothemis jorina***	21	9	2	1	1	1	1	
36	Common Redbolt	*Rhodothemis rufa*	1						8	
37	**Bronze Flutterer**	***Rhyothemis obsolence***				2			6	F
38	Yellow-barred Flutterer	*Rhyothemis phyllis*		10	5	54	29	7	6	
39	**Sapphire Flutterer**	***Rhyothemis triangularis***	1			9			6	
40	White-barred Duskhawk	*Tholymis tillarga*		15						
41	Scarlet Basker	*Urothemis signata*	4	1					4	
42	Saddlebag Glider	*Tramea transmarina*			1	2	2	21		
43	Dawn Dropwing	*Trithemis aurora*	13	2	40	8	13	46		
44	Indigo Dropwing	*Trithemis festiva*			9		2			
	Total Species/Zone		14	15	24	19	21	23	20	

F: Forest Dependent; R: Rare

Zone A:

This zone comprises mainly matured secondary forest with patchy swamp and stream. A total of 14 species were recorded in six months. The dense forest is always difficult to observe animals and more problematic for the canopy species which hardly come down to the lower level.

This site seems to harvest a healthy population of **Telephone Sylva** which only prefers swamp forest.

The occurrence of 148 **Orange-striped Threadtail** is the largest for a single species in any zone. The encounters of males which tend to stay near water are outnumbered (ratio of 1:4) by females which prefer to stay on the forest floor slightly away from the water. This species seems to be doing well as compared to when it was first discovered in Singapore almost a decade ago with more known localities.

As this zone is adjacent to the Upper Seletar Reservoir, this may explain the higher sightings of 21 **Banded Skimmer** which prefers bigger water body.

Zone B:
This is a deserted fruit orchard that has growth to a secondary forest over the years with patches of open grassland and shrub. A bit of seasonal wet patch at the Southwestern corner which also attract some Odonata.
Total of 15 species were recorded in this zone with interesting forest species such as **Spoon-tailed Dushhawker**, **Handsome Grenadier** and **Dark-tipped Forest Skimmer**.

Zone D:
A deserted fruit orchard and secondary forest with patches of tall grass and short grass open areas. A permanent stream flows through the zone from South to North.
This zone recorded the most numerous species (24) of all seven surveyed sectors. Stream loving forest species **Common Flashwing** only recorded in this zone. Other forest dependants **Grey Sprit** and **Orange-striped Threadtail** are also found in this zone. No surprises are the twenty odd open country species.

Zone E:
This zone comprises of mainly disturbed secondary forest with small patch of swamp. Forest dependant species recorded in this zone include **Orange-striped Threadtail**, **Handsome Grenadier**, **Dark-tipped Forest-skimmer** and **Bronze Flutterer**. Also worth mention is the record of 9 **Sapphire Flutterers** in the zone with total of 19 species recorded.

Zone F
This is the Zoo and River Safari proper with many man made ponds and canals. This zone also surrounded by Upper Seletar Reservoir all except the West.
Forest species **Orange-striped Threadtail**, **Handsome Grenadier** and **Dark-tipped Forest-skimmer** are recorded in this zone. Unusual record of rare species of **Sultan** is sighted once here among twenty other species.

Zone G
The Night Safari of Zone G is better preserved than the zone F with patches of swamp forest within the zone beside other man made ponds and canals.
This zone has 23 species recorded. Usual forest species **Orange-striped Threadtail** and **Dark-tipped Forest-skimmer were recorded**. A single sighting record of the rare **Sultan** is worth taking notice.

Zone H
A big swampy pond in the Western side of the zone proves to be attractive to the many species of dragonflies here. The Eastern side of the zone is mainly secondary forest and a stream with swampy pond at the South-Eastern corner also good with few forest species. Forest species like **Grey Sprite**, **Forktail**, **Variable Sentinel** and **Bronze Flutterer are recorded in this zone**. Other interesting species include **Fiery Coraltail** which is quite rare with only few recorded localities; **Scarlet Pygmy** which usually occurs only in swampy area and also six individuals of **Sapphire Flutterer**. A total of twenty species recorded in this zone.

Summary:
A total of 44 species of Odonata were recorded in this survey for the seven zones. These make up of approximately one third of the known odonata species found in Singapore. They

are certainly many more species could be found in this area if longer survey period is conducted. Many of the rare or forest dependent species certainly worth conserving, not to forget other beautiful open country species that are also add colour to the lively habitats of this area.

Conclusion and Suggestion:

This area harvest no fewer than 44 odonata species over the six months survey is very encouraging result consider just by pure observation without any capturing of individuals. The odonata is certainly worth protecting with its colourful display and easy to observe, they can be a group of species to be used as environmental health accessing indicators.

In order to preserve odonata, we must preserve all natural habitats of ponds, swamps and streams within and surrounding this area. No fogging in the air or spraying to the water bodies of insecticide or chemicals are allowed so as not just to protect the odonata but their prey animals too. We also need to keep the habitat of the area as diverse as possible if biodiversity of the area is the ultimate aim.

References

-Gragonflies of Peninsular Malaysia and Singapore by A. G. Orr. Published by Natural History Publications 2005.

-A photographic guide to the Dragonflies of Singapore by Tang Hung Bun, Wang Luan Keng and Matti Hamalainen. Published by The Museum of Biodiversity Research, NUS 2010.

Annex 14.7

Butterflies

Report on Butterflies Survey at Mandai Area

From April to October 2015

Yeo Suay Hwee

Introduction:

Butterfies and Moths form one of the most colourful insect orders – **Lepidoptera** - The scaled winged insects.

The sight of butterflies fluttering and feeding from flower to flower or a pair of courting butterflies dancing among the foliage is something that many of us do appreciate and enjoy.

The different attractive colours and patterns on their wings make them the most noticeable insects in animal kingdom.

Majority of the butterflies active during the day when there are enough sunshine, this make butterflies observation relatively easy except for those look alike species within the genus or families.

Method of Survey:

The area is further divide into eight sectors from Zone A to Zone H. Only three surveys were carried out for Zone H as this sector only added to the survey in June 2015. A total of 39 day surveys were carried out with one day survey per sector each month.

The Day Surveys were done by observation when walking in the specific transects of the zone in the morning. Visual sightings of species were recorded with the aids of photography if field identification is difficult or impossible. No collection of specimen is involved in this survey. We made no attempt to collect the caterpillars as identification of individual species is time consuming and require vast knowledge of their host plants.

Findings:

The following table shows the sightings of individuals in species and different sectors.

Species identified to genus level will be listed in this table but will not be counted as a recorded species. No number will be assigned to this identification level.

Second subspecies listed in this table will have suffix of **a** behind the listing number.

	Butterflies List									
		Mandai Area (Zone)	**A**	**B**	**D**	**E**	**F**	**G**	**H**	**Remarks**
	Species									
1	**Common Birdwing**	***Troides helena cerberus***					1			
2	**Common Rose**	***Pachliopta aristolochiae asteris***				1	1	1		
3	Common Mime	*Chilasa clytia clytia*		2		1				
4	Lime Butterfly	*Papilio demoleus malayanus*	1			4	2			
5	**Banded Swallowtail**	***Papilio demolion demolion***								F
6	Common Mormon	*Papilio polytes romulus*	3	21	28	22	10	11		
7	Great Mormon	*Papilio memnon agenor*		2						
8	Common Bluebottle	*Graphium sarpedon luctatius*		1		5		6		
9	Blue Jay	*Graphium evemon eventus*					1	4		
10	Tailed Jay	*Graphium agamemnon agamemnon*	1			1				
11	**Five Bar Swordtail**	***Pathysa antiphates itamputi***								F
12	Painted Jezebel	*Delias hyparete metarete*	2	5	13	22	19	35		
13	Psyche	*Leptosia nina malayana*			8	6		3		
14	Striped Albatross	*Appias libythea olferna*			5	15		9		

15	Mottled Emigrant	*Catopsilia pyranthe pyranthe*						2		
16	Lemon Emigrant	*Catopsilia pomona pomona*	2	3	21	24	52	33		
17	Orange Emigrant	*Catopsilia scylla cornelia*				2	4			
18	Common Grass Yellow	*Eurema hecabe contubernalis*				8		7		
19	**Forest Grass Yellow**	***Eurema simulatrix tecmessa***								
	Grass Yellow	*Eurema spp*			46	23	12	21		
20	Three Spot Grass Yellow	*Eurema blanda snelleni*								
21	**Anderson's Grass Yellow**	***Eurema andersonii andersonii***		1						
22	Chocolate Grass Yellow	*Eurema sari sodalis*		23		1		1	1	
23	Tree Yellow	*Gandaca harina distanti*				1				
24	Dark Glassy Tiger	*Parantica agleoides agleoides*					1	4		
25	Blue Glassy Tiger	*Ideopsis vulgaris macrina*			3	10	2			
26	Striped Blue Crow	*Euploea mulciber mulciber*			3	4	2	8		
27	**Spotted Black Crow**	***Euploea crameri bremeri***						1		F
28	**Magpie Crow**	***Euploea radamanthus radamanthus***								F
29	**Common Tree Nymph**	***Idea stolli logani***					1			F
30	**Common Evening Brown**	***Melanitis leda leda***		1	1	1		1		
31	**Tawny Palmfly**	***Elymnias panthera panthera***			4			4		
32	Common Palmfly	*Elymnias hypermnestra agina*		1	6	19	16	15		
33	**Malayan Bush Brown**	***Mycalesis fusca fusca***								
34	**Perseoides Bush Brown**	***Mycalese perseoides perseoides***	1	11						R
35	Dark Brand Bush Brown	*Mycalesis mineus macromalayana*		9		26				
36	**Long Brand Bush Brown**	***Mycalesis visala phamis***		10						
38	Dingy Bush Brown	*Mycalesis perseus cepheus*		11	1					
	Bush Brown	*Mycalesis sp.*			65		2	9		
39	Dark Grass Brown	*Orsotriaena medus cinerea*		10	125	4				
40	**Malayan Six Ring**	***Ypthima fasciata torone***								R
41	Common Five Ring	*Ypthima baldus newboldi*								
42	**Malayan Five Ring**	***Ypthima horsfieldii humei***								R
	Ring	*Ypthima sp.*			1			1		
43	Common Faun	*Faunis canens arcesilas*		5		2		4		F
44	**Palm King**	***Amathusia phidippus phidippus***			1			1		R
45	**Saturn**	***Zeuxida amethystus amethystus***		1						F, R
46	**Angled Castor**	***Ariadne ariadne ariadne***								
47	Malayan Eggfly	*Hypolimnas anomala anomala*		3	2		7	17	1	
48	Great Eggfly	*Hypolimnas bolina bolina*						3		
48	Jacintha Eggfly	*Hypolimnas bolina jacintha*						1		

a										
49	Autumn Leaf	*Doleschallia bisaltide bisaltide*						1		
49a	**Autumn Leaf**	***Doleschallia bisaltide pratipa***								
50	Chocolate Pansy	*Junonia hedonia ida*		11	18	16	20	33		
51	**Grey Pansy**	***Junonia atlites atlites***			8	3				
52	Peacock Pansy	*Junonia almana javana*			2	7	4			
53	Blue Pansy	*Junonia orithya wallacei*				10		1		
54	Tawny Coster	*Acraea violae*			1			1		
55	**Malay Lacewing**	***Cethosia hypsea hypsina***								F
56	Leopard Lacewing	*Cethosia cyane*					1			
57	Leopard	*Phalanta phalantha phalantha*		3	1	2	1	9		
58	Rustic	*Cupha erymanthis lotis*				5	8	26		F
59	Cruiser	*Vindula dejone erotella*				2		2		
60	**Commander**	***Moduza procris milonia***						2		
61	Knight	*Lebadea martha parkeri*	2			18		8		
62	**Lance Sergeant**	***Athyma pravara helma***								R
63	**Dot-Dash Sergeant**	***Athyma nefte subrata***	1	1						
64	**Colonel**	***Pandita sinope sinope***								R
65	Common Sailor	*Neptis hylas papaja*				6		3		
66	Grey Sailor	*Neptis leucoporos cresina*				2				
67	**Chocolate Sailor**	***Neptis harita harita***								R
68	Short Banded Sailor	*Phaedyma columella singa*								
	Sailor Spp.				15	2	4	5		
69	**Burmese Lascar**	***Lasippa heliodore dorelia***								R
70	Malayan Lascar	*Lasippa tiga siaka*								
71	Common Lascar	*Pantoporia hordonia hordonia*				1		2		
72	**Perak Lascar**	***Pantoporia paraka paraka***								
	Lascar Spp.					1		1		
73	Malay Viscount	*Tanaecia pelea pelea*	2	1		2	1	15		F
74	Horsfield's Baron	*Tanaecia iapis puseda*		4	1	13	2	7		F
75	Malay Baron	*Euthalia monina monina*								F
76	Baron	*Euthalia aconthea gurda*		1						
77	Archduke	*Lexias pardalis dirteana*	2	6		5		2	1	F
78	Purple Duke	*Eulaceura osteria kumana*	4	2		1		1		F
79	**Courtesan**	***Euripus nyctelius euploeoides***								R
80	Plain Nawab	*Polyura hebe plautus*								
81	**Spotted Judy**	***Abisara geza niya***	1							R, F
82	**Malay Tailed Judy**	***Abisara savitri savitri***						1		R, F
83	**Malayan Plum Judy**	***Abisara saturata kausambioides***								F
84	**Lesser Harlequin**	***Laxita thuisto thuisto***				1				R, F
85	**Sumatran Gem**	***Poritia sumatrae sumatrae***								R, F
86	Bigg's Brownwing	*Miletus biggsii biggsii*		1						
87	**Blue Brownwing**	***Miletus symethus petronius***								F
88	**Lesser Darkwing**	***Allotinus unicolor unicolor***								
89	**Pale Mottle**	***Logania marmorata damis***			1					
90	Malayan Sunbeam	*Curetis santana malayica*				1				
91	**Elbowed Pierrot**	***Caleta elna elvira***								F

92	Lesser Grass Blue	*Zizina otis lampa*			2	28	3	16		
93	Pygmy Grass Blue	*Zizula hylax pygmaea*			1					
94	Cycad Blue	*Chilades pandava pandava*				1				
95	Gram Blue	*Euchrysops cnejus cnejus*			2		1			
96	**Silver Forget-Me-Not**	***Catochrysops panormus exiguus***								R
97	Pea Blue	*Lampides boeticus*								
98	Common Hedge Blue	*Acytolepis puspa lambi*						1		
99	**Metallic Caerulean**	***Jamides alecto ageladas***								R
100	Common Caerulean	*Jamides celeno aelianus*			4	6		9	1	
101	**Sky Blue**	***Jamides caeruleus caeruleus***	10							R
102	Rounded 6-Line Blue	*Nacaduba berenice icena*								
103	**Dark Malayan Sixline Blue**	***Nacaduba calauria malayica***								R, F
104	Pointed Line Blue	*Ionolyce helicon merguiana*								
105	Common Line Blue	*Prosotas nora superdates*								
106	Tailless Line Blue	*Prosotas dubiosa lumpura*					23			
107	**Scarce Silversteak**	***Iraota rochana boswelliana***						1		
108	Ciliate Blue	*Anthene emolus goberus*								
109	**Pointed Ciliate Blue**	***Anthene lycaenina miya***								R
110		*Arhopala amphimuta amphimuta*								F
111		*Arhopala major major*								F
112	**Vinous Oakblue**	***Arhopala athada athada***								F
113	**Aberrant Oakblue**	***Arhopala abseus abseus***								
114	**Tailed Disc Oakblue**	***Arhopala atosia malayana***	1							
	Oakblue Spp.	***Arhopala sp.***						2		
115	Yamfly	*Loxura atymnus fuconius*						1		
116	**Bifid Plushblue**	***Flos diardi capeta***								R, F
117	**Shining Plushblue**	***Flos fulgida singhapura***								R, F
118	**Darky Plushblue**	***Flos anniella anniella***								R, F

119	**Plain PlushBlue**	***Flos apidanus saturatus***		1						R
120		*Semanga superba deliciosa*								
121	Acacia Blue	*Surendra vivarna amisena*								
122	**Scarce Silverstreak**	***Iraota rochana boswelliana***								
123	Branded Imperial	*Eooxylides tharis distanti*	1			3		1	1	F
124	**Great Imperial**	***Jacoona anasuja anasuja***				1				R, F
125	**Cornelian**	***Deudorix epijarbas cinnabarus***								R
126	**Yellow Flash**	***Rapala domitia domitia***								R, F
127	**Suffused Flash**	***Rapala suffusa barthema***								
128	**Indigo Flash**	***Rapala varuna orseis***								R
129	**Orange Awlet**	***Burara harisa consobrina***								R
130	**Common Awl**	***Hasora badra badra***				1				
131	**Plain Banded Awl**	***Hasora vitta vitta***				2				R
132	**Brown Awl**	***Badamia exclamationis***								R
133	**Hieroglyphic Flat**	***Odina hieroglyphica ortina***								
134	**Common Snow Flat**	***Tagiades japetus atticus***								
135	**Large Snow Flat**	***Tagiades gana gana***						2		R
136	**Ultra Snow Flat**	***Tagiades ultra***								R, F
137	**Malayan Snow Flat**	***Tagiades calligana***								R, F
138	**Chestnut Angle**	***Odontoptilum angulatum angulatum***								R
139	Bush Hopper	*Ampittia dioscorides camertes*								
140	**Dark Banded Ace**	***Halpe ormenes vilasina***								R, F
141	Chestnut Bob	*Iambrix salsala salsala*		2	12	4		4		
142	Chocolate Demon	*Ancistroides nigrita maura*			2	3	3	1		
14	Banded Demon	*Notocrypta paralysos*		3	15		1			F

3										
144	Grass Demon	*Udaspes folus*			6			2		
145	**Chequered Lancer**	***Plastingia naga***								F
146	**Yellow Chequered Lancer**	***Plastingia pellonia***	1							R, F
147	**Pugnacious Lancer**	***Pemara pugnans***				1				R,F
148	Yellow Vein Lancer	*Pyroneura latoia latoia*								F
149	**Banded Redeye**	***Gangara lebadea lebadea***								R
150	**Common Redeye**	***Matapa aria***								R
151		***Erionota torus***								R
152	Banana Skipper	*Erionota thrax thrax*				1				
153	Coconut Skipper	*Hidari irava*								
154	**White Spotted Palmer**	***Eetion elia***		1						R, F
155	Yellow Grass Dart	*Taractrocera archias quinta*								
156	Common Dartlet	*Oriens gola pseudolus*								
157	Lesser Dart	*Potanthus omaha omaha*		2	8	9		1		
158	Besta Palm Dart	*Telicota besta bina*								
159	**Palm Dart**	***Telicota augias augias***								
160	Small Branded Swift	*Pelopidas mathias mathias*			1					
161	Formosan Swift	*Borbo cinnara*			2	1				
162	**Great Swift**	***Pelopidas assamensis***								
163	**Conjoined Swift**	***Pelopidas conjunctus conjunctus***								
164	Contiguous Swift	*Polytremis lubricans lubricans*		4						
165	**Paintbrush Swift**	***Baoris oceia***								
166	**Full Stop Swift**	***Caltoris cormasa***		2						
167	**Philippine Swift**	***Caltoris philippina philippina***								

168	**Quaker**	***Neopithercops zalmora zalmora***	1							R, F
169	**Spotted Flitter**	***Zographetus doxus***	1							
170	**Pygmy Posy**	***Drupadia rufotaenia rufotaenia***	1							R, F
171	Palm Bob	*Suastus gremius*		7						
	Total Species/sector		19	35	32	51	26	49	5	99

F: Forest Dependent; R: Rare; R: Very Rare

Zone A:
This zone comprises mainly matured secondary forest with patchy swamp and stream. Dense forest in this zone make spotting butterflies more difficult and results as only 19 species were recorded in six months. Nevertheless, this zone recorded some important forest species such as **Spotted Judy**, **Yellow Chequered Lancer**, **Quaker** and **Pygmy Posy**; Rare species like **Perseoides Bush Brown** and **Sky Blue**.

Zone B:
This is a deserted fruit orchard that has growth to a secondary forest over the years with patches of open grassland and shrub. The patches of plant species like Heliconia. Clerodendrum, Leea prove attractive to the butterflies.
No fewer than 35 species are recorded here, **Plain PlushBlue**, **Saturn** and **Perseoides Bush Brown** are just some of the rare species found in this zone. Many of the forest dependant species are encountered here too.

Zone D:
A deserted fruit orchard, nursery and secondary forest with patches of tall grass and short grass open areas.
A total of 32 species recorded in this zone. As expected, all except **Horsfield's Baron** and **Banded Demon** are non-forest dependent species. **Palm King** is the only species here classified as rare.

Zone E:
This zone comprises of mainly disturbed secondary forest with small patch of swamp. Surprisingly, this zone gathers the biggest number of 51 species recorded. Many of them are forest dependents and some good forest species such as **Rustic**, **Cruiser**, **Archduke**, **Purple Duke** and **Lesser Harlequin**. **Pugnacious Lancer** is classified as very rare with only one record for the zone and the whole of Mandai area.

Zone F:
This zone covers the Zoo and River Safari with many cultivated flowering plants. Only 26 species of butterflies are recorded in this zone. Several forest species are recorded here including the **Common Tree Nymph, Rustic**, **Malay Viscount**, **Horsfield's Baron** and **Banded Demon**.

Zone G:
The Night Safari of Zone G is better preserved than the zone F with patches of swamp forest within the zone.

At 49, this area houses the second largest species list. Rare species such as **Large Snow Flat**, **Malay Tailed Judy**, **Palm King** and **Spotted Black Crow** are present in this zone. Quite a number of commoner forest species also recorded including the unusual high number of 26 **Rustic**.

Zone H:
This is mainly a secondary forest with a big swamp pond at this Western side of the Ulu Sembawang Road. The rest of the area at the Eastern side of the road is mainly secondary forest with a stream flowing through a swampy pond at the Southeastern tip before draining out under Mandai Road to Upper Seletar Reservoir.
They are only a handful of butterflies recorded in this zone and mainly forest dependent species. This is partially due to less surveys and shorter hours of observation in each survey.

Summary
A total of 99 species/subspecies (including two subspecies treated as two separate species) butterflies were recorded, this represent about one third of the know species found in Singapore. The butterflies check list prepared by Khew Sin Khoon for the Mandai area is at 155 Species. We have added 16 new species previously not recorded and hence the new check list has increased to stand at 171 species.

Conclusion
Butterflies are integral part of the whole ecosystem. Due to their close relationship with the plants, they are therefore very sensitive to any change on the surrounding vegetation. Any habitat destruction will greatly affect their chance of survival. We view butterflies as important indicators to the ecosystem, with careful chosen of target species, we should be able to check the status of the habitat by monitoring of their present in the area.

Reference
A field guide to the Butterflies of Singapore by Khew Sin Khoon, Published by Ink On Paper 2010.

Annex 14.8

Reduviidae

Report on the Assassin Bugs (Hemiptera: Reduviidae) of Mandai for an Environmental Impact Assessment (EIA)

Yeo Huiqing

Abstract
In this Environmental Impact Assessment (EIA), assassin bugs from the Mandai area was surveyed from May to October and 20 species from seven subfamilies were recorded. Analysis using incidence-based species accumulation curve indicated that there are more species to be found with increased sampling effort. Non-metric multidimensional scaling (NMDS) revealed that community structure of reduviids in four zones (A, B, D & E) are similar with a few species unique to each zone. Most of the reduviid species have a low distribution and occurrence and are encountered infrequently. Several species which are rare or have specific habitat types are highlighted. Zone B is recommended to be conserved while zone E has little conservation value for reduviid species. Several measures are suggested to minimize the effects of fragmentation.

Introduction

The Reduviidae (Hemiptera: Heteroptera) are commonly referred to as the assassin bugs and is a family consisting of more than 6,800 species (Capriles, 1990). The reduviids are mainly predatory on a wide range of invertebrates, with several subfamilies known to have specialised diets (Hwang & Weirauch, 2012; Miller, 1953; Schuh & Slater, 1995). As reduviids are mostly predatory (with the exception being parasitic) and are higher up in the trophic food chain, they infrequently sighted. They are also highly cryptic in their behaviour and few are attracted to light traps (Casson & Hodkinson, 1991; Frost, 1964; Walker, 1873). A study conducted by Casson and Hodkinson (1991) found the fogging was the most effective sampling method, however it is a highly invasive method and is not permitted to be carried out.

Despite low abundances and occurrence, the assassin bugs play an important link in the ecosystem as both predators of invertebrates and in turn as a prey to other animals. Their presence offers potential insights into the types of prey and microhabitat present in an environment, much like bio-indicators (Moir and Brennan, 2007). For example, the presence of specialists like members of the family Ectrichodiinae will indicate that their prey (millipedes) can be found in the area or habitat (Forthman & Weirauch, 2012).

Mandai is located at the northern tip of the Central Catchment Nature Reserve (CCNR) in Singapore and serves as a buffer area. A variety of vegetation types are present in Mandai area, ranging from grassy areas to disturbed secondary forest and old secondary forest (Yee et al., 2011). This mix in vegetation types provide numerous microhabitats and could therefore harbour rich biodiversity (Chase, 2011; Nosil, 2012; Walter, 1991).

The Mandai area was previously surveyed for reduviids from June 2013 to February 2014 and from May 2014 to Aug 2014 prior to this Environmental Impact Assessment (EIA). However they were mainly focused on the unnamed road and the forest patch near Mandai Lake Road (N1.407915, E103.784195). The previous samplings, together with records from the Lee Kong Chian Natural History Museum (LKCNHM) yielded 23 species from seven

subfamilies. However, in the current EIA, 20 species from seven subfamilies were identified. The subfamily Harpactorinae was found to be the most specious, followed by Emesinae and Salyavatinae.

Materials and Methods

Study site. **—** The Mandai area is divided into eight zones (A, B, C, D, E, F, G and H). However, due to constraints such as permit issues and restricted access into some areas, only five zones (A, B, D, E and F) were surveyed. Zone F encompasses the Wildlife Reserves Singpaore (WRS) - Singapore Night Safari and the Zoo. The Mandai area consists of a variety of habitat types of mainly mature and disturbed secondary forest, bamboo patches and grassy plots with shrubs. It is situated north of the Central Catchment Nature Reserve (CCNR) and acts as a buffer zone for the nature reserve.

Data collection. **—** The duration of the study is carried out between 10th May to 27th October 2015. The surveys lasted one and a half hours and were carried out between 1945h to 2300h as most reduviids are nocturnal. In addition, diurnal species can also be spotted at night. GPS coordinates were taken at the start and end of each field survey. The method of active visual searching was employed and a variety of microhabitats were sampled, such as above and beneath foliage, tree bark, leaf litter and termite trails. At least one specimen per species encountered in each zone were collected and species which were not identifiable in the field were also collected for further examination.

Active visual searching was carried in various microhabitats encountered along the transects using flashlights and head torches. The microhabitats examined were the top and undersides of foliage of trees and shrubs, crevices of tree trunks and tree bark, the top layer of leaf litter, termite trails (for Salyavatinae) and spider webs (for Emesinae). The specimens were caught using containers and a net was used if they are out of reached. Occasionally, sweep netting was employed in grassy areas. At least one specimen per species encountered in each zone were collected and species which were not identifiable in the field were also collected for further examination under the microscope.

Specimens collected were killed by freezing and placed in 100% ethanol to preserve the DNA in case further molecular work is needed. The specimens will eventually be pinned and deposited in the Zoological Reference Collection (ZRC) of the LKCNHM, at the National University of Singapore. The specimens were identified to species or the lowest taxa possible using taxonomic keys and descriptions, as well as in comparison with the museum specimens. The species identification were verified with experts whenever necessary.

The images presented in this report were taken using the Visionary Digital BK Plus Lab System provided by the LKCNHM. A series of shots were taken at different depths of field and stacked using Helicon Focus software. Scale bars were included and editing were done in Adobe Photoshop CC 2014.

Statistical analysis. **—** The vegan package in R was used in plotting species accumulation curves for each zone (A, B, D, E) using Kindt exact method with 500 permutations. Non-

parametric extrapolation was done using first-order Jackknife and coverage based Chao and Lee, 1992 to estimate asymptotic species richness. Using SPECIES package in R, the range of values for species richness were obtained and reported.

Non-metric multidimensional scaling (NMDS) using Bray-Curtis was carried out to get a visual representation of the reduviid community compositions between the four zones. NMDS adopting Bray-Curtis distance was performed using 'metaMDS' function with the community package vegan 1.6-10 (Oksanen et al., 2013) in the R statistical program version R.2.15.2 (R Development Core Team, 2006). For the interpretation of patterns, only stress values of 0.20 were deemed acceptable (Clarke, 1993). The plots were ordinated on three dimensions if the stress values exceed 0.20.

Results

Species Richness

In total, twenty species from seven subfamilies are recorded (Table 1) for the five zones in Mandai. Their diverse morphology can be seen from the habitus photos under the LKCNHM Animal and Plants of Singapore site (http://nathist.science.nus.edu.sg/#A-Arth-Hexa-Hemi). Zone D has the highest species richness with ten species, followed by Zone B (9) and Zone A (8). Zone F has the least number of species recorded (2) and this could be due to the manicured environment in WRS. Specimens collected from Zone D represented seven subfamilies while those collected from Zone B represented five subfamilies and from Zone A, three subfamilies. Incidence-based species accumulation curve were carried out for all the zones (Fig. 1) as well as for each zone (A, B, D and E; Fig. 1) and asymptotic species estimation was performed (Table 2).

Table 1. Twenty species of reduviids recorded from seven subfamilies in zones A, B, D, E and F. The total number of hours (N) surveyed for each zone is provided.

Subfamily	**Species**	**Zones**				
		A (N=13.5)	**B (N=13.5)**	**D (N=10)**	**E (N=13.5)**	**F (N=8)**
Emesinae	*Emesopsis gauis*			+		
	Gardena melinarthrum	+				
	Gardena muscicapa	+	+	+		
	Tridemula plurima	+				
Harpactorinae	*Biasticus* sp.					+
	Cosmolestes picticeps		+			
	Euagoras cf. *plagiatus*		+	+		+
	Rhynocoris sp.		+			
	Sycanus sp. 1	+	+	+		
Peiratinae	*Ectomocoris atrox*		+	+		
Reduviinae	*Acanthaspis inermis*		+			
	Debris-piling nymph		+	+		
	Inara flavopicta		+	+		

Salyavatinae	*Lisarda annularis*	+			+	
	Lisarda inornata	+		+	+	
	Lisarda pallidispina	+			+	
	Lisarda rhypara	+		+	+	
Stenopodainae	*Pygolampis ridleyi*			+		
	Sastrapada sp.		+			
Tribelocephalinae	*Tribelocephala* cf. *indica*			+		
Total		8	9	10	4	2

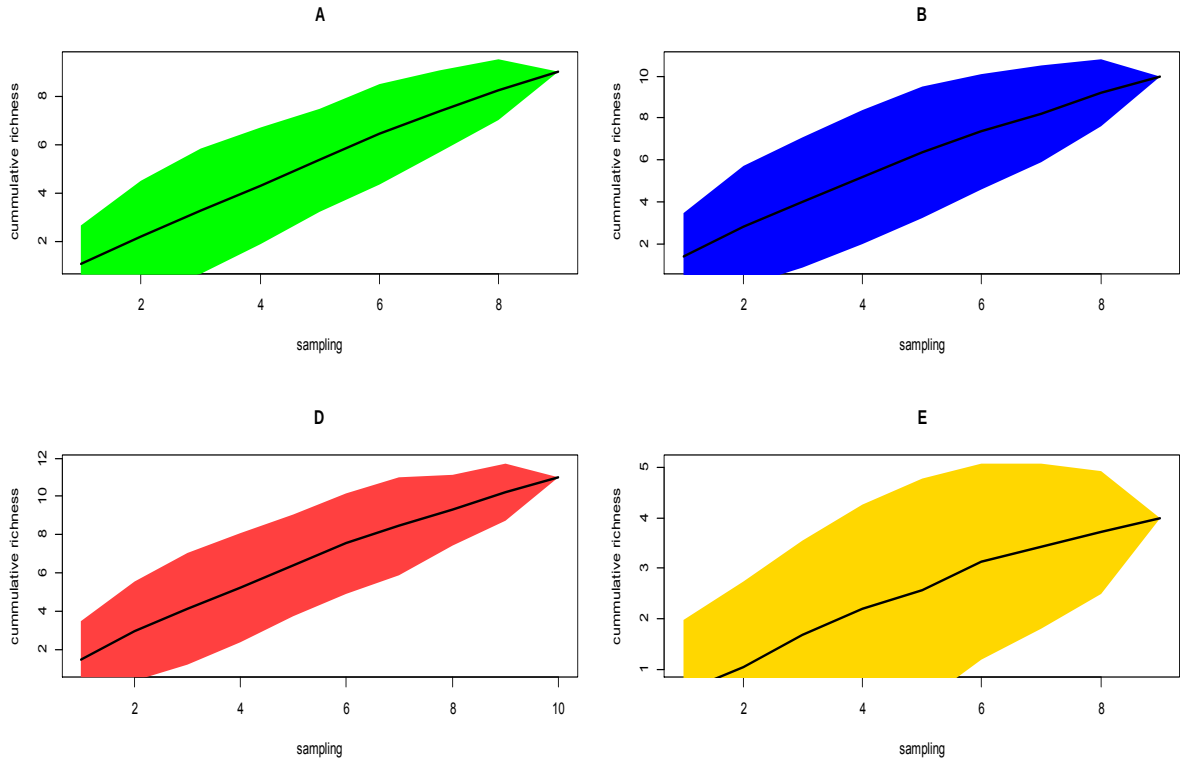


Fig. 1. Incidence-based species accumulation curves for Zones A, B, D and E respectively. Colour bars show confidence intervals.

Table 2. Non-parametric extrapolation to estimate asymptotic species richness for each zone

Zones	**A (n=13.5)**	**B (n=13.5)**	**D (n=15)**	**E (n=13.5)**	**F (n=8)**	**All Zones**
Chao & Lee 1992	12 ± 2	15 ± 1	15 ± 1	-	-	47 ± 1
Jackknife (1st order)	13 ± 2	16 ± 2	16 ± 2	-	-	48 ± 2
Actual records	8	9	10	4	2	20

(A, B, D, E and F) using two measures. The total number of hours (N) surveyed for each zone is provided.

The asymptotic species richness were estimated to be 12-13 for zone A, 15-16 for B and D. Asymptotic estimates for all zones E and F could not be carried out as there are too many null results. Overall, all the zones are estimated to have a total species diversity of 47-48 species.

Community structure/ assemblages

Despite the small sample size, the NMDS plot has a stress level of 0.00176 (< 0.20) when ordinated on two dimensions. Hence, the plot is deemed acceptable for the interpretation of patterns (Fig. 2). The four zones have a high level of overlaps for their 95% confidence interval ellipses, suggesting that community structure of reduviids in the four zones are similar with a few species unique to each zone.

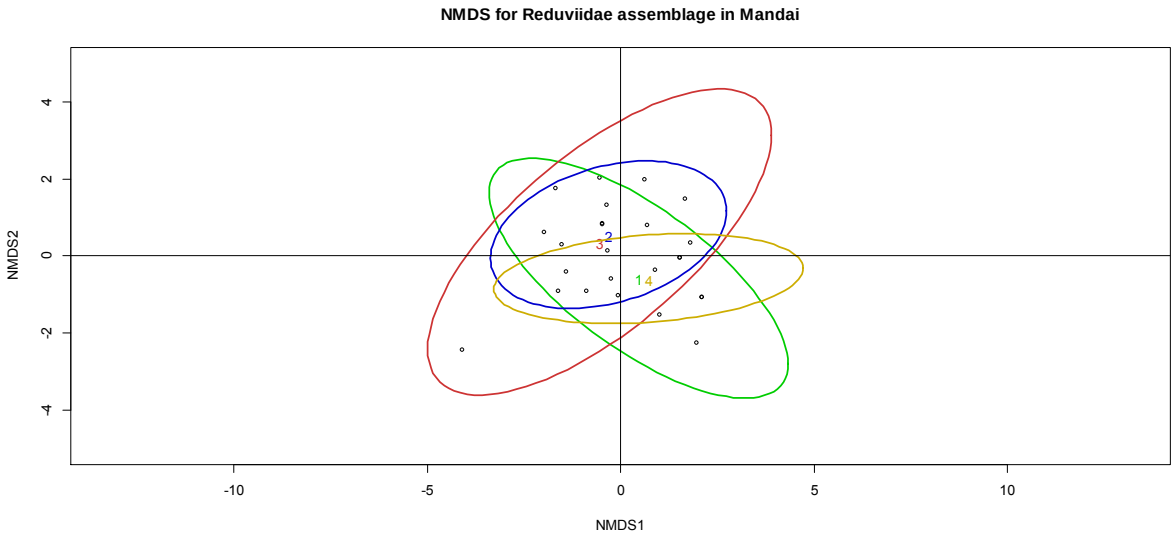


Fig. 2. Non-metric multidimensional scaling (NMDS) ordination of the community structure of reduviids in the four zones. 1 = Zone A, 2 = Zone B, 3 = Zone D, 4 = Zone E. Dimension = 2, stress-level = 0.00176.

Histograms were also plotted to show the distribution and occurrence of species (Fig. 3). The number of zones in which each species are found is defined as the distribution in this analysis. In contrast, occurrence is defined as the number of times which a species is recorded during the samplings. From the results, most of the species have a low distribution and occurrence and are encountered infrequently.

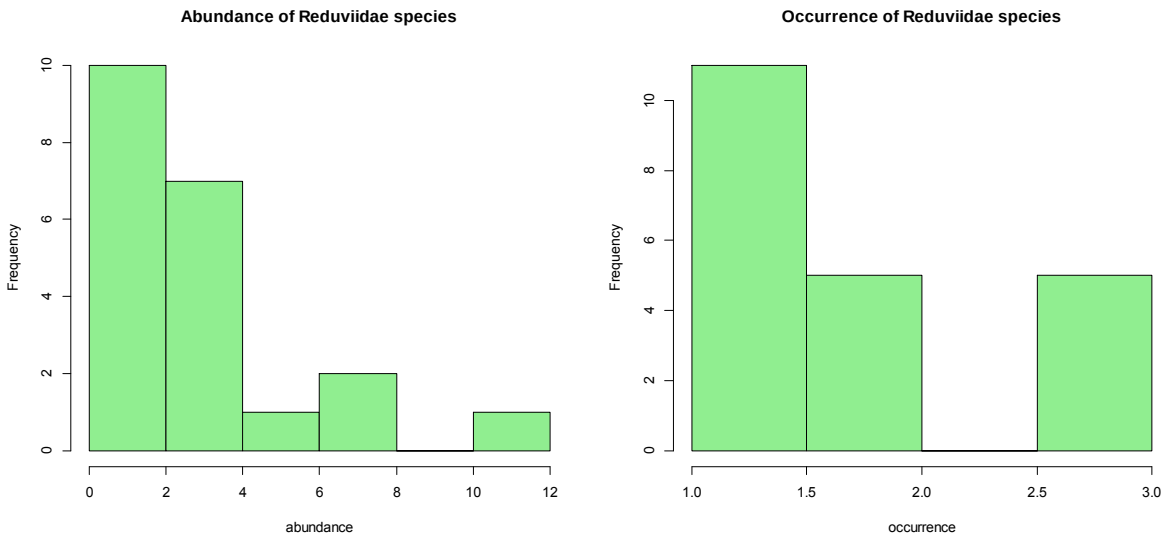


Fig. 3. Histograms showing the distribution of species (the number of zones in each species can be found at) and occurrence of species (the number of times a species was recorded during the samplings).

Discussion

From the results, a total of 20 species from seven subfamilies were recorded. In comparison to the total species diversity of 96, the Mandai area contains about 20.8% reduviids in Singapore (Yeo, unpublished). Contrasting 20 species to the 23 recorded during the preliminary EIA in May 2014, there are three lesser species. This is in part due to the constraint in sampling in area C which encompasses the entrance of an unnamed road parallel to the Project westernboundary and may result in the difference in species composition. For example, *Agyrius* cf. *podagricus* are often only found on banana trees which are located at the entrance of the unnamed road and is not included in checklist for this EIA.

Overall, all the zones are estimated to have a total species diversity of 47-48 species. In comparison to the actual number of species recorded during this EIA, the asymptotic estimate of the number of species is higher, suggesting that there are more species that have not been sighted during this EIA.

Species composition were found to be similar in all the zones with the exception of a few species which are unique to each zone. This could be due to the result of a small sample size and it might even out with more sampling effort. However, the multivariate analysis using NMDS accounts only for taxonomic units. It does not take into account the life history traits, guilds, or niche specialisations (Cao, Larsen, & Thorne, 2001; Van den Brink et al., 2011). In zone E, the overlapping area suggest that the species composition is a small subset of the rest of the zones and consists of mainly the Salyavatinae under the genus *Lisarda*.

From the results, most species of reduviids have a low distribution and occurrence and are encountered infrequently. This corresponds with their cryptic, hiding behaviour (Haridass, 1985; Louis, 1974) and their low abundance due to their predatory nature and trophic level

(Cohen, Jonsson, & Carpenter, 2003; Jonsson, Cohen, & Carpenter, 2005). As the development of the Mandai area will likely result in habitat loss and fragmentation, species with low distribution and occurrence will be impacted due to various factors such as fragment size, fragment isolation and edge effects. Many forested species avoid edges due to the difference in microclimate and as a result are unable to disperse to more favourable habitats thus limiting gene flow and eventually local extinction (Ewers, Thorpe, & Didham, 2007; Tscharntke, Steffan-Dewenter, Kruess, & Thies, 2002). Some examples of potential assassin bugs which might be unable to cross matrices and move between fragments effectively are *Acanthaspis inermis* which are often under the tree bark of mature trees, *Sastrapada* sp. which is brachypterous and *Tribelocephala* cf. *indica* which dwells in leaf litter. Species which are closely associated with a habitat might be affected, such as *Agyrius* cf. *podagricus* which are often found on banana plants. In the long run, the effects of fragmentation include the dominance of few abundant species and the gradual replacement of specialists with generalists (Eskildsen et al., 2015).

A notable species found during the sampling is *Tribelocephala* cf. *indica* (Fig. 4). The subfamily Tribelocephalinae is known to be highly cryptic, soil-dwelling species. There are only 124 species described worldwide thus far as compared to an estimate of 6800 reduviid species (Capriles, 1990). The subfamily was last found and recorded in Singapore by Professor DH Murphy (Murphy, unpublished). He identified two species to the genus of *Opisthoplatys,* although the specimens were not found in the LKCNHM and verification is not yet possible. An assassin bug expert was consulted and hence this may serve as the first record of the genus *Tribelocephala* in Singapore (Hwang, pers. comm.)

Fig. 4. *Tribelocephala* cf. *indica* found in Mandai.

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Annex 14.9

Orthoptera

Environmental Impact Assessment (EIA) report 2015: Orthoptera (grasshoppers, crickets and katydids) of Mandai forest

Tan Ming Kai

Abstract. Orthopterans are important drivers in ecosystems and play numerous ecological roles. Given that orthopterans have specialised requirements for vegetation structure and microclimate, they can be good indicators of vegetation change. 86 species were recorded from the six zones within Mandai forest and Wildlife Reserve Singapore. Zone D has the highest richness of 51 species recorded. Species accumulation curves indicate that there are still many more species that are undiscovered from the sampling effort. The NMDS plots show that Zone A has the most distinct community structure. Most species are encountered only rarely (low occurrence and low distribution). Key recommendations include: (1) provide corridors or connections (via vegetation between different zones), (2) maintain plant diversity and layers of vertical stratification and (3) provide buffer zones surrounding these preserved natural vegetation.

Introduction

Orthoptera refers to an order of insects including grasshoppers, crickets and katydids. They are among the most diverse (around 27,000 species worldwide) and common terrestrial macro-invertebrates (Eades, Otte, Cigliano, & Braun, 2015; Samways, 1997). These insects can be found in most terrestrial habitats, from the dipterocarp forests and grasslands to mangroves and coastal forests, and even highly urbanised areas. Orthopterans also occupy a diverse array of microhabitats, from subterranean and leaf litters to canopy and streams. Many species have interesting biology, including phenotypic plasticity and have the largest genomes among insects (Gotham & Song, 2013; Hanrahan & Johnston, 2011).

Orthoptera can be a useful group for bioindicators. This is because they are: (1) diverse and abundant; (2) important drivers of ecosystems and (3) good indicators of vegetation change. Being diverse in nearly every habitat and microhabitat (especially in biodiverse Southeast Asia), orthopterans are important players in ecosystems and play numerous ecological roles. Orthopterans are also important drivers of ecosystem processes as primary consumers, prey to predators and even pollinate flowers (Lockwood, 1998; Micheneau et al., 2010; Quinn, Johnson, Butterfield, & Walgenbach, 1993; Samways, 1997; Yang & Gratton, 2014). As

important prey of insectivorous birds and herptiles, diversity of orthopterans can influence that of other charismatic and keystone species (Belovsky & Slade, 1993). Moreover, given that orthopterans have specialised resource use depending on the vegetation structure and microclimate, they can be good indicators of vegetation change (Bazelet & Samways, 2011; Fartmann, Krämer, Stelzner, & Poniatowski, 2012; Gardiner & Dover, 2008; Gardiner, Pye, Field, & Hill, 2002; Joern, 1979, 1982). Given that most species can be found at night, opportunistic samplings near the ground and within human height along with light trapping to attract canopy species would provide a representative data.

Material and Methods

Sampling

The study duration ranged about five months from April to October 2015. Nocturnal surveys between 1930–2230 hours were conducted approximately once a week. Each survey will last for 1.5 hours. Opportunistic sampling of adult and nymph orthopterans was conducted up to 5 m into the vegetation on either side of the transect, and up to 2 m above ground for 30 minutes. This involved searching vegetation, sweeping vegetation, breaking off branches and examining the interior, and locating calls. Specimens that could not be identified in the field were collected and euthanized for closer examination. They were subsequently deposited in the Zoological Reference Collection (ZRC) of the Lee Kong Chian Natural History Museum (LKCNHM), National University of Singapore.

Statistical analysis

Species accumulation curves using Kindt exact method were plotted using vegan package in R with 500 permutations. To estimate asymptotic species richness, non-parametric extrapolation was done using first-order Jackknife, coverage based Chao and Lee 1992. Range of values obtained from the different methods were reported. This was done using SPECIES package in R.

To visualise the differences in the orthopteran community compositions between the four zones (A, B, D, E) , non-metric multidimensional scaling (NMDS) using Bray-Curtis distance was performed using the ‘metaMDS’ function implemented with the community package vegan version 1.6-10 (Oksanen et al., 2013) in the R statistical program version R.2.15.2 (R

Development Core Team, 2006). Stress values of 0.20 and below are deemed acceptable for interpretation of patterns (Clarke, 1993), and where this was exceeded, the plots were ordinated on three dimensions.

Results

Species richness

In total, 86 species were recorded from the six zones within Mandai forest and Wildlife Reserve Singapore. Zone D has the highest richness of 51 species recorded. Eleven species were recorded in Singapore Zoological Garden; 12 in the Night Safari. Incidence-based species accumulation curves (Fig. 1) and asymptotic species estimation (Table 1) are performed on Zones A, B, D and E. The species accumulation curves indicate that there are still many more species that are undiscovered from the sampling effort. This suggests that the actual recording of species from the different zones are an underestimation of the diversity in Mandai. Species estimation using first order Jackknife and Chao & Lee (1992) also suggest the same. The values produced from the estimation indicated a much higher value than what was recorded during the sampling. The list of species found can be found in Table 2. The rare (32 species) and endemic (10 species) species are noted with special remarks.

Community structure/ assemblages

NMDS ordination was performed for the four zones (A, B, D and E). The Zoo and Night Safari are omitted because the inter-spatial noise between manicured and natural vegetation is too large for reasonable interpretation. NMDS plot ordinated on two dimensions has a stress level of 0.157 and is deemed acceptable for interpretation of patterns (Clarke, 1993) (Fig. 2). The NMDS plots show that Zone A has the most distinct community structure (with little overlap in 95% confidence interval ellipse with other zones). Zones B and D have the most overlap for their respective 95% confidence interval ellipses, suggesting that the community structure of the orthopterans in the zones are similar.

Histograms showing the distribution and occurrence of species were also plotted (Fig. 3). Distribution here is a function of the number of zones in which each species can be found. Occurrence here is a function of the number of times during the sampling at which a species was recorded. General observation is that the most species are encountered only rarely (low

occurrence and low distribution). This shows that the diversity of orthopterans in Mandai is currently a healthy one. Effects of fragmentation include the dominance of few abundant species and the gradual replacement of specialists with generalists (Tscharntke, Steffan - Dewenter, Kruess, & Thies, 2002).

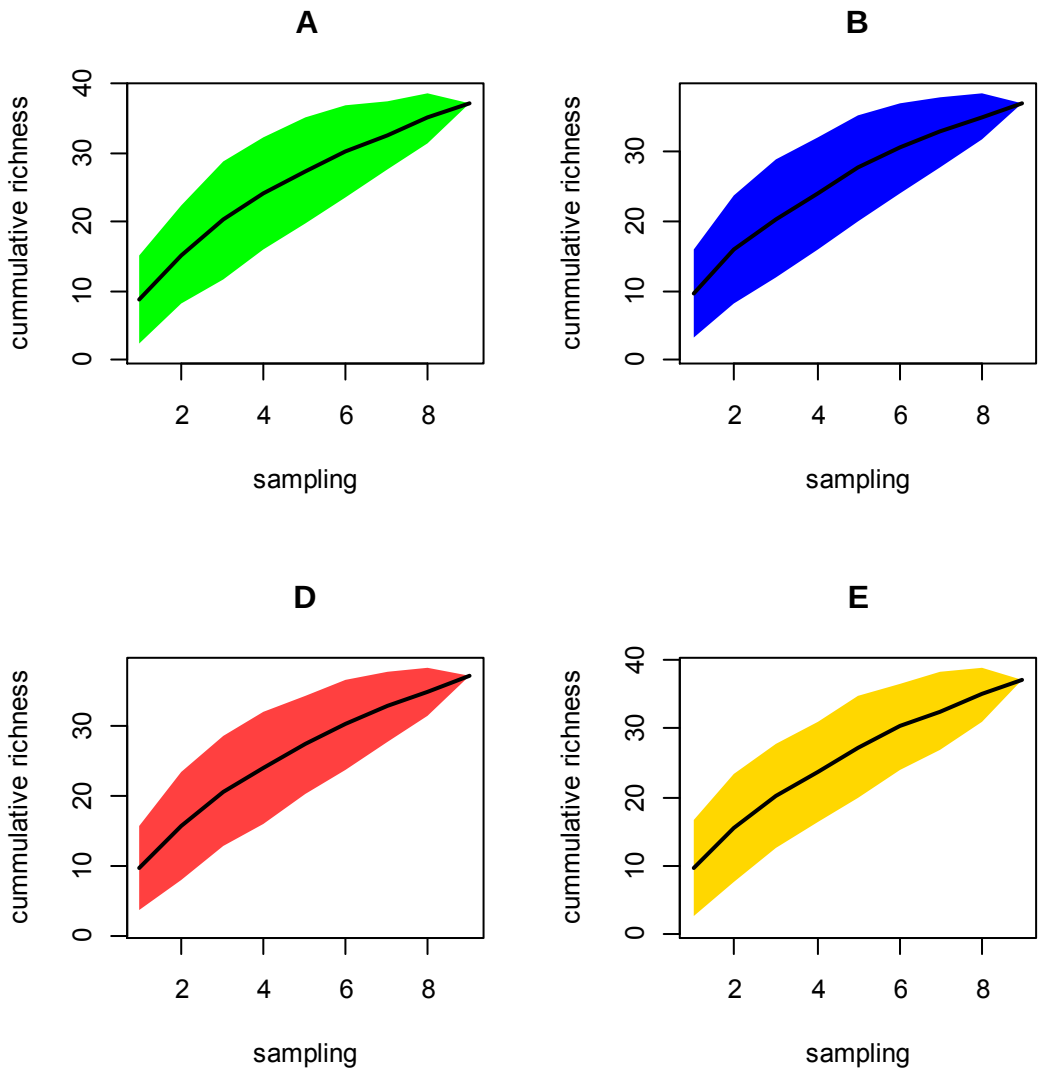

Fig. 1. Species accumulation curves for Zones A, B, D and E. Colour bars show confidence intervals.

Table 1. Non-parametric extrapolation to estimate asymptotic species richness for each zone using two measures. Actual recordings of the number of species in each zone are also provided.

	A (n=9)	B (n=9)	D (n=9)	E (n=9)
Chao & Lee 1992	79 ± 2	165 ± 4	158 ± 3	97 ± 3
Jackknife (1st order)	85 ± 4	195 ± 12	168 ± 5	105 ± 5
Actual records	37	47	51	38

Table 2. Checklist of Orthoptera from different zones of Mandai area. The number represents the occurrence of the species in the respective zones. Species highlighted yellow represent rare species (due to low occurrence and restricted distribution) Species with '^^^" represent species currently known only to Singapore (endemic).

Taxon	Zones					
	A (n=9)	B (n=9)	D (n=9)	E (n=9)	NS (n=2)	Z (n=3)
Agraeciini sp. 1						1
Aiolopus thalassinus tamulus (Fabricius, 1798)			1			
Alloteratura sp. 1	1	3	1	2		
Amusurgus sp. 1	3		1	4	1	1
Arnobia pilipes tropica Gorochov, 1998		2		2	1	
Apalacris varicornis Walker, 1870		3	1	2		
Apterornebius sp. 1	5	2		1		
Aphonoides sp. 1	4	1	1	1		
Aphonoides sp. 2	1	1	1	1		
Asiophlugis temasek temasek Gorochov & Tan, 2011 ^^^	1	1		1		
Asiophlugis thaumasia (Hebard, 1922) ^^^				1		
Atractomorpha sp. 1		4	1			
Cardiodactylus singapura Robillard, 2011	4	2		2		
Chondroderella borneensis (Brunner von Wattenwyl, 1895)		2	1	3		
Conocephalus (Anisoptera) longipennis (Haan, 1842)		1	2			1
Conocephalus (Anisoptera) maculatus (Le Guillou, 1841)		8	6	2	1	
Conocephalus (Anisoptera) melaenus (Haan, 1842)	1		7	5	1	2
Conocephalus sp. 1		3	2			
Coptotettix sp. 1	1	1	4		1	
Coptotettix sp. 1		3				
Criotettix cf. robustus (Hancock, 1907)				1		
Cycloptiloides timah Ingrisch, 2006 ^^^	5	6				
Ducetia japonica (Thunberg, 1815)			5			
Duolandrevus sp. 1	2			1		
Duolandrevus (Surdolandrevus) sp. 1	1	1				
Euconocephalus sp. 1		3	1			1
Euconocephalus nasutus (Thunberg, 1815)		1				
Euconocephalus pallidus (Redtenbacher, 1891)		2				
Euconocephalus picteti (Redtenbacher, 1891)			1	1		
Euconocephalus varius (Walker, 1869)		5	2			
Euscyrtus (Osus) concinnus (Haan, 1842)	1	6	8	4		1
Elimaea (Elimaea) chloris (Haan, 1842)		4	3	1		
Euparatettix sp. 1	2	8	3			
Erianthus sp. 1			5	5	1	
Ectatoderus angusticollis Chopard, 1969	2	2		1		
Gryllacris (signifera group) sp. 1	1		2			
Gryllacris sp. 1	1	1				
Gymnogryllus cf. angustus (Saussure, 1877)	1					
Gymnogryllus malayanus Desutter-Grandcolas, 1996 ^^^	1					
Gesonula mundata mundata (Walker, 1870)		1	1			

Gryllotalpa nymphicus Tan, 2012 ^^^		1				
Holochlora sp. 1		1				
Homoeoxipha lycoides (Walker, 1869)		5	2	1		
Hexacentrus unicolor Serville, 1831			8	2		
Hedotettix gracilis (Haan, 1842)			1			
Jambiliara selita Ingrisch & Tan, 2012 ^^^	1					
Lucretilis sp. 1	1					
Lipotactes maculatus Hebard, 1922	6	4		4		
Loxoblemmus parabolicus Saussure, 1877		9				
Mecopoda elongata (Linnaeus, 1758)	1		6	5	1	
Meconematini sp. 1	3	1				
Macedna martini Karsch, 1891	2					
Meltripata picta Bolívar, 1923		1	1			
Natula longipennis		8		1		
Nisitrus vittatus (Haan, 1842)	4		7	8	1	2
Oceaniphisis sp. 1	1					
Ornebius cf. pullus Ingrisch, 2006	4			2	1	
Ornebius albipalpus Ingrisch, 2006	3					
Oxya hyla intricata (Stål, 1861)		4	1			
Oxya japonica japonica (Thunberg, 1815)		8	3	2		1
Phlaeoba antennata Brunner von Wattenwyl, 1893			5	6		
Phlaeoba infumata Brunner von Wattenwyl, 1893			1			
Pteronemobius sp. 1		1		1		
Phaneroptera (Phaneroptera) brevis (Serville, 1838)		7	4			
Pseudoxya diminuta (Walker, 1871)	1		5	5	1	
Phaesticus insularis (Hancock, 1907)	1					
Pareuthymia sp. 1	1					
Peracca (Peracca) macritchiensis Tan & Ingrisch, 2014	4					
Patiscus malayanus Chopard, 1969		1	2			
Rhaphidophora sp. 1	2	1	1			
Sclerogryllus sp. 1			2			
Sonotrella (Calyptotrella) bipunctata (Chopard, 1969)			1	1		
Sonotrella (Megatrella) typica Gorochov, 2002 ^^^				1		
Singapuriola separata Gorochov & Tan, 2012 ^^^		5	1			
Svistella sp. 1	2	4	9	1	1	1
Svistella sp. 2			3			
Svistella sp. 3	1					
Teleogryllus sp. 1			1			
Trilophidia annulata (Thunberg, 1815)		2	2			
Tremellia timah timah Gorochov & Tan, 2012 ^^^		2	6	1		
Traulia azureipennis (Serville, 1838)			3	2		
Valanga nigricornis (Burmeister, 1838)		7	2			
Velarifictorus (Velarifictorus) aspersus aspersus (Walker, 1869)			4			1
Varitrella (Cantotrella) orion Tan & Gorochov, 2014 ^^^		8	1			
Xenocatantops humilis (Serville, 1838)			9	8	1	2
Xiphidiopsis (Xiphidiopsis) sp. 1	1		2	1		

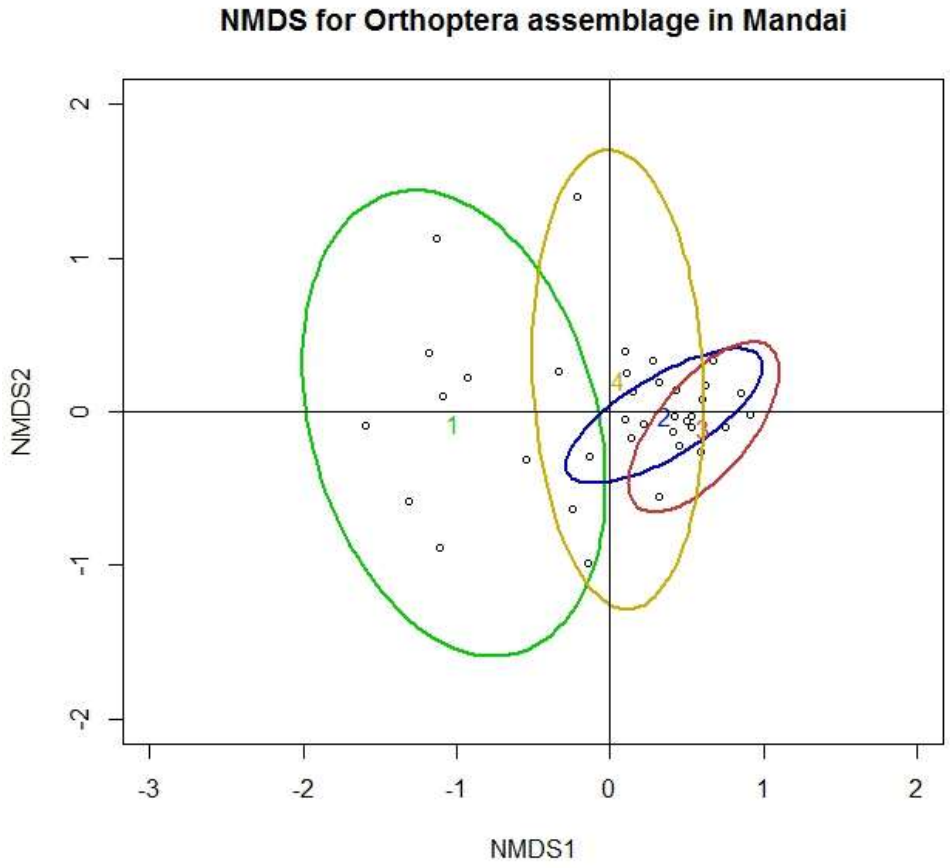

Fig. 2. Non-metric multidimensional scaling (NMDS) ordination of the community structure of orthopterans in the four zones. 1 = A, 2 = B, 3 = D, 4 = E. Dimension = 2, stress-level = 0.157.

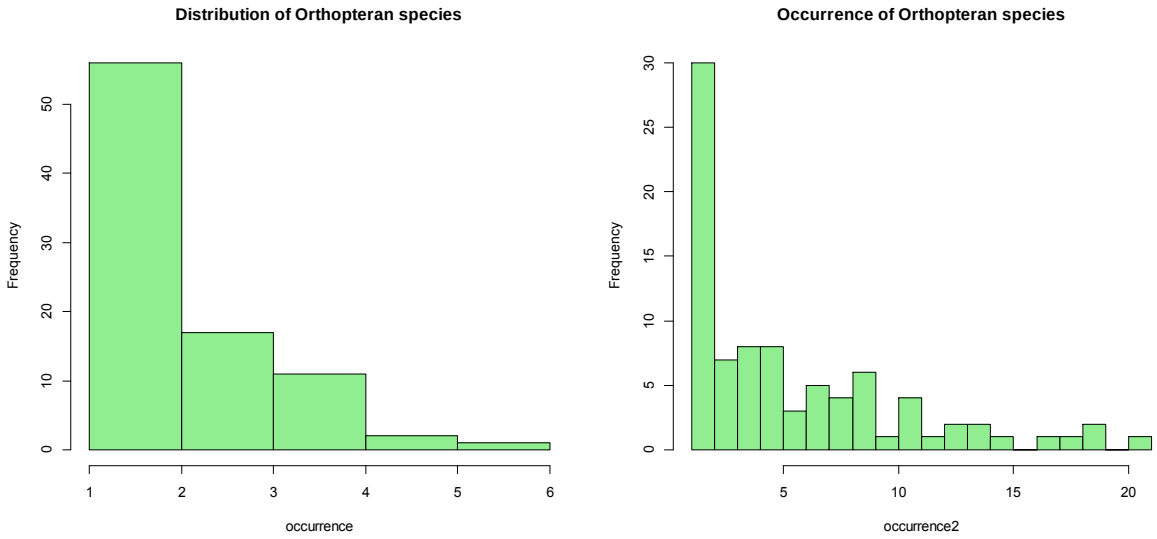

Fig. 3. Histograms showing the distribution of species (number of zones in which each species can be found) and occurrence of species (number of times during the sampling at which a species was recorded.

Discussion and recommendations

Summary of findings

Tan et al. (2015) reported 84 species from Mandai area from sampling and known literature. This is comparable to the species richness (86 species) found in this current assessment. The richness in Mandai area constitute a fair representation of total species richness recorded in Bukit Timah and Central Catchment Nature Reserve (150 species) (Tan, 2012a, 2012b). The community structure in different zones of the Mandai area are slightly different as indicated by the NMDS and Table 2. This suggests that different parts of Mandai area support a different community of orthopterans. It was also found that most species recorded in Mandai area are rare (low occurrence and/or with limited distribution).

Recommendations

1. Pure habitat loss, fragmentation isolation, small fragment size and edge effect greatly affect insect diversity (Tscharntke et al., 2002). Development of Mandai will lead to these impacts. To minimise impact on orthopteran diversity due to the development of the area, it is recommended to maintain natural vegetation in different zones and provide corridors or connections (via vegetation between different zones). This allow migration of species between different parts of the affected Mandai. This will minimise fragmentation isolation. Edge effect can also then be reduced. Connections should also be provided to the adjacent nature reserve. This is because isolated preserved vegetation within the development can lead to sink population (loss of genetic diversity and eventual local extinction of populations).
2. Orthoptera are known to have strong association with plants (Gangwere, 1961; Joern, 1982). Herbivores are generally known to maintain or enhance plant diversity via direct and indirect effect on plant competition (Olff & Ritchie, 1998). Management of herbivores thus is an important component in effort in conservation of plant diversity and hence biodiversity in general (Olff & Ritchie, 1998). Plant diversity is necessary to maintain orthopteran diversity and vice versa (Olff & Ritchie, 1998). It is recommended to maintain a diversity of natural vegetation. This is especially the case because most species are rare and are likely to be specific to microhabitat the vegetation creates. It is recommended that plant diversity should be maintained. Different layers of vertical stratification found in tropical forests should also be preserved.
3. Quality of fragments and landscape mosaics also determine effect of development on insect populations (Tscharntke, Klein, Kruess, Steffan-Dewenter, & Thies, 2005;

Tscharntke et al., 2002). It is important to minimise impact of preserved natural vegetation by providing buffer zones surrounding these preserved natural vegetation. Buffer zones should also be provided between the development and the adjacent nature reserve because development in Mandai can also affect the insect diversity from the adjacent nature reserve.

Conclusion

Mandai yields a high diversity of specialist orthopterans which represent a substantial diversity in BTNR and CCNR. This shows that the population there is a healthy one. Any large scale disturbance will affect the population there. As such, suggestions are provided here to minimise impact on the orthopteran population and also other interacting species in Mandai.

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Annex 14.10

Aquatic fauna

Survey of the freshwater fish and decapod crustaceans of the Mandai Lake area

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Summary

A total of 22 freshwater fish species (12 native and 10 non-native species) and 6 decapod crustaceans (3 native and 3 non-native species), along with incidental sightings of 4 reptile species (2 native and 2 non-native species), were obtained from this present series of surveys from May to October 2015. Amongst the native fish species obtained, only 4 are associated with forested habitat systems; and they are: *Rasbora einthovenii* and *R. elegans* (Cyprinidae), *Betta pugnax* (Osphronemidae) and *Channa lucius* (Channidae). Amongst the native decapod crustaceans obtained, only 2 species are associated with forested habitat systems; and they are: *Irmengardia johnsoni* (Gercarcinucidae; endemic to Singapore) and *Geosesarma perracae* (Sesarmidae). Amongst the aquatic habitats surveyed, the remnant swamp forest habitat (linking to reservoir inlet nearer to Lorong Lada Hitam) in Area H is highlighted, as it contains 3 forest habitat fish species (out of 4 species obtained).

The aquatic habitats linked to the Upper Seletar Reservoir (in areas A and F) contain a high proportion of non-native fish and decapod crustacean species: area A with 38 % (5 out of 13 species) and 50 % (2 out of 4 species) respectively; and area F with 38 % (3 out of 8 species) and 50 % (2 out of 4 species) respectively. These habitats from areas A and F also contain the highest number of fish species (13 and 8 respectively), due to the physical linkage to the reservoir.

The stream in area D also contains a high proportion of non-native fish species – 50 % (3 out of 6 species), possibly due to its open terrain in disturbed habitat. Interestingly, no decapod crustaceans were obtained from the stream in area D.

The two aquatic habitats in area H used to be streamlines but due to the impoundment of Seletar River to form the Upper Seletar Reservoir, these have become mainly stagnant water pools. The aquatic habitat further away from Lorong Lada Hitam is more exposed and display signs of recreational fishing (monofilament lines, discarded netting material, discarded fish traps). This habitat has a high proportion of non-native fish species – 50 % (2 out of 4 species). The other aquatic habitat (discussed earlier herein) nearer to Lorong Lada Hitam is shaded and has swamp forest floral elements (e.g. *Lasia spinosus*) growing along the water margin.

SUMMARY OF SURVEY RESULTS

Family	Species	Area A	Area D	Area F	Area H	Less than 10 individuals	More than 11 individuals	Distribution status	Local conservation status
FISH									
Osteoglossidae	*Scleropages formosus*	+				+		Non-native	None CITES I
Cyprinidae	*Barbodes rhombeus*		+				+	Non-native	None
Cyprinidae	*Brachydanio albolineatus*		+				+	Non-native	None
Cyprinidae	*Rasbora borapetensis*				+		+	Non-native	None
Cyprinidae	*Rasbora einthovenii*	+		*	+		+	Native	Restricted but common
Cyprinidae	*Rasbora elegans*				+	+		Native	Restricted but common
Clariidae	*Clarias batrachus*		+			+		Native	Widespread and common
Synbranchidae	*Monopterus javanensis*		+			+		Native	Widespread and common
Zenarchopteridae	*Dermogenys collettei*	+		+			+	Native	Widespread and common
Poeciliidae	*Gambusia affinis*	+		*		+		Non-native	None
Poeciliidae	*Poecilia reticulata*		+				+	Non-native	None
Cichlidae	*Acarichthys heckelli*	+				+		Non-native	None
Cichlidae	*Cichlasoma urophthalmum*				+	+		Non-native	None
Eleotridae	*Oxyeleotris marmorata*	+				+		Native	Widespread and common
Gobinellidae	*Brachygobius sabanus*	+		*			+	Non-native	None
Gobinellidae	*Eugnathogobius siamensis*	**						Native	Restricted and rare
Gobinellidae	*Gobiopterus brachypterus*	**						Native	Widespread and common

Gobinellidae	*Rhinogobius giurinus*	+		*		+		Non-native	None
Osphronemidae	*Betta pugnax*			+	+		+	Native	Restricted but common
Osphronemidae	*Trichopsis vittata*	+	+		+		+	Native	Widespread but uncommon
Channidae	*Channa lucius*	+		*	+	+		Native	Restricted and rare
Channidae	*Channa striata*	+		+	+		+	Native	Widespread and common
CRUSTACEAN									
Atyidae	*Caridina johnsoni*	+					+	Native	Widespread and common
Palaemonidae	*Macrobrachium lankesteri*				+		+	Non-native	None
Palaemonidae	*Macrobrachium nipponense*	+		*			+	Non-native	None
Parastacidae	*Cherax quadricarinatus*	+		+			+	Non-native	None
Gercarcinucidae	*Irmengardia johnsoni*			+			+	Native	Endangered **Endemic to Singapore**
Sesarmidae	*Geosesarma perracae*	+		*		+		Native	Restricted but common
REPTILE									
Emydidae	*Trachemys scripta elegans*	+			+	+		Non-native	None
Geoemydidae	*Siebenrockiella crassicollis*				+	+		Non-native	None
Trionychidae	*Amyda ornata*		+			+		Native	Restricted and Uncommon
Varanidae	*Varanus salvator*		+			+		Native	Widespread and common
		Area A	**Area D**	**Area F**	**Area H**				
Total number of species (a+b+c)		18	8	12	11				
a. FISH		13	6	8	8				
b. CRUSTACEAN		4	0	4	1				

c. REPTILE	1	2	0	2				
Proportion of native: non-native species	**Area A**	**Area D**	**Area F**	**Area H**				
FISH	8:5	3:3	5:3	6:2				
CRUSTACEAN	2:2	-	2:2	-				

* obtained from a survey conducted in 2013; ** obtained from rapid surveys conducted in 2014.

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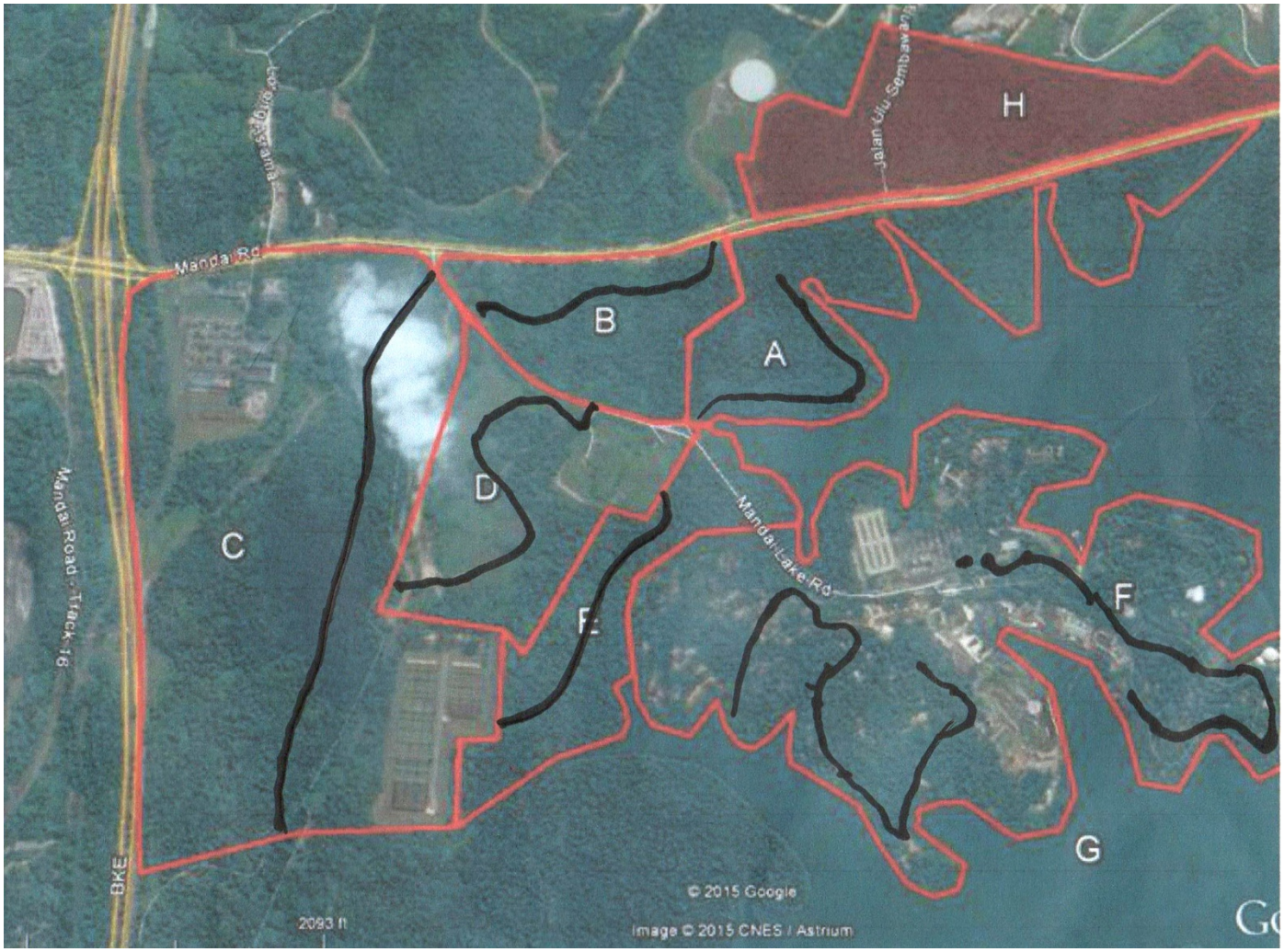


Map showing survey sections A to G. Streamlines in sections A, D, F and H surveyed (black lines refer to terrestrial transects by other teams).

Individual Survey Results

AREA A

28 July 2015 – **Area A** furthest eastern inlet stream

Mandai03 - 01°24.880'N 103°47.834'E; Mandai04 – 01°24.878'N 103°47.831'E; Mandai05 – 01°24.879'N 103°47.806'E

Mandai03 and Mandai04: headwater section, stagnant pools of water over sandy substratum with roadside debris, closed canopy of oil palms

Mandai05: clear flowing water section, over sandy, silt and clay bottom with roadside debris; partial canopy of riparian vegetation and oil palms

Push net, 30 m stretch, 30 min (Mandai05). [Mandai03 and Mandai04 stretch had no fish or decapods in the stagnant water pools]

Family	**Species**	**0-5**	**5-10**	**10-50**	**50-100**	**>100**	**status**	**Local conservation status**
Fish								
Cyprinidae	*Rasbora einthovenii*				+		Native	Restricted but common
Channidae	*Channa lucius*	+					Native	Restricted and rare
Crustacean								
Parastacidae	*Cherax quadricarinatus*	+					Non-native	None

Comments: for both native fish species, only juveniles were obtained for the second species; for non-native crustacean species, only juveniles were obtained (proportion of catch not noted).

28 July 2015 – **Area A** inner inlet stream

Mandai06 – 01°24.650'N 103°47.202'E; stagnant clear water over submerged leaf litter, clay and silty bottom; closed canopy of riparian vegetation

Push net, 20 m stretch, 30 min

Family	**Species**	**0-5**	**5-10**	**10-50**	**50-100**	**>100**	**Distribution status**	**Local conservation status**
Fish								
Cyprinidae	*Rasbora einthovenii*	+					Native	Restricted but common
Zenarchopteridae	*Dermogenys collettei*			+			Native	Widespread and common
Poeciliidae	*Gambusia affinis*		+				Non-native	None
Eleotridae	*Oxyeleotris marmorata*	+					Native	Widespread and common
Gobinellidae	*Brachygobius sabanus*			+			Non-native	None
Gobinellidae	*Rhinogobius giurinus*	+					Non-native	None
Osphronemidae	*Trichopsis vittata*	+					Native	Widespread but uncommon
Crustacean								
Atyidae	*Caridina johnsoni*			+			Native	Widespread and common
Palaemonidae	*Macrobrachium nipponense*		+				Non-native	None
Parastacidae	*Cherax quadricarinatus*	+					Non-native	None

Comments: for all native fish species, only juveniles were obtained; for non-native fish species, both adults and juveniles were obtained; for all crustacean species, both adult and juvenile were obtained (proportion of catch not noted).

Other subjects: *Leptobrachium nigrops* tadpoles (numerous, >10)

28 July 2015 – **Area** A innermost inlet stream next to sluice drain along Mandai Lake Road

Mandai07 – 01°24.448'N 103°47.047'E; dried up swampy area next to sluice drain leading into Upper Seletar Reservoir

Family	Species	0-5	5-10	10-50	50-100	>100	Distribution status	Local conservation status
None								

13 August 2015 – **Area A** furthest eastern inlet stream

Mandai11: clear flowing water section, over sandy, silt and clay bottom with roadside debris; partial canopy of riparian vegetation and oil palms

Push net, 30 m stretch, 30 min

Family	Species	0-5	5-10	10-50	50-100	>100	status	Local conservation status
Fish								
Cyprinidae	*Rasbora einthovenii*			+			Native	Restricted but common
Crustacean								
Parastacidae	*Cherax quadricarinatus*		+				Non-native	None
Sesarmidae	*Geosesarma perracae* (sighted)	+					Native	Restricted but common

Comments: for the native fish species, both juveniles and adults were obtained; for native crustacean species, only one juvenile was sighted; non-native crustacean species, only juveniles was obtained (proportion of catch not noted). Spawn of Malayan Giant frog sighted along streamline.

13 August 2015 – **Area A** inner inlet stream

Mandai06 – 01°24.650'N 103°47.202'E; stagnant clear water over submerged leaf litter, clay and silty bottom; closed canopy of riparian vegetation

Push net, 20 m stretch, 30 min

Family	**Species**	**0-5**	**5-10**	**10-50**	**50-100**	**>100**	**Distribution status**	**Local conservation status**
Fish								
Osteoglossidae	*Scleropages formosus*	+					Non-native	None CITES I
Zenarchopteridae	*Dermogenys collettei*			+			Native	Widespread and common
Poeciliidae	*Gambusia affinis*		+				Non-native	None
Cichlidae	*Acarichthys heckelii*	+					Non-native	None
Eleotridae	*Oxyeleotris marmorata*	+					Native	Widespread and common
Gobinellidae	*Brachygobius sabanus*		+				Non-native	None
Gobinellidae	*Rhinogobius giurinus*	+					Non-native	None
Osphronemidae	*Trichopsis vittata*	+					Native	Widespread but uncommon
Crustacean								
Atyidae	*Caridina johnsoni*				+		Native	Widespread and common
Palaemonidae	*Macrobrachium nipponense*		+				Non-native	None
Reptile								
Emydidae	*Trachemys scripta elegans*	+					Non-native	None

Comments: for all native fish species, both juveniles and adults were obtained; for non-native fish species, both juveniles and adults were obtained; for all crustacean species, both adult and juvenile were obtained (proportion of catch not noted). Note for *Scleropages formosus*, only a subadult was sighted, which quickly swam out of the inlet. Note for *Trachemys scripta elegans*, 3 adults were sighted basking on half-submerged tree trunk at mouth of inlet.

7-8 September 2015 – **Area A** furthest inlet stream

Mandai13 (01°24.878'N 103°47.802'E): clear flowing water section, over sandy, silt and clay bottom with roadside debris; partial canopy of riparian vegetation and oil palms

Push net, 30 m stretch, 30 min

Family	**Species**	**0-5**	**5-10**	**10-50**	**50-100**	**>100**	**status**	**Local conservation status**
Fish								
Cyprinidae	*Rasbora einthovenii*			+			Native	Restricted but common
Zenarchopteridae	*Dermogenys collettei*	+					Native	Widespread and common
Channidae	*Channa lucius*	+					Native	Restricted and rare
Crustacean								
Parastacidae	*Cherax quadricarinatus*		+				Non-native	None

Comments: for native fish species, only adults were obtained; for non-native crustacean species, only juvenile was obtained.

AREA D

18 June 2015 – **Area D** stream (01°24.284'N 103°46.734'E)

Open country stream running parallel to the Project western boundary; clear flowing water over sandy mud base; overgrown bank vegetation.

Push net, 25 m stretch, 30 min [Md01]

Family	Species	0-5	5-10	10-50	50-100	>100	Distribution status	Local conservation status
Fish								
Cyprinidae	*Barbodes rhombeus*			+			Non-native	none
Cyprinidae	*Brachydanio albolineatus*				+		Non-native	none
Clariidae	*Clarias batrachus*	+					Native	Widespread and common
Synbranchidae	*Monopterus javanensis*	+					Native	Widespread and common
Poeciliidae	*Poecilia reticulata*					+	Non-native	none

Comments on fish: for all native species, only juveniles were obtained; for non-native species, both adults and juveniles were obtained (proportion of catch not noted).

Other subjects: Buffalo leech (3), Baya Weaver (2 nests), Changeable Hawk-eagle (1)

25 June 2015 – **Area D** stream, next to cycling track (1°24.239'N 103°46.716'E)

Small stream cutting under cycling track next to the Project western boundary; shaded clear water pools, slow flowing, over sandy base; overgrown bank vegetation

Long handled scoop net, 20 scoops, 30 min

Family	Species	0-5	5-10	10-50	50-100	>100	status	Local conservation status
Fish								
Cyprinidae	*Brachydanio albolineatus*				+		Non-native	none
Poeciliidae	*Poecilia reticulata*				+		Non-native	none

Comments on fish: for non-native species, both adults and juveniles were obtained (proportion of catch not noted).

28 July 2015 – **Area D** Unnamed stream along Project Western Boundary

Mandai08 – 01°24.487'N 103°46.766'E; clear flowing stream over sand and silt bottom; open country stream

Push net, 40 m stretch, 30 min

Family	Species	0-5	5-10	10-50	50-100	>100	Distribution status	Local conservation status
Fish								
Cyprinidae	*Barbodes rhombeus*			+			Non-native	none
Cyprinidae	*Brachydanio albolineatus*				+		Non-native	none
Poeciliidae	*Poecilia reticulata*					+	Non-native	none

Comments on fish: for all non-native species, both adults and juveniles were obtained (proportion of catch not noted).

29 July 2015 – **Area D** Unnamed stream along Project Western Boundary

Mandai09 – 01°24.487'N 103°46.766'E; clear flowing stream over sand and silt bottom; open country stream

Baited fish trap (4 units), 50 m stretch, overnight

Family	**Species**	**0-5**	**5-10**	**10-50**	**50-100**	**>100**	**Distribution status**	**Local conservation status**
Fish								
Cyprinidae	*Barbodes rhombeus*			+			Non-native	none
Synbranchidae	*Monopterus javanensis*	+					Native	Widespread and common
Osphronemidae	*Trichopsis vittata*	+					Native	Widespread but uncommon
Reptile								
Varanidae	*Varanus salvator*	+					Native	Widespread and common

Other notes: an individual (about 1.4m length) *Varanus salvator* was caught in one of the fish traps and subsequently released unharmed. One buffalo leech.

Comments on fish: for all non-native species, both adults and juveniles were obtained (proportion of catch not noted).

5 August 2015 – **Area D** Unnamed stream along Project Western Boundary

Upstream - 01°24.276'N, 103°46.749'E; downstream - 01°24.481'N, 103°46.771'E; clear flowing stream over sand and silt bottom; open country stream

Baited fish trap (5 units), 80 m stretch, overnight

Family	**Species**	**0-5**	**5-10**	**10-50**	**50-100**	**>100**	**Distribution status**	**Local conservation status**
Fish								
Cyprinidae	*Barbodes rhombeus*			+			Non-native	none
Synbranchidae	*Monopterus javanensis*	+					Native	Widespread and common
Reptile								
Trionychidae	*Amyda ornata*	+					Native	Restricted and Uncommon

Other notes: the *Amyda ornata* is a juvenile, around 5 cm carapace length.

Comments on fish: for all fish species, both adults and juveniles were obtained (proportion of catch not noted).

AREA F

18-19 May 2015 – **Area F** swampy inlet, within compounds of Night Safari, WRS

Shallow stream, swampy area, over silty and clay bottom; partial canopy of riparian vegetation (01°24.165'N 103°47.260'E)

Push net, 30 m stretch, 30 min

Family	Species	0-5	5-10	10-50	50-100	>100	status	Local conservation status
Fish								
Zenarchopteridae	*Dermogenys collettei*			+			Native	Widespread and common
Osphronemidae	*Betta pugnax*		+				Native	Restricted but common
Channidae	*Channa striata*	+					Native	Widespread and common
Crustacean								
Gercarcinucidae	*Irmengardia johnsoni*			+			Native	Endangered
Parastacidae	*Cherax quadricarinatus*	+					Non-native	None

Comments: for all native fish species, both adults and juveniles were obtained (proportion of catch not noted).

Other subjects: *Limnonectes blythii* tadpoles; presence of buffalo leech.

29 September 2015 – **Area F** swampy inlet, within compounds of Night Safari, WRS

Mandai 16 (01°24.165'N 103°47.260'E): shallow flowing stream, swampy area, over silty and clay bottom; partial canopy of riparian vegetation

Push net, 30 m stretch, 30 min

Family	**Species**	**0-5**	**5-10**	**10-50**	**50-100**	**>100**	**status**	**Local conservation status**
Fish								
Zenarchopteridae	*Dermogenys collettei*	+					Native	Widespread and common
Gobinellidae	*Rhinogobius giurinus*	+					Non-native	None
Osphronemidae	*Betta pugnax*			+			Native	Restricted but common
Crustacean								
Gercarcinucidae	*Irmengardia johnsoni*			+			Native	Endangered

Comments: for all fish species, only juveniles were obtained.

AREA H

7-8 September 2015 – **Area H** swampy inlet, nearer to Lorong Lada Hitam

Mandai14 (01°24.807'N 103°47.469'E): clear tannin stained water, swampy area, over silty and deep leaf litter bottom; partial canopy of riparian vegetation

Push net, 30 m stretch, 30 min

Family	Species	0-5	5-10	10-50	50-100	>100	status	Local conservation status
Fish								
Cyprinidae	*Rasbora einthovenii*		+				Native	Restricted but common
Osphronemidae	*Betta pugnax*			+			Native	Restricted but common
Osphronemidae	*Trichopsis vittata*	+					Native	Widespread but uncommon
Channidae	*Channa lucius*	+					Native	Restricted and rare
Reptile								
Geoemydidae	*Siebenrockiella crassicollis*	+					Non-native	None

Comments: for all native fish species, both adults and juveniles were obtained (proportion of catch not noted). Three adult *Siebenrockiella crassicollis* sighted.

Other subjects: *Leptobrachium nigrops*, *Chalcorana labialis* and *Hylarana erythraea* tadpoles; presence of buffalo leech.

7-8 September 2015 – **Area H** swampy inlet, further away from Lorong Lada Hitam

Mandai15 (01°24.772'N 103°47.259'E): murky water, swampy area, over clayey and silty bottom; open canopy of riparian vegetation

Scoop net, 10 m stretch, 30 min

Family	**Species**	**0-5**	**5-10**	**10-50**	**50-100**	**>100**	**status**	**Local conservation status**
Fish								
Cyprinidae	*Rasbora borapetensis*				+		Non-native	None
Cyprinidae	*Rasbora elegans*	+					Native	Restricted but common
Cichlidae	*Cichlasoma urophthalmum*	+					Non-native	None
Channidae	*Channa striata*	+					Native	Widespread and common
Crustacean								
Palaemonidae	*Macrobrachium lankesteri*		+				Non-native	None
Reptile								
Emydidae	*Trachemys scripta elegans*	+					Non-native	None

Comments: for all native fish species, only juveniles were obtained or sighted; for non-native fish species, both juveniles and adults were obtained or sighted (proportion of catch not noted); for crustacean species, only adults were obtained (proportion of catch not noted). One adult *Trachemys scripta elegans* sighted.

Other subjects: presence of buffalo leech.

Mandai Lake Area Survey Figures

Location pictures

Area A: furthest reservoir inlet (Mandai05 – 28 July 2015)

Area A inner reservoir inlet – Top upstream, bottom downstream (Mandai06 – 28 July 2015)

Area A: innermost inlet dried up stream along Mandai Lake Road (Mandai07 - 28 July 2015)

Area D: The unnamed stream along the Project western boundary (Mandai08 - 28 July 2015)

Area F: swampy stream within Night Safari (WRS) (Mandai16 – 29 September 2015)

Area H: inlet nearer to Lorong Lada Hitam (Mandai14 - 8 Sep 2015)

Area H: inlet further from Lorong Lada Hitam (Mandai15 - 8 Sep 2015)

Unnamed Stream Parallel to the Project Western Boundary survey figures

Fish pictures

Family Cyprinidae

Barbodes rhombeus (non-native species) from the unnamed stream parallel to the Project western boundary in Area D – top 20.0 mm SL juvenile, bottom 65.4 mm SL adult

Brachydanio albolineatus (non-native species) from the unnamed stream parallel to the Project western boundary in Area D – 23.9 mm SL adult

Rasbora borapetensis (non-native species) from Mandai North inlet in Area H – 21.6 mm SL juvenile

Rasbora einthovenii (native species) from far reservoir inlet in Area A – 47.2 mm SL adult

Rasbora elegans (native species) from Mandai North inlet in Area H – 25.4 mm SL juvenile

Family Clariidae

Clarias batrachus (native species) from Upper Seletar Reservoir spillway – 150.0 mm SL (for illustration purpose)

Family Synbranchidae

Monopterus javanensis (native species) from the unnamed stream parallel to the Project western boundary in Area D – 310.0 mm SL adult

Family Zenarchopteridae

Dermogenys collettei (native species) from inner reservoir inlet in Area A – male above 28.4 mm SL, female below 40.6 mm SL

Family Poeciliidae

Gambusia affinis (non-native species) from inner reservoir inlet in Area A – top female 23.8 mm SL, bottom male 19.5 mm SL

Poecilia reticulata (non-native species) from the unnamed stream parallel to the Project wstern boundary in Area D – top male 14.8 mm SL, bottom female 20.0 mm SL

Family Cichlidae

Acarichthys heckelii (non-native species) from inner reservoir inlet in Area A – 46.1 mm SL juvenile

Family Eleotridae

Oxyeleotris marmorata (native species) from inner reservoir inlet in Area A – 20.6 mm SL juvenile

Family Gobinellidae

Brachygobius sabanus (non-native species) from inner reservoir inlet in Area A – 12.7 mm SL adult

Eugnathogobius siamensis (native species) from inner reservoir inlet in Area A – 11.5 mm SL (not obtained from surveys in 2015)

Gobiopterus brachypterus (native species) from inner reservoir inlet in Area A – 18.1 mm SL (not obtained from surveys in 2015)

Rhinogobius giurinus (non-native species) from inner reservoir inlet in Area A – 21.5 mm SL

Family Osphronemidae

Betta pugnax (native species) from Mandai North inlet in Area H – 38.2 mm SL adult

Trichopsis vittata (native species) from the unnamed stream parallel to the Project western boundary in Area D – 33.0 mm SL adult

Family Channidae

Channa lucius (native species) from CCNR – 74.1 mm SL juvenile (for illustration purpose)

Channa striata (native species) from inner reservoir inlet in Area A – 52.7 mm SL juvenile

The unnamed stream parallel to the Project Western Boundary area survey figures

Crustacean pictures

Family Atyidae

Caridina johnsoni (native species) – female above, male below (both less than 10 mm); from inner reservoir inlet in Area A

Family Palaemonidae

Macrobrachium lankesteri (non-native species) – male around 50 mm; from Mandai North inlet in Area H (further from Lorong Lada Hitam)

Macrobrachium nipponense (non-native species) – male around 50 mm; from inner reservoir inlet in Area A

Family Gecarcunicidae

Irmengardia johnsoni (native species) from inlet stream within Night Safari in Area F (2013)

Family Sesarmidae

Geosesarma perracae (native species) from inlet stream within Night Safari in Area F (2013)

Family Parastacidae

Cherax quadricarinatus (non-native species) – juvenile 32.3 mm carapace length; from furthest reservoir inlet in Area A

Annex 15.0

Forest Restoration Plan & Plant and Species Association

Annex 15.1

Forest Restoration Plan

Forest Restoration Plan
Mandai Development

Prepared for ERM
by Dr. Chua Siew Chin
EkoTree LLP

27 January 2016

Table of Contents

Part 1. Forest Restoration Guidelines for Mandai Eco-Link

1.1. Overview

The first part of this restoration framework provides broad theoretical concepts for restoring tropical rainforests. The second part of the document provides practical guidelines for restoring forests on the Mandai Eco-Link. The guidelines are drawn from the author's experiences working on secondary forests in Singapore and from Nparks' reforestation experiences. A large part of the information also comes from "Restoring Tropical Rainforests, a practical guide", by Elliott, Blakesley & Hardwick 2013. A planning schedule, starting from sourcing plant materials to monitoring the planted trees, is given at the end of this section (Figure 1.4).

1.2. Relevant theoretical concepts

Repairing ecological processes as end points of forest restoration

Forest restoration is a process that releases or accelerates forest succession, and transforms a degraded landscape to one which resemblances the original forest. Forest restoration goes beyond planting of trees; it emphasizes on reinstating ecological processes that will restore forest biodiversity, structure and functions (e.g. carbon sequestration, nutrient cycling and water and air purification). By focusing on reinstating ecological processes as end points of forest restoration, we ensure that in the long run, the forests are self-sustaining without human intervention, and that the forests are resilient to human disturbances.

Understanding tropical rainforests

This section summarizes ecological concepts that are key to understanding tropical rainforests and their restoration.

Restoration is accelerating forest succession

Disturbances such as tree fall or forest clearance set off a chain of events known as forest succession, where sun- loving tree species seize the opportunity to grow, and as the environment changes, are replaced by other species more tolerant of the changed environment. This continues until a stable and self-perpetuating plant community (i.e. climax community) establishes. Forest restoration essentially attempts to speed up this natural process, which could span over time scale of decades to centuries, depending on the scale of disturbances, seed sources availability and the facilitating or inhibiting effects of existing vegetation (Corlett 1995; Finegan 1996). Successful restoration applies the right tools according to the scale of disturbances, plant in species that could not disperse into the restoration area easily, and select species that facilitate the progression of succession towards the climax vegetation.

Feedbacks between organisms and their environment

Interacting relationships among organisms, as well as between organisms and their environment form the basis of the ecological processes in rainforests. The quality of sunlight, soil nutrients, water, etc., all form part of the environment that selectively favors the growth of some plants and not others. The plants in turn shape the environment by altering soil fertility and the microclimate. Hence, existing plants also influence the environment that select for the next generation of plants. The plants also provide food resources and habits for animals, which could in turn interact with the plants as pollinators, seed dispersal agents or herbivores. Forest restoration should aim to restore these relationships, especially those that facilitate succession. For example, restoration should aim to restore species that ameliorate soil fertility, have larger crowns that could shade out weeds, and fruit early to provide food resources to attract animals.

Diversity improves the stability and resilience of forests

Diversity of genes, species and functions are interlinked and together increase the stability and resilience of rainforests. **Genetic diversity** increases the chance that some genes in the existing gene pool would enable the organisms to cope under anthropogenic stresses, including climate change. A way of increasing global genetic diversity in forest restoration is by **propagating**

native stock, as this is opposed to propagating only a subset of the genetic stock that nurseries could provide. At the species level, tropical rainforests are found to be very resilient to disturbances, because the extremely high **taxonomic diversity** guarantees that a loss or reduction in population of some species is less likely to cause a loss in functions (e.g. pollination, seed dispersal), as other species serving similar functions still survive. Diversity also begets more diversity to further feedback on the stability of the system. For example more species of plants will help to support more species of animals, by providing a variety of food and complex microhabitats. Finally, these translate to the **stability of larger scale ecosystem functions** such as nutrient cycling, carbon sequestration and filtration of air and water (Aerts & Honnay 2011; Harrison *et al.* 2014).

Use of native species

The use of native plant species is important for restoring as much as possible, the original ecological processes in the forests. This is because we do not fully understand the intricate relationships among organisms in the forests, and re-introducing native plants is the safest way to restore the original complex relationships, which are the basis of many ecological processes. At the same time, introducing non-native plants risks upsetting the ecological balance. For example, without the predators and competitors found in their natural home range, non-native plants could gain advantage over native species and become invasive.

Where non-native tree species currently dominate the landscape, these should be gradually phased out and replaced by native trees. The shade of these non-native trees could provide an ideal environment to plant mid to late successional native trees, or be host to native strangler figs (See section 1.3.3.7(c.ii) under "Practical Guidelines"). The gradual removal of non-native trees would allow wildlife to slowly adapt to a new environment. For example, the non-native *Falcataria moluccana* is common within the project site and is used by local birds. Gradual thinning of *Falcataria moluccana* together with planting of mid to late successional trees in the understorey would restore the site without overly affecting the existing wildlife.

1.3. Forest Restoration for Mandai Eco-Link - Practical Guidelines

1.3.1. Mandai Eco-Link as a Wildlife Corridor

The Mandai Eco-Link will be a forested bridge connecting two forest fragments of the Central Catchment Nature Reserve (CCNR), which are currently separated by the Mandai Lake Road. (Refer to Appendix 1 for full vegetation maps and the extent of the nature reserves.) At the point of writing the design of the Eco-Link is still at the conceptual stage.

1.3.2. Site assessment

A vegetation map around the Mandai Eco-Link was prepared based on vegetation survey conducted by Prof Hugh Tan's team and Camphora Pte Ltd. Further field verification was undertaken across the site as part of this work.

1.3.3. Guidelines

1. **Protect existing native flora and wildlife** in the surrounding mature secondary forests, as these would help to disperse seeds into the restoration area. The forests would buffer against edge effects such as wind and insolation. In particular, the secondary forests surrounding the intended Eco-Link contain many primary forest tree species, and these would increase species diversity of the restoration area in future.

2. **Compatible development & maintaining a buffer against construction (Figure 1.2)**
   a. As much as possible, there should be **continuity with the mature secondary forests**, and construction impacts at these areas should be minimized
   b. **Rainforest Park** at the northwest and southeast could potentially be compatible developments adjacent to the Eco-Link, provided that the design of the rainforest Park augments the connectivity of the Eco-Link to the mature secondary forests.
   c. The current design concept indicates that a component of the bird park will be sited at the western end. Linkage to the bridge should be avoided or minimized here, to avoid wildlife from venturing into the sanctuary.

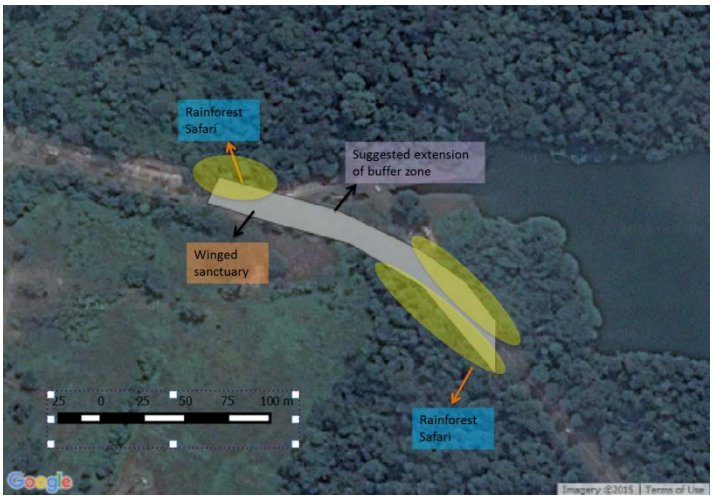


Figure 1.2. Yellow highlights indicate good connection between the bridge to the existing secondary forests, and construction impacts at these areas should be minimized. Grey zone indicates potential footprint of the Eco-Link along the current Mandai Lake Road.

   d. **Reforesting the drive through area** at the north would significantly improve the connectivity between the mature secondary forests and also extend the proposed buffer zone.
   e. Human scent, light and sound deter animals. As such **designating "no public access" areas,** or avoid putting trails at critical linking points between mature secondary forests and Eco-Link would promote animal movements.

3. **Substrate preparation** requires at least 1.5 – 2 m soil depth from the top, consisting of the more fertile top soil, follow by loamy soil. Only less than 1.5 m of top soil is needed, as tropical plants typically have shallow roots, an adaptation to the shallow nutrient layers in tropical rain forests. The top soils that are excavated from other part of the project site could be reused here. However, these top soils could carry weed seeds, and thus there is a need to apply the herbicide glyphosate (see pt. 4 below) or do manual weeding. Using the layering structure used by Eco-Link@BKE as a reference, the remaining layers beneath the soil are layers of sand, gravel, geotextile and drainage cell, all of which facilitate drainage. A waterproofing membrane is the bottom most layer. A layer of coco noir nets could be laid on top to prevent soil erosion prior to planting trees.

4. **Site preparation** is needed prior to planting. This includes **weeding** where necessary, although there should be minimum weeds at Eco-Link, as this site has no prior existing vegetation. If necessary, and pending approval by the relevant authorities (e.g. Public Utilities of Singapore and National Parks Board), herbicides that decompose rapidly could be used to get rid of weeds. An example is the herbicide glyphosate. Herbicides that contain atrazine should be avoided as these degrade slowly and could spread through the soil water during rainfalls. Post tree planting, herbicide should not be used as they might affect the planted trees. **Native seedlings** should be distinguished from weeds and be protected as part of the protocol for carrying out Assisted Natural Regeneration (ANR) (See pt. 9 of this section on ANR). An **in-built watering system** could also be built to minimize tree mortality during drought. This is the experience gained from the construction of Eco-Link@BKE, where the planting coincided with a severe drought period in Singapore, leading to high tree mortality.

5. **Hygiene.** To prevent the accidental spread of unwanted seeds, fungi and other biological materials, check the provenance of materials before bringing them to the site. This includes soil, mulch, equipment, etc. All equipment brought on site should be washed and/or sterilized of potential seed before use.

6. **Inoculating nursery saplings with mycorrhizal fungi** to improve plant growth. Mycorrhizae is prevalent in tropical rainforests (Peay, Baraloto & Fine 2013), and has been well documented for Dipterocarpaceae, the dominant tree family in our region (Brearley 2012). Planting experiments show that mycorhizae improve plant growth and plants' resistance to environmental stresses (Tapwal et al. 2015), and that the fungi-plant relationships appear to be largely non-specific (Peay *et al.* 2015). Thus it would be possible to mix some local forest soils from Dipterocarp forests, with potting soil for the saplings to improve plant growth.

7. **Tree planting**
   a. Trees are best planted during the **wet seasons**. Although Singapore has high rainfall almost throughout the year, planting in October/November would allow plants' roots to establish better during the wet monsoon season, and reduce the need for watering.

   b. **Intensive, high density planting** is recommended for the Eco-Link, as there is no existing vegetation. Trees will be planted at about 2-3 m apart, with a target of 3,000 trees/ ha**.** For stage 1 planting, Eco-Link design option has an approximate area of 0.29 ha and requires about 870 trees. More trees might be required at stage 2 planting depending on the planting success. Considerations for planting distance should also factor in the maximum gliding distances fauna in the project area are capable of. The Malayan Colugo (*Galeopterus variegatus*)[1] is understood to be able to glide distances of 31.4 m ± 24.7 m and the Horsfield's Flying Squirrel (*Iomys horsfieldii*) can glide for several metres without loss in height[2].

   c. High density planting **promotes canopy closure** and minimizes weeding cost, as the sun-loving weeds are shaded out. Shorter saplings should be planted closer together (1.8 – 2.5 m). For very close planting, some plants would die from competition and cause a gradual thinning of the plants. The resulting dead material will help to **accumulate leaf litter**, which is natural in the forests, and build up the biodiversity of the decomposers (fungi, insects, etc.) in the soil.

   d. **Species selection.**
      i. **Pioneer and climax species.** Species should be planted according to their light and soil preferences, although much less is known about soil requirement of different plant species. In general, pioneers/early successional tree species are light-demanding and could be further separated into 1. **Short-lived pioneers** that are fast-growing, prefer higher soil nutrients, and produce leaf litter with higher nutrients, which improves the soil; and 2. **Long-lived pioneers** that are slow-growing, tolerate low soil nutrients and produce poor nutrient leaf litter that decomposes slowly (Burslem, Turner & Grubb 1994; Grubb, Turner & Burslem 1994). To rapidly restore forest structure at Mandai Eco-Link and with the availability of fertile top soil**, fast-growing pioneers are preferred over slow growing pioneers. Climax species** are usually shade-tolerant, slow growing and adapted to low soil nutrients. Some late successional tree species are also able to

[1] Brynes G, Lim NT, Yeong C, Spence AJ, Dumont ER (2011) Sex differences in the locomotor ecology of a gliding mammal, the Malayan colugo (*Galeopterus variegatus*). Journal of Mammalogy. 92(2):444-451.
[2] Horsfield's Flying Squirrel (*Iomys horsfieldii*). Retrieved from http://www.ecologyasia.com/verts/mammals/horsfield's-flying-squirrel.htm

grow under high light conditions and could be planted during the early successional stage to jump start succession (Shono, Davies & Chua 2007b). Mid-successional species are a somewhat arbitrary group that have characteristics intermediary of pioneer and climax species.

ii. **Framework species.** Trees selected should ameliorate site conditions and promote seed dispersal from the surrounding secondary forests into the restoration site. This would cut cost and also greatly improve the biodiversity of the restoration site, as nurseries generally have limited forest plant species. This method of planting trees that would further succession is call the framework species method. Framework species generally 1.) **grow fast** to close the canopy and shade out weeds 2.) **fruit and flower early** to attract animals, including seed dispersing fauna, 3.) **survive well** in open canopy areas and/areas with very degraded soil. Two notable groups of plants serve well as framework species, namely the **figs and the legumes**.

A special note here is made on the **strangler figs**, which in nature grow on host trees and over time, strangle and replace the hosts. In addition to being keystone species that provide food for animals all year round, the convoluted structure of the strangler figs also provide nesting materials and shelters for animals (Hails & Kavanagh 2013). Some of the stranglers such as *F. microcarpa,* could be grown from seeds with tree-like habit in a pot. On the restoration sites, the seedling of strangler figs could be wrapped to the top of a pole (e.g. dead wood, bamboo poles that would degrade over time) using coconut fiber ("Re-establishing strangler figs", 2008). It is also possible to attach the seedlings of strangler figs to non-native trees, so that over time, the strangler figs would replace the non-native trees.

iii. **Diversity**. At least **30** different tree species should be planted, especially species that are not commonly found in the secondary forests and are unlikely to regenerate naturally at the site. Planting a variety of plant species that attain **different heights at maturity** would mimic the multi-layered structure of the rainforest, and help to provide different microhabitats for animals.

iv. **Native species**. The use of native species from native parent trees would help to diversify genetic material and conserve native gene pool. Propagating our native trees is crucial to their long term survival, as primary forests in Singapore are very small and fragmented, and the trees have very limited dispersal range (Chua *et al.* 2013). Native seedlings could be salvaged from forests that will be affected by development (e.g. Rainforest Park), or beneath mother trees in the mature secondary forests. For example, seedlings and saplings of primary forest species *Aquilaris malaccensis* and *Hopea griffithii* were found within the vegetation survey areas. Mortality of seedlings in nature is very high, and **transplanting these wild seedlings** would benefit the forests. Alternatively, seeds of pioneer species could be found in the soil near the parent trees. **Growing seeds from the seed bank** is another relatively easy option. To further increase biodiversity, late successional native saplings grown from nursery could also be introduced to the site at stage 2 planting, under the shade of established plants (Figure 1.4).

v. **Trees of conservation significance** that are affected by development within the project areas could be **transplanted** to the Eco-Link to improve the forest structure and biodiversity. However, previous experiences in transplanting trees suggest that trees survive better when planted in a small gap, as opposed to very exposed areas (pers. comm. Nparks). Thus it is recommended that transplanted trees be planted near the edges to existing forests.

Table 1.1 gives a summary of the plant categories and their purposes for restoration, as well as some examples of species for each category. Refer to Appendix 2 for a complete list of tree species and their characteristics that are important for restoration. Note that Appendix 2 is also given as an excel sheet for ease of usage.

Table 1.1. Plant categories and their purposes for tropical forest restoration.

I. Successional stage	**Purpose**	**Examples**
Short-lived pioneers/ early successional species	• Able to grow under high light conditions. • Usually grow fast to shade out weeds and serve as barriers against edge effects • Could fruit and flower within a few years to attract animals. • Preferred over long-lived pioneers if soil fertility is good.	*Macaranga* spp. (e.g. *M. bancana, M. conifera, M. gigantae, M. heynei*), *Trema tomentosa, Trema cannabina, Mallotus paniculatus, Ficus grossularioides, Campnosperma auriculata*
Long-lived pioneers (early successional species)	• Able to grow under high light conditions. • Able to tolerate poor soil, e.g. very low phosphorus • Usually are tall trees at maturity, and could improve forest structure.	*Adinandra dumosa* *Ixonanthes reticulate, Rhodamnia cinerea, Syzygium zeylanicum*
Mid successional species	• Grow moderately well under high light, and could also tolerate the semi shade conditions • Usually are tall canopy species that provide variation in forest structure.	*Calophyllum* spp. (e,g, *C. pulcherrimum, C. tetrapterum, C. teysmanii, C. ferrugineum*), *Cratoxylum cochinchineses, Archidendron ellipticum, Streblus elongatus, Timonius wallichinaus*
Subset of climax species/ late successional plants that could tolerate high light conditions	• Tall, slow growing and long-lived. Provide variation in forest structure • Jump start succession as these species are found at the final stable and self-perpetuating plant community.	*Parkia speciosa, Intsia palembanica, Koompassia malaccensis, Shorea leprosula, Syzygium syzgioides*
II. Framework species	**Purpose**	**Examples**
Ficus	• Species that fruit early to provide food for animals. • Dense roots are found to improve soil structure. • Strangler figs form complex structures with their trunks and aerial roots, which serve as habitats for birds and other small animals	• *Ficus glossulariodes, F. aurata, F. fistulosa, F. variegata* • *Ficus caulocarpa, F. microcarpa, F. virens*
Legumes	• Able to fix nitrogen in the soil and improve soil fertility. • Usually grows well and fast, even on degraded soil. They could thus quickly shade out weeds.	*Archidendron clypearia, Parkia speciosa, Archidendron ellipticum, Archidendron jiringa, Intsia palembanica, Koompassia malaccensis*

vi. **Height considerations.** Tree selection for the Eco-Link should consider the maximum heights attainable by candidate species. The maximum height for trees on the Eco-Link should not exceed 25 m, with the tallest trees planted in the centre of the Eco-Link. This is to ensure that tree falls, which could occur from a microburst, will happen within the confines of the Eco-Link thereby minimizing disruption to traffic on Mandai Lake Road below.

8. Maintenance

a. **Fertilize** the planted saplings with 50 – 100 g of generic fertilizer (N:P:K 15:15:15) to boost the growth of the plants and to help close the canopy rapidly. Fertilizing should always be done after weeding so that the nutrients are not taken up by the weeds. Fertilizer should be applied at frequency of about three to four times a year, for two years.

b. **Mulching**, which is applying materials such as dead plant matter around the saplings, helps to reduce desiccation and weed growth. Leave about a gap of 3 cm between the mulch and stem of seedling to prevent fungal infection. Unwanted dead plants materials generated from other areas of the project site could be made into mulch as well. A local company that takes in horticultural waste and converts it into compost is GreenBack Pte Ltd (www.greenback.com.sg).

c. **Weeding** reduces competition and on-going weeding /weed suppression is required. Weeding should be done at about 4-6 weeks intervals, especially during the rainy season. The weeds would include herbaceous plants such as *Imperata cylindrica*, and seedlings of non-native trees such as *Cecropia pachystachya*, *Spathdodea campanulata* and *Falcataria moluccana*. Weeding by hand, and not by machine, is necessary in order to retain naturally established native seedlings. **Ring weeding** and **weed pressing** are two recommended techniques. Ring weeding involves removing the weeds and their roots in a 50 cm radius ring around the sapling. The weeds could be used as mulching for the seedling. **Weed pressing** is done in the space between the saplings, by using a board to flatten down the herbaceous weeds. Weeds grow back slower as the flattened vegetation shade out the seeds/plants beneath. There is less oxygen flow in between the flattened vegetation which decreases the chances of fire. Weeding should cease three years after planting as the canopy closes.

d. **Tree anchoring and protection** to minimize tree fall, in particular for areas susceptible to damage by strong winds such as along the edges of the reservoir, valleys leading up to the reservoir, and at high points (ie Mandai Eco-Link).

9. Enhance natural regeneration via Assisted Natural Regeneration (ANR). ANR refers to any activities that enhance natural forest regeneration without planting trees (Shono, Cadaweng & Durst 2007a). For the Mandai Eco-Link, suitable ANR includes weeding and applying fertilizer to the seedlings that naturally recruited into the site. A pre-planting survey could be done to check for seedlings of native trees on the new soil substrate. Ad hoc **monitoring of native species** could be done concurrently with weeding post planting The initial challenge would be differentiating the native vs. non-native plants, and keeping a photo catalog of the plants would help to identify the seedlings.

10. Site monitoring is important for evaluating the success of the restoration**.** Two teams of two persons could record the height/diameter and survival of **all planted trees** in three to four days**. About 20% of the total planting area** should be monitored for all seedlings that **natural recruit** into the area. This includes native, non-native, and climbers, herbs and trees. This could be done by randomly establishing 5 x 5 m permanent quadrats. For example, for a total planting area of 0.3 ha, 20% of the area (meaning 0.06 ha) should be

monitored. This translates to 24 5 x 5 m permanent quadrats. The data should be analyzed for changes in species diversity of native and non-native plants, as well as to assess forest structure. The aim of the monitoring is to assess whether the forest is able to self-regenerate, and progress towards climax forest. Or is it populated with only the planted species? Monitoring animal usage can help to determine whether the restoration site is functioning well as food and habitat resources for the animals. Camera traps could be used for passive monitoring. Site monitoring could also involve collecting data on species suitability for restoration, and allow timely intervention where necessary (e.g. the need for weeding or pest eradication).

11. A **schedule** for pre- and post-planting work is given in Figure 1.4. The estimated timeline helps to plan for the sourcing of plant materials up as well as site maintenance and monitoring.

12. Habitat enhancement for animals.

a. **Fallen logs** that result from clearing other areas within the project site could be used to create **ground habitats** on site. This would help create niches for ground fauna, retain soil moisture and improve soil conditions over time.
b. Aquatic habitats for amphibians and insects could be included within or near the Eco-Link, by engineering natural low points to become small pools or water inlets from the reservoir. Alternatively, a small waterhole could be constructed and maintained by linking it to the watering system for the Eco-Link.

Pre-Planting Tasks			Time before planting
Sourcing for plant materials	Local native plants:	1. Establish nursery to grow seedlings	18 - 24 months
		2. Sources of local native plants	
		i. Collect seeds from native trees in forests	18 months
		ii. Collect forest soil and germinate seeds from seed bank	15 months
		iii. Salvage wild seedlings from forests and transplant to nursery	12 months
	Non-local native plants:	1. Establish nursery to hold saplings	8 months
		2. Purchase saplings from nurseries	6 months
Nursery preparation	1. Acclimatize saplings to similar harsh conditions of planting sites prior to transplanting		2 months
	i. Trees to be planted in full sun should stand in full sun during their final month in the nursery. Similar for shade-tolerant trees.		
	ii. Gradually reduce watering by 50% to slow shoot growth. But water immediately at signs of wilting.		
	2. Label saplings for future monitoring		1 month
Site preparation	1. Identify, mark and protect any native seedlings in restoration site		1 month
	2. Clear site of weeds		1 month
	3. Transport saplings and planting equipment to site		1-7 days
Post-Planting Tasks			Time after planting
Maintenance	1. Apply fertilizer		1 - 2 weeks, and thereafter about once every 4 months
	2. Weeding		1 month, and thereafter every 4-6 weeks until canopy closes
Monitoring	1. Measure initial heights of trees, approximate 4 days needed for one team of two persons		1 - 2 weeks
	2. Ad hoc monitoring of natural recruitment of native trees, do ring weeding and fertilize		every 2 months
	3. Record height and survival of planted trees.		every year
	4. Survey naturally regenerated seedlings in permanent 5 x 5 m quadrats. Total area of quadrats should make up 20% of total planted area		every year
	5. Assess animal usage		continous with camera traps/ once a month bird survey
	6. Review planting success, e.g. in case of planting failure, supplement with more pioneers and mid successional trees/ if stage 1 planting is successfully, consider stage		2 years

To increase biodiversity, late succesional native saplings could also be introduced to the site at stage 2 planting, under the shade of established plants.

Figure 1.4. Task schedule for restoration of Mandai Eco-Link. The schedule is adapted from Elliott, Blakesley & Hardwick 2013.

Part 2. Landscaping Recommendations for Arrival Nodes

2.1. Overview

The landscaping and planting recommendations here aim to maximize the contribution of arrival node west and east (Figure 2.1) to the forest landscape, by improving the flora diversity as well as the connectivity of the greenery for wildlife. First, general recommendations that are applicable to both arrival nodes are presented. Thereafter, catering to the different existing vegetation at the site, specific recommendations are made for each arrival node. These recommendations are made based on the design concepts made available in September/October 2015, with the understanding that modifications to the design concepts are still possible.

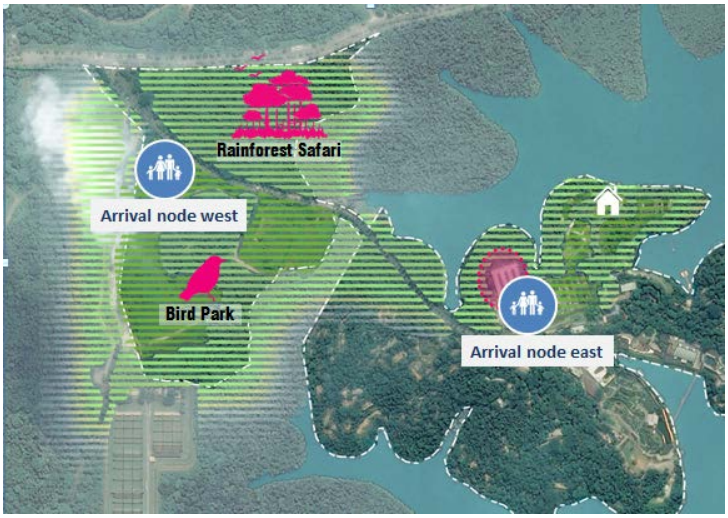


Figure 2.1. Approximate location of arrival node west and east.

2.2. General recommendations

1. **Integrate arrival nodes with surrounding forest ecosystem**
   - **a.** Pre and post planting trees, **promote natural recruitment of native plants** by identifying and protecting the seedlings that have naturally recruited into the site, which is also part of Assisted Natural Regeneration (see section 1.3.3.9 on ANR). This improves the overall biodiversity and the ecosystem functions of the landscape.
   - **b.** Allow a **gradual transition** from existing forests (Figure 2.3) to the arrival node, which would create a gradual change in microclimate of the understorey. This improves the growth of mid to late successional species (see Table 1.1 for details of successional classification of plants). Achieve the gradual transition by putting in suitable soil substrate (as opposed to hard surfaces), planting trees and shrubs, and discouraging high human activities right at the edges of forests. A proposed **buffer zone** adjacent to the forests would also promote this transition while mitigating edge effects.

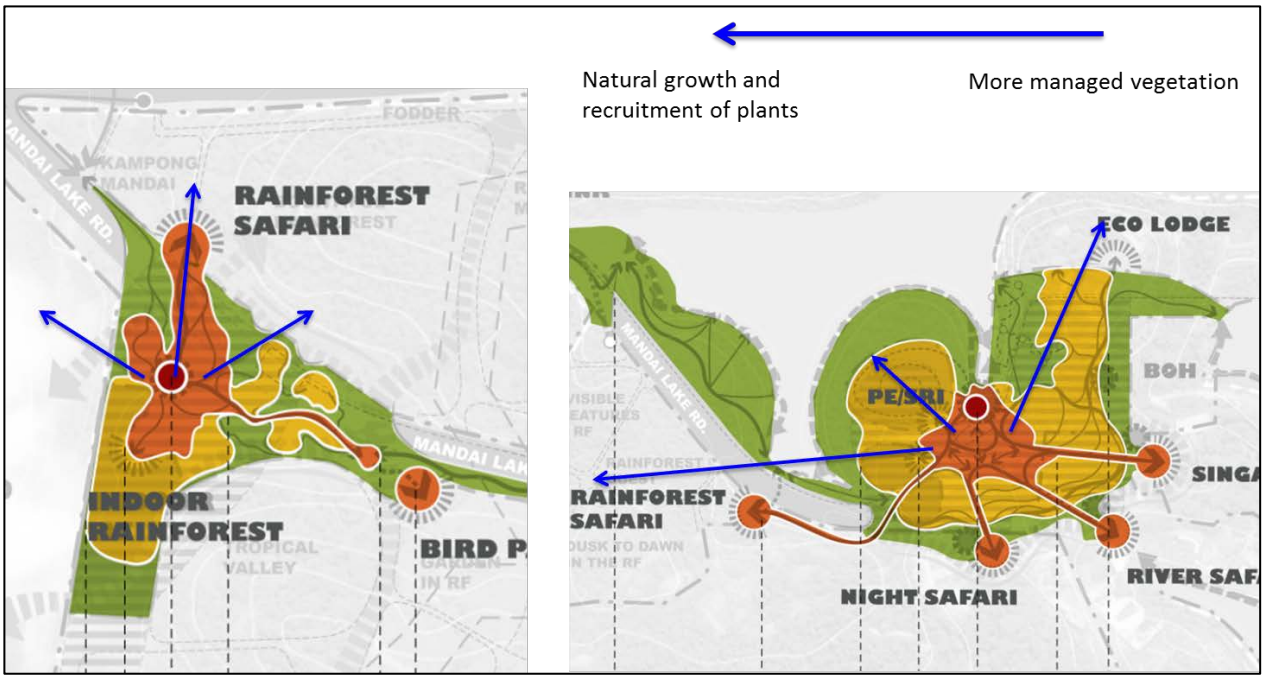
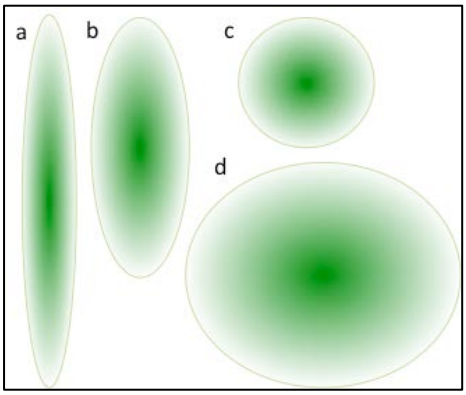


Figure 2.3. Gradual transition from managed vegetation to forests, in the direction of the blue arrows. (Modified from Masterplan v7.pptx)

2. Create conducive microhabitats within arrival nodes



a. **Plant trees in cluster** with minimum edge:area ratio, for a given area. This is analogous to edges of forests, which tend to attract weedy plants and disturbance-tolerant animals; in Figure 2.4 for example, shape (d) would be preferable over shape (a), and (b) would be better than (c), if (b) has a bigger area.

b. **Allow continuity of greenery** to minimize edges. This could be continuity of tree canopy, which is important for movements of birds and other arboreal animals.

c. **Appropriate selection of trees.** Planting tree species in the environment optimal to their growth reduces cost and effort. In general, early successional tree species are light demanding and fast growing, although a subset of these species are adapted to very degraded soils and are slow growing. On the other hand, late successional tree species are usually shade tolerant and slow growing. For the purpose of attracting wildlife and promoting seed dispersal, it is generally advisable to plant trees that mature fast, and provide food resources such as fruit and flowers earlier (Table 1.1).

2.3. Recommendations specific to Arrival Node West

1. **Existing vegetation** at Arrival Node West includes degraded grasslands, and woodlands that are dominated by non-native tree species (Figure 2.2a).

2. **Planting at grasslands** (Refer to Table 1.1 and Appendix 2 for examples of plant categories)

    a. The species selected should be well adapted to 1) sunny and dry conditions, 2) potential poor soils, and 3) grow fast to shade out herbaceous weeds (grasses etc.).

    b. **Plant more pioneer species** (~50%) especially at the edges. Other than **short-lived pioneers** (Table 1.1), **long-lived pioneers** (Table 2) **and legumes** could also be planted, as these grow well on degraded soils. **Ficus** trees also improve root structure and attract animals. Some mid-late successional tree species that grow moderately well under high light could be planted under the shade of pioneers.

    c. **Hand weeding** of herbaceous plants and other non-native tree seedlings around the planted sapling might be conducted periodically to prevent invasion of non-natives.

3. **Plant selection at non-native woodlands** (Refer to Table 1.1 and Appendix 2 for examples of plant categories)

    a. **Gradual replacement of non-native with native trees.** Although non-native, these secondary forests still provide important habitats for fauna. Gradual removal of these non-native trees would allow wildlife to slowly adapt to a new environment. The following strategies are recommended:
        i. **Plant mid to late successional native trees under the shade** of the non-natives, since most mid to late successional trees prefer less light. Select from Appendix 2, **at least 30 plant species** that belong to successional stages 2 and 3 and are moderately light tolerant/ shade tolerant. Lastly, check under the column "Habit" that species selected are of different stature (height) at maturity, in order to mimic the natural forest structure.
        ii. **Selectively remove non-native trees** to allow more planting space and light.
        iii. Wrap seedling of strangler figs to some non-native trees (e.g. plant strangler figs in one out of 10 non-native trees), so that over time, the strangler figs could replace some of the non-native trees and improve species diversity ("Re-establishing strangler figs", 2008).

2.4. Recommendations specific to Arrival Node East

1. **Improve connectivity with good quality secondary forests** around Arrive Node East. These forests are excellent seed sources and can augment the limited diversity of planted trees.

2. Allow gradual change of forest environment to the more open managed vegetation at the center of the arrival node could promote animal movement. This could be done by:
    a. Planting a proposed **continuous buffer zone** of trees next to the existing forests to protect the existing forests from further edge effects.
    b. **Minimize maintenance near the forests,** other than weeding of non-native species, to allow natural regrowth.

3. **Plant selection** (Refer to Table 1.1 and Appendix 2 for examples of plant categories)
    a. **At the proposed buffer zone**, plant early-mid successional plant species that are moderately tall at maturity and could thus act as effective barriers. Understorey plants could also be planted to add variation to the forest structure. This is akin to the "Nature Ways" planting strategy of Nparks
    b. **From the proposed buffer zone to the rest of the arrival node**, a range of early to mid successional plants with varying stature at maturity could be planted.

Part 3. Landscaping Recommendations for Rainforest Park

3.1. General assessment & recommendations

1. **Existing Vegetation.** The intended Rainforest Park is located at the northwestern part of the project, on former farmland. (Figure 3.1) (henceforth Rainforest Park North). It consists of largely non-native secondary forests and a patch of young native secondary forest in the center, and more mature secondary forests abutting the existing nature reserve. A small patch of scrubland is adjacent to the Mandai Lake Road. A second area for the Rainforest Park is proposed on part of the existing Night Safari, to serve as a dual land use (Figure 3.2, henceforth Rainforest Park South). Only half of this area, a triangular section, has been surveyed by Camphora Pte Ltd. It consists of mature secondary forests with many trees that are of conservation significance (Figure 3.2.). The remaining areas include physical structures that are part of the Night Safari. The western edge of the Rainforest Park South is adjacent to the nature reserve.

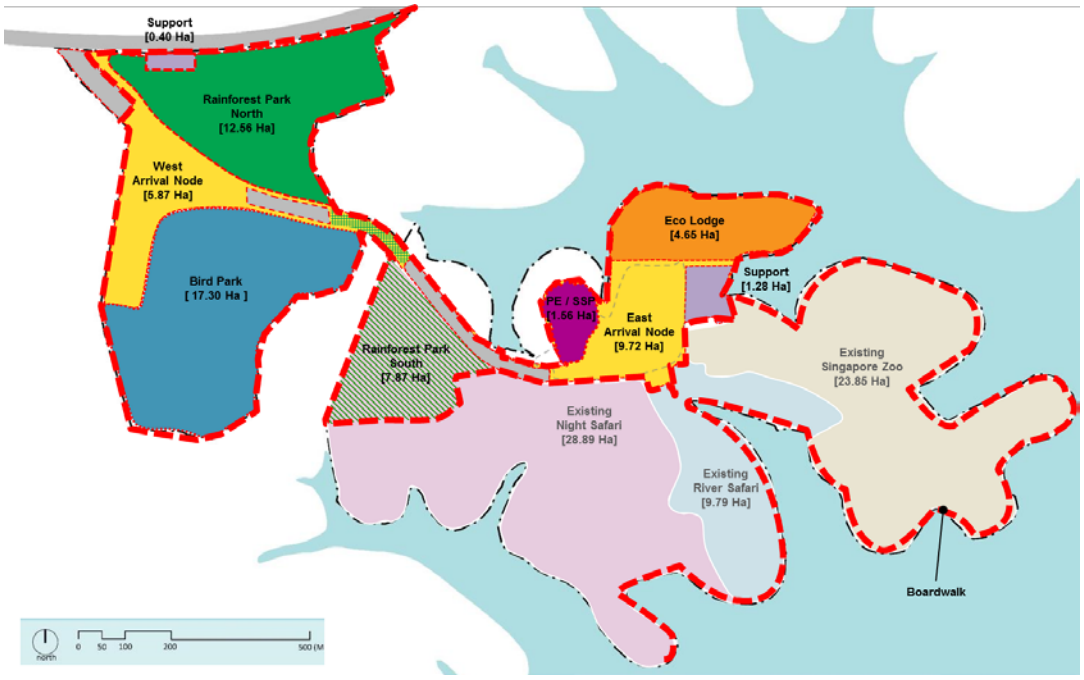


Figure 3.1. Proposed location of Rainforest Park North

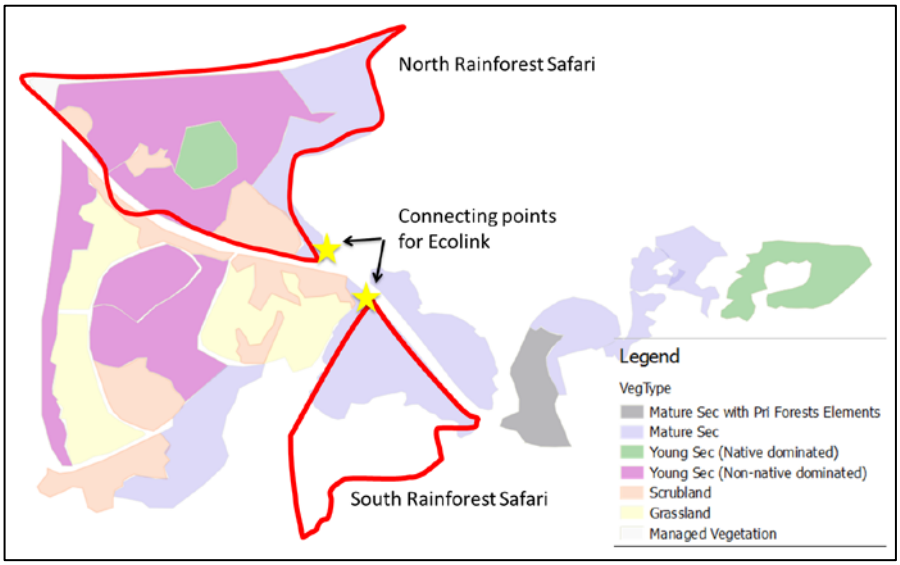


Figure 3.2. Vegetation types at the proposed Rainforest Park .

2. Ensuring **the integrity of existing mature rainforests** for the following reasons:
    a. The mature rainforests in most of the Rainforest Park North, and in a portion of the Rainforest Park South, would be part of the **proposed 50 m buffer** zone for the nature reserves. Within this proposed buffer zone, there should be no physical structures..
    b. The mature secondary forests next to Mandai Lake Road would be the **connecting points for the Mandai Eco-Link** (Figure 3.2.) and their integrity is important to promote animal usage. In particular, protecting the edge of the Rainforest Park South that is adjacent to the Mandai Lake Road, would **increase the functional width** of the Eco-Link.
    c. These forests are important **seed sources** for good regeneration of the younger secondary forests.
    d. The rich diverse forests could **provide wild seedlings** for on-going enrichment planting at other parts of the project. This would help to conserve local genetic material.
    e. In line with the theme of Rainforest Park, these mature secondary forests will help to provide **an authentic rainforest experience** for visitors.

3. **Focus development in existing non-native and degraded forests and/ areas with existing structures.**
    a. For the Rainforest Park North, development should be focused on
        i. the western end, within the non-native dominated secondary forests,
        ii. the scrubland area adjacent to the existing Mandai Lake Road; and
        iii. to **avoid clearing young native secondary forests** in the middle of the Rainforest Park North.
    b. For the Rainforest Park South, the development should be focused on areas with existing physical structures.

4. **Improve structure and biodiversity of the forests by:**
    a. **Planting late successional plant species** beneath the shade of non-native trees. These the non-native trees could serve as nurse trees.
    b. **Selectively thinning areas with dense non-native trees** to allow more light and space to facilitate growth of planted trees beneath. In particular, Nghiem *et al.* 2015 highlighted a list of invasive species to Singapore that should be removed (Appendix 3). Table 3.1 listed the abundance of these species that were surveyed by Camphora Pte Ltd within the Rainforest Park areas.
    c. Retain non-native, non-invasive fruit trees that have historical values and if they are of good vigor (Table 3.2).
    d. Use fell trees to create ground habitats, and to convert dead plant materials into mulch

5. **Natural trails or boardwalks** are preferred over paved surfaces. Hard paved surfaces reduce water infiltration, which could result in increasing muddy conditions next to the paved surfaces, especially given the high clay content of rainforest soils. This would negatively affect plants' growth and make trail maintenance difficult. Boardwalks, such as the ones found in nature reserves are recommended if natural earthen trails are not possible.

Table 3.1. List of invasive non-native plants in Rainforest Park that should be removed over time. (Compiled from data provided by Camphora Pte Ltd, 15 Dec 2015. A2B and A3 are Camphora's naming system.)

Species	Stem count in Rainforest Park North/A2B	Stem count Rainforest Park South (only section that was surveyed by Camphora)/A3
Acacia auriculiformis	36	2
Cecropia pachystachya	1	
Falcataria moluccana	9	
Spathodea campanulata	229	2

Table 3.2. List of non-native fruit trees in Rainforest Park that could be retained for historical and cultural values. (Compiled from data provided by Camphora Pte Ltd, 15 Dec 2015. A2B and A3 are Camphora's naming system.)

Species	Common name	Stem count in Rainforest Park North/A2B	Stem count in Rainforest Park South (only section that was surveyed by Camphora)/A3
Durio zibethinus	Durian	226	
Elaeis guineensis	Oil palm	93	28
Artocarpus heterophyllus	Jackfruit	2	
Artocarpus integer	Cempedak	10	1
Dimocarpus longan	Longan	16	
Cocos nucifera	Coconut	9	
Mangifera indica	Mango	3	

3.2. Mitigating measures base on design concept plan (October 2015)

The mitigating measures here are not completed, as it is understood that the design plan is still at the conceptual stage. As such the discussion is focused on overall layout and specific prominent features. More detailed discussion should be generated later to review the new design plans.

3.2.1. Rainforest Park North (refer to Figure 3.3)

1. The Rainforest Park North area is currently situated within the mature secondary forests, and within the proposed 50 m buffer zone. Construction here should be minimal.

2. Radiating trails from nodes should be avoided, as visitors would tend widen the trails as they cross from one trail to another.

3.2.3. Rainforest Park South (refer to Figure 3.4.)

1. The central component of the Rainforest Park is situated within mature secondary forests. The proposed buffer zones for the nature reserve will also extend to proposed components of the Rainforest Park. Construction at these areas should be minimal.

2. Non-native trees, especially of tropical origins, should not be planted within these areas. Non-native tropical tree species could establish themselves in these similar habitats and become invasive.

Part 4. Landscaping Recommendations for Bird Park

4.1. General assessment & recommendations

1. **Existing Vegetation.** The intended Bird Park is located at southwestern part of the project, on former farmland and orchid garden (Figure 4.1). It consists of degraded non-native secondary forests surrounded by grasslands and scrublands. At the southeast is a patch of native-dominated mature secondary forests (Figure 4.2).

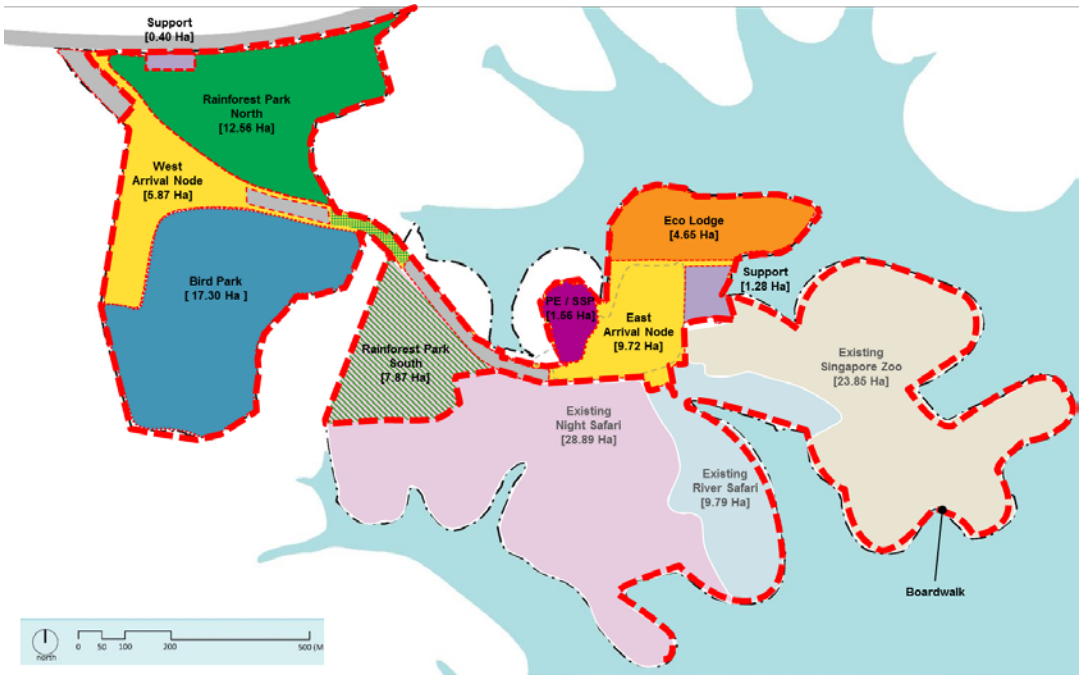


Figure 4.1. Proposed location of Bird Park

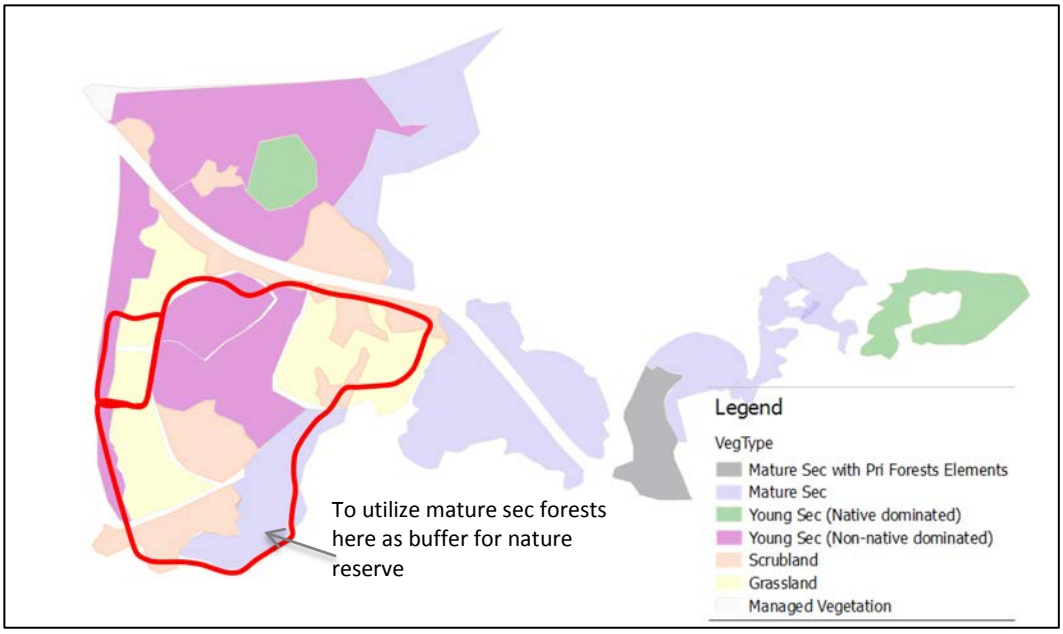


Figure 4.2. Vegetation types at the proposed Bird Park

2. **Retain** as much as possible, **the existing mature rainforests as buffer for the nature reserve.** The existing mature rainforests on the southeast would be within the **proposed 50 m buffer** zone for the nature reserves and their good structure would provide effective buffer against noise and light pollution from the Bird Park. Within this proposed buffer zone, there should be no physical structures.

3. **Conserving native species of conservation significance.** Camphora Pte Ltd noted 68 tree species of conservation significance, most of which are located within the zone of mature secondary forest, and some within the non-native dominated secondary forests in the center of the proposed Bird Park**. The first choice of conservation should be to retain the trees in-situ,** and if this is not possible, to transplant these trees either to the Mandai Eco-Link, or to the Rainforest Park. Transplanting trees incur huge costs and there is the risk of tree mortality. Thus this should be a second choice. The GPS coordinates of the trees of conservation significance have been provided by Camphora Pte Ltd, and the trees are also marked on site for easy reference. Experienced contractors should be used in transplanting these trees.

4. **Removal of non-native invasive trees.** This location has trees which were found to be as non-native and invasive by Nghiem *et al.* 2015. The full list of non-native invasive plants is found in Appendix 2. Table 4.1 listed the abundance of these species that were surveyed by Camphora Pte Ltd within the Bird Park. With the exception of *Hevea brasiliensis*, all the other species have light demanding seedlings that grow well in abandoned land, thus they should be removed to minimize their spread in the open development area. For tree species such as *Falcataria moluccana,* which are good habitats for some birds, the removal should be done in stages, to complement the planting of fast growing of native secondary tree species.

Table 4.1. List of invasive non-native plants in Bird Park that should be removed over time. (Compiled from data provided by Camphora Pte Ltd, 15 Dec 2015. A2A is Camphora's naming system.)

Species	Stem count in BirdPark/A2A
Acacia auriculiformis	39
Cecropia pachystachya	54
Cecropia peltata	29
Falcataria moluccana	52
Hevea brasiliensis	4
Spathodea campanulata	381

5. **Retaining habitats for fauna.** Despite the poor vegetation diversity, rare invertebrates to Singapore have been discovered by the fauna survey team. The habitats of these fauna should be integrated into the landscape design where possible.

6. **Avoid introduction of non-native invasive species, especially of tropical origins.**
   - **a.** As far as possible, native trees should be used in the plantings, or non-native plantings should be **confined to enclosed areas**. Note there are still risks of escapees.
   - **b.** Chong *et al.* (2011) found that weed risk assessment done by other tropical regions using the **Australian Weed Risk Assessment** ("Weed risk assessment system", 2015) predicted well the naturalization of existing weeds in Singapore (in other words, their ability to self-sown and be invasive). The dataset of A-WRA scores compiled by Chong *et al.* (2011) could be used to screen for plants that are likely to naturalize in Singapore, which is a pre-requisition to becoming invasive (See ChongEtAl_SI_ERM.xls, tab "Compiled Sources."). **Note that this list should only be used for plants whose naturalization status in Singapore is unknown**. (See ChongEtAl_SI_ERM.xls, tab "Singapore", for list of non-native plants and their naturalized status in Singapore. Source: *Chong et al. 2011*). Further monitoring and care in preventing spread of these imported plants are still necessary.

4.2. Mitigating measures base on design concept plan (October 2015)

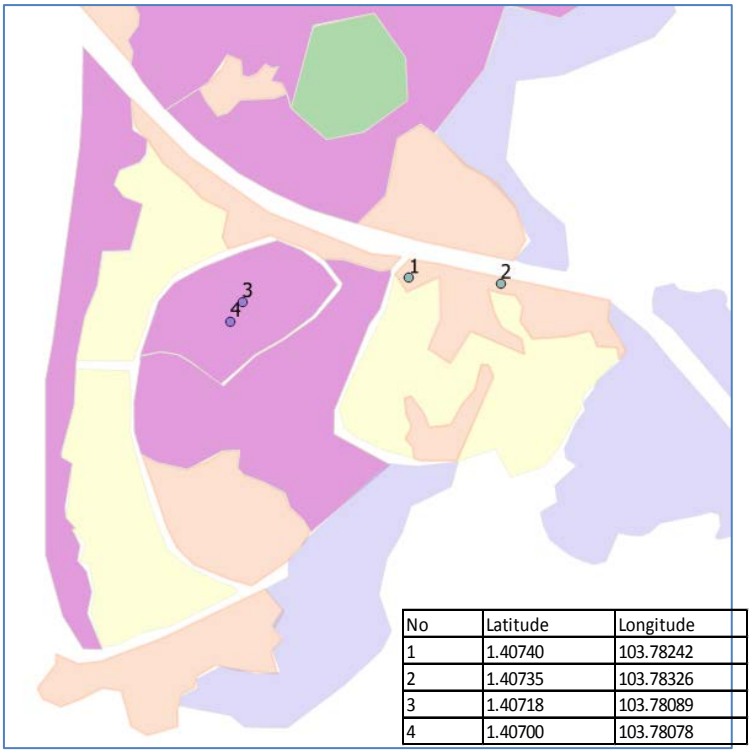
Similar to the rainforest Park, the mitigating measures here are for the design concept plan, More detailed discussion should be generated later to review the new design plans.

1. A **buffer zone** of 50 m is proposed beside the CCNR, within which there should be no physical barriers.

2. Location of the developments in low lying areas should optimize existing natural low points for water gathering, as shown in Figure 4.4. Plant species from Nee Soon Swamp Forest in Singapore could be used as a reference for sourcing vegetation for the wild wetlands. A list of more than 100 plant species are described by (Tan *et al.* 2013).

Figure 4.4. Waterways and natural low points within project area. (Source: Masterplan v7.pptx)

3. Existing bamboo patches are found within the site and instead of creating new habitats, these existing bamboo patches could be integrated into the plans. Location and GPS coordinates of these bamboo patches are given in Figure 4.5.



No	Latitude	Longitude
1	1.40740	103.78242
2	1.40735	103.78326
3	1.40718	103.78089
4	1.40700	103.78078

Figure 4.5. Locations of existing bamboo patches at project site with their GPS coordinates at the bottom right. (Source: Camphora Pte Ltd and from S.C. Chua)

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Appendix 1. Proposed Landuse and Vegetation Map for Mandai Development

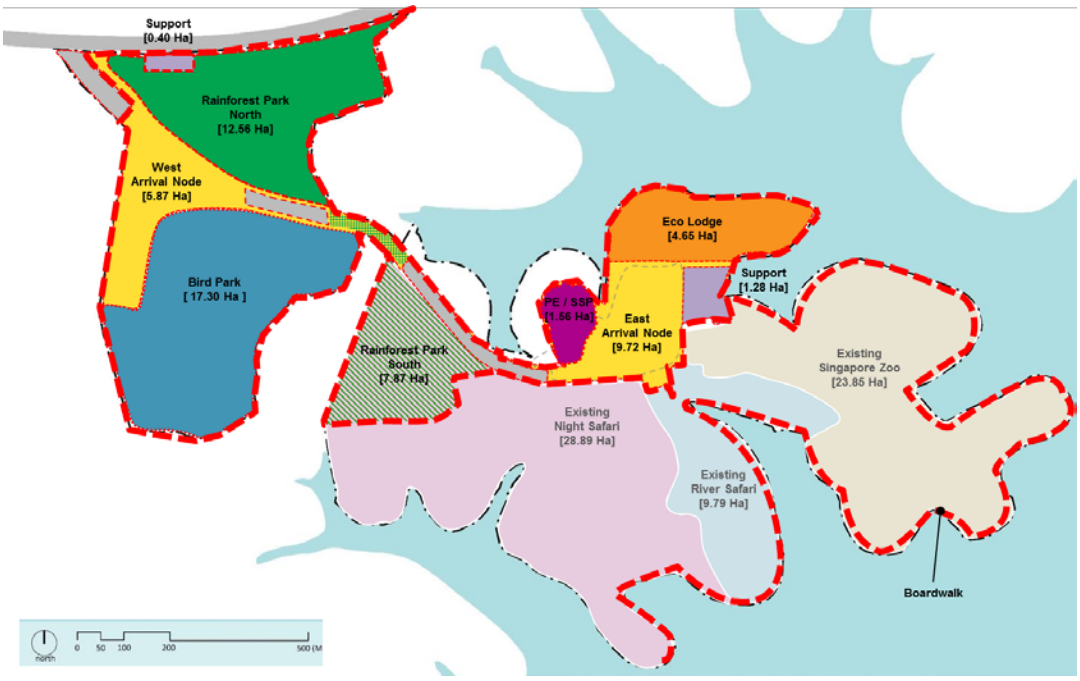


Figure A1.1. Proposed landuse for Mandai Development.

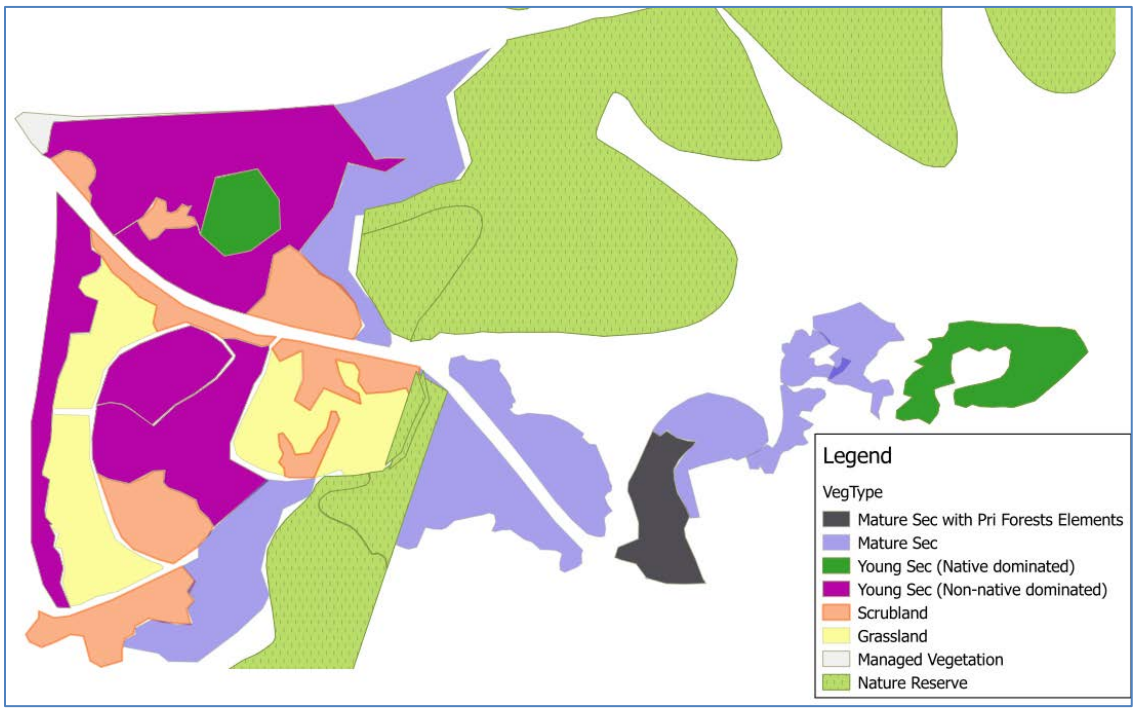


Figure A1.2. Vegetation Zonations for Mandai Development Site.

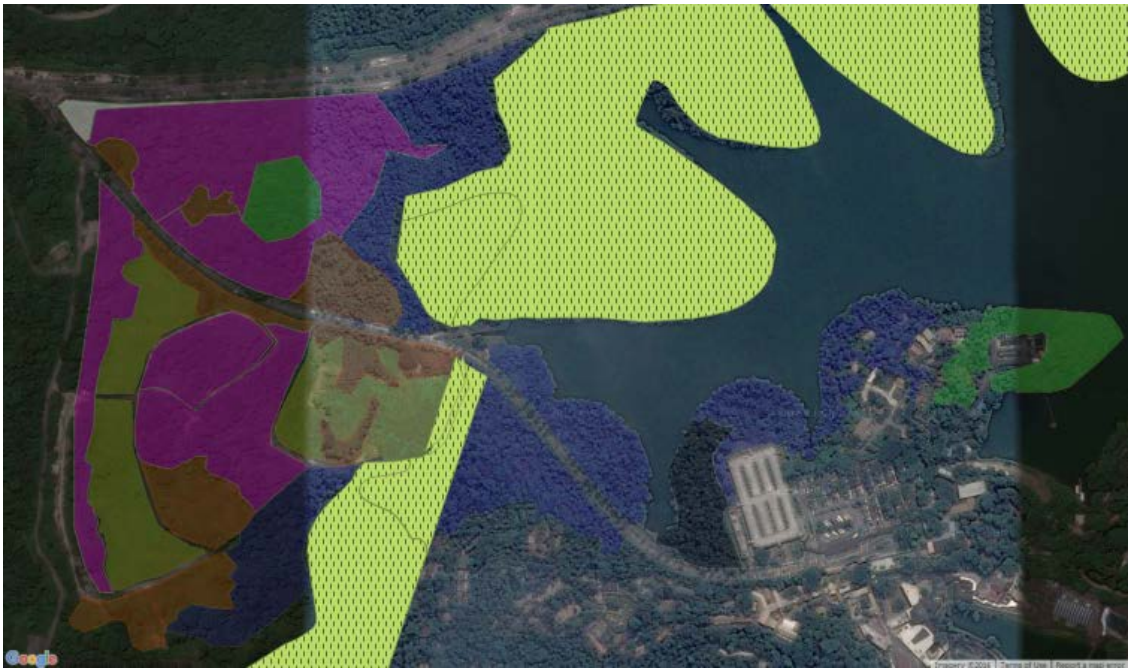


Figure A1.3. Vegetation Zonations for Mandai Development Site overlaying Google Earth Satallite Image.

Appendix 2. Recommended list of trees for restoration at Mandai Eco-Link.

The list is compiled based on previous research by Shono, Davies & Chua 2007c, Chua 2014, online web resources (Slik 2009), Tree Flora of Malaya Volume 1- 4 (Whitmore 1972a, 1972b, Ng 1978; Ng 1989), Wayside trees of Malaya Volume 1 and 2 (Corner 1988), and the author's experiences. The species are listed first by light requirement, then by species.

No.	Species	Habit (shrub; trees of understorey/ mid canopy/canopy /emergent)	Food resource	Successional stage (1= early, 2= mid, 3=late)	Light requirement at seedling/sapling stage	Presence of mature individuals at project site	N-fixing	Framework Species
1	*Bridelia tomentosa*	shrub/treelet	yes	1	light demanding	yes		yes
2	*Clerodendrum laevifolium*	shrub	yes	1	light demanding	no		yes
3	*Dillenia suffruticosa*	shrub/understorey	yes	1	light demanding	yes		yes
4	*Ficus aurata*	understorey	yes	1	light demanding	no		yes
5	*Ficus grossularioides*	understorey	yes	1	light demanding	no		yes
6	*Ixonanthes reticulata*	canopy		1	light demanding	no		
7	*Macaranga bancana*	understorey	yes	1	light demanding	yes		yes
8	*Macaranga conifera*	mid-canopy	yes	1	light demanding	yes		yes
9	*Macaranga gigantea*	mid-canopy	yes	1	light demanding	yes		yes
10	*Macaranga heynei*	mid-canopy	yes	1	light demanding	yes		yes
11	*Macaranga hypolueca*	mid-canopy	yes	1	light demanding	no		yes
12	*Mallotus paniculatus*	shrub	yes	1	light demanding	yes		yes
13	*Melastoma malabathricum*	shrub	yes	1	light demanding	no		yes
14	*Trema cannabina*	shrub	yes	1	light demanding	no		yes
15	*Trema tomentosa*	shrub	yes	1	light demanding	no		yes
16	*Alstonia angustifolia*	canopy		2	moderately light demanding	no		
17	*Alstonia angustiloba*	canopy		2	moderately light demanding	yes		
18	*Archidendron clypearia*	shrub		2	moderately light demanding	yes	yes	yes
19	*Archidendron ellipticum*	mid-canopy		2	moderately light demanding	no	yes	yes
20	*Archidendron jiringa*	mid-canopy		2	moderately light demanding	yes	yes	yes
21	*Artocarpus elasticus*	canopy	yes	2	moderately light demanding	yes		
22	*Calophyllum*	mid canopy	yes	2	moderately light demanding	yes		yes

No.	Species	Habit (shrub; trees of understorey/ mid canopy/canopy /emergent)	Food resource	Successional stage (1= early, 2= mid, 3=late)	Light requirement at seedling/sapling stage	Presence of mature individuals at project site	N-fixing	Framework Species
	ferrugineum							
23	*Calophyllum pulcherrimum*	mid canopy	yes	2	moderately light demanding	yes		yes
24	*Calophyllum tetrapterum*	mid canopy	yes	2	moderately light demanding	no		
25	*Calophyllum teysmanii*	mid canopy	yes	2	moderately light demanding	no		
26	*Campnosperma auriculata*	canopy	yes	2	light demanding	yes		yes
27	*Cinnamomum iners*	understorey	yes	2	moderately light demanding	yes		yes
28	*Clerodendrum villosum*	shrub	yes	2	moderately light demanding	yes		yes
29	*Cratoxylum cochinchinense*	mid canopy		2	moderately light demanding	no		
30	*Cratoxylum formosum*	mid-canopy		2	moderately light demanding	yes		
31	*Elaeocarpus ferrugineus*	mid-canopy	yes	2	moderately light demanding	yes		
32	*Elaeocarpus mastersii*	mid-canopy	yes	2	moderately light demanding	yes		yes
33	*Elaeocarpus pedunculatus*	mid-canopy	yes	2	moderately light demanding	yes		yes
34	*Elaeocarpus petiolatus*	mid-canopy	yes	2	moderately light demanding	yes		yes
35	*Ficus caulocarpa*	mid-canopy/strangler	yes	2	moderately light demanding	yes		yes
36	*Ficus fistulosa*	understorey	yes	2	moderately light demanding	yes		yes
37	*Ficus microcarpa*	mid-canopy/strangler	yes	2	moderately light demanding	yes		yes
38	*Ficus variegata*	mid canopy	yes	2	moderately light demanding	yes		yes
39	*Ficus virens*	mid-canopy/strangler	yes	2	moderately light demanding	no		yes
40	*Garcinia eugeniaefolia*	mid canopy	yes	2	moderately light demanding	no		
41	*Garcinia parvifolia*	canopy	yes	2	moderately light demanding	yes		
42	*Garcinia scortechinii*	mid canopy	yes	2	moderately light demanding	no		

No.	Species	Habit (shrub; trees of understorey/ mid canopy/canopy /emergent)	Food resource	Successional stage (1= early, 2= mid, 3=late)	Light requirement at seedling/sapling stage	Presence of mature individuals at project site	N-fixing	Framework Species
43	*Gironniera nervosa*	mid canopy	yes	2	moderately light demanding	no		
44	*Guioa pubescens*	mid canopy	yes	2	moderately light demanding	yes		
45	*Gynotroches axillaris*	canopy	yes	2	moderately light demanding	yes		
46	*Ilex cymosa*	mid-canopy	yes	2	moderately light demanding	yes		
47	*Lindera lucida*	mid-canopy	yes	2	moderately light demanding	yes		yes
48	*Litsea elliptica*	canopy	yes	2	moderately light demanding	yes		
49	*Litsea firma*	canopy	yes	2	moderately light demanding	yes		
50	*Macaranga griffithiana*	mid-canopy	yes	2	moderately light demanding	no		yes
51	*Prunus polystachya*	canopy	yes	2	moderately light demanding	yes		
52	*Pternandra coerulescens*	mid-canopy	yes	2	moderately light demanding	yes		
53	*Pternandra echinata*	mid-canopy	yes	2	moderately light demanding	yes		
54	*Rhodamnia cinerea*	mid canopy	yes	2	moderately light demanding	yes		
55	*Streblus elongatus*	mid canopy	yes	2	moderately light demanding	no		
56	*Syzygium borneense*	canopy	yes	2	moderately light demanding	yes		
57	*Syzygium grande*	canopy	yes	2	moderately light demanding	yes		
58	*Syzygium lineatum*	mid canopy	yes	2	moderately light demanding	yes		yes
59	*Syzygium polyanthum*	understorey	yes	2	moderately light demanding	yes		yes
60	*Timonius wallichianus*	mid canopy	yes	2	moderately light demanding	yes		
61	*Vitex pinnata*	mid canopy	yes	2	moderately light demanding	yes		
62	*Xanthophyllum affine*	mid-canopy	yes	2	moderately light demanding	yes		
63	*Anisoptera laevis*	emergent		3	shade tolerant	yes		
64	*Aporosa benthamiana*	mid-canopy	yes	3	shade tolerant	yes		
65	*Aporosa frutescens*	mid-canopy	yes	3	shade tolerant	yes		
66	*Aquilaria malaccensis*	emergent	yes	3	shade tolerant	yes		
67	*Archidendron contortum*	emergent		3	shade tolerant		yes	yes
68	*Ardisia colorata*	shrub	yes	3	shade tolerant	yes		
69	*Ardisia teysmanniana*	shrub	yes	3	shade tolerant	yes		
70	*Artocarpus dadah*	mid canopy	yes	3	shade tolerant	no		
71	*Baccaurea motleyana*	mid-canopy	yes	3	shade tolerant	yes		

No.	Species	Habit (shrub; trees of understorey/ mid canopy/canopy /emergent)	Food resource	Successional stage (1= early, 2= mid, 3=late)	Light requirement at seedling/sapling stage	Presence of mature individuals at project site	N-fixing	Framework Species
72	*Baccaurea parviflora*	shrub/treelet	yes	3	shade tolerant	yes		
73	*Beilschmiedia madang*	canopy	yes	3	shade tolerant	yes		
74	*Bhesa paniculata*	emergent	yes	3	shade tolerant	yes		
75	*Bhesa robusta*	canopy	yes	3	shade tolerant	yes		
76	*Bouea oppositifolia*	mid canopy	yes	3	shade tolerant	yes		
77	*Calophyllum lanigerum*	mid canopy	yes	3	shade tolerant	yes		
78	*Canarium littorale*	mid canopy	yes	3	moderately light demanding	no		
79	*Canthium glabrum*	understorey	yes	3	shade tolerant	yes		
80	*Carallia brachiata*	mid canopy	yes	3	shade tolerant	yes		
81	*Cleistanthus malaccensis*	understorey		3	moderately light demanding	no		
82	*Cryptocarya griffithiana*	mid-canopy	yes	3	shade tolerant	yes		
83	*Dialium indum*	emergent		3	shade tolerant	ni	yes	yes
84	*Dialium platysepalum*	emergent		3	shade tolerant	yes	yes	yes
85	*Diospyros lanceifolia*	mid-canopy	yes	3	shade tolerant	yes		
86	*Dipterocarpus caudatus*	emergent		3	moderately light demanding	no		
87	*Dyera costulata*	emergent		3	shade tolerant	yes		
88	*Eurycoma longifolia*	understorey	yes	3	shade tolerant	yes		
89	*Ficus vasculosa*	canopy	yes	3	shade tolerant	yes		
90	*Gluta wallichii*	emergent		3	shade tolerant	yes		
91	*Glycosmis chlorosperma*	shrub	yes	3	shade tolerant	yes		
92	*Hopea ferruginea*	canopy		3	shade tolerant	yes		
93	*Horsfieldia sucosa*	mid canopy	yes	3	shade tolerant	yes		
94	*Intsia palembanica*	emergent		3	moderately light demanding	no	yes	yes
95	*Ixora congesta*	understorey	yes	3	shade tolerant	?		
96	*Ixora pendula*	understorey	yes	3	shade tolerant	?		
97	*Knema malayana*	understorey	yes	3	shade tolerant	yes		
98	*Koompassia malaccensis*	emergent		3	moderately light demanding	no	yes	yes
99	*Lithocarpus conocarpus*	mid canopy	yes	3	shade tolerant	yes		
100	*Lithocarpus elegans*	canopy	yes	3	shade tolerant	yes		

No.	Species	Habit (shrub; trees of understorey/ mid canopy/canopy /emergent)	Food resource	Successional stage (1= early, 2= mid, 3=late)	Light requirement at seedling/sapling stage	Presence of mature individuals at project site	N-fixing	Framework Species
101	*Lithocarpus ewyckii*	canopy	yes	3	moderately light demanding	no	yes	yes
102	*Litsea accedens*	mid storey	yes	3	shade tolerant	yes		
103	*Memecylon garcinioides*	shrub	yes	3	shade tolerant	yes		
104	*Memecylon minutiflorum*	canopy	yes	3	shade tolerant	yes		
105	*Memecylon paniculatum*	understorey	yes	3	shade tolerant	yes		
106	*Nothaphoebe umbelliflora*	canopy	yes	3	shade tolerant	no		
107	*Parkia speciosa*	emergent		3	moderately light demanding	no	yes	yes
108	*Pellacalyx axillaris*	mid-canopy	yes	3	shade tolerant	yes		
109	*Pentace triptera*	canopy		3	moderately light demanding	no		
110	*Pimelodendron griffithianum*	mid canopy	yes	3	shade tolerant	yes		
111	*Porterandia anisophylla*	understorey	yes	3	shade tolerant	yes		
112	*Sandoricum koetjape*	mid canopy	yes	3	moderately light demanding	no		yes
113	*Shorea leprosula*	emergent		3	moderately light demanding	yes		
114	*Sindora wallichii*	emergent		3	shade tolerant	yes	yes	yes
115	*Sterculia rubiginosa*	mid-canopy	yes	3	shade tolerant	yes		
116	*Strombosia ceylanica*	canopy	yes	3	shade tolerant	yes		
117	*Syzygium nemestrinum*	canopy	yes	3	shade tolerant	yes		
118	*Syzygium palembanicum*	canopy	yes	3	shade tolerant	yes		
119	*Syzygium scortechinii*	mid-canopy	yes	3	shade tolerant	yes		
120	*Syzygium syzygioides*	canopy	yes	3	moderately light demanding	yes		
121	*Xanthophyllum eurhynchum*	mid-canopy	yes	3	shade tolerant	yes		
122	*Xerospermum noronhianum*	mid-canopy	yes	3	shade tolerant	no		

Appendix 3. List of non-native and invasive trees (source: Nghiem *et al.* 2015)

No.	Species	Native range	Shade tolerant seedlings
1	*Acacia auriculiformis*	N. Australia to New Guinea	no
2	*Andira inernis*	Tropical America and Africa	yes
3	*Cercopia pachystachya*	South America	no
4	*Cecropia peltata**	South America	no
5	*Falcataria moluccana*	The Moluccas, New Guinea, the Bismarck Archipelago	no
6	*Hevea brasiliensis*	Tropical America	yes
7	*Leucaena leucocephala*	Central America	no
8	*Manihot carthagenesis subp. Glaziovii*	West Brazil	no
9	*Muntingia calabura*	Tropical America	no
10	*Piper aduncum*	Tropical America	no
11	*Pipturus argenteus*	N. Australia to Borneo, Pacific islands to the Philippines, islands on the west coast of Pen. Malaysia	no
12	*Spathodea campanulata*	West Africa	moderate

*****_Cecropia peltata_ was not listed as invasive in Nghiem *et al.* 2015, but it is included here because of its potential to be invasive based on its similarity to *C. pachystachya* (Lok *et al.* 2010).

Annex 15.2

Planting and Species Association

Annex 15.2: List of Trees for Restoration at Mandai Ecolink with Known Fauna Associations

No.	Species	Habit (shrub; trees of understorey/ mid canopy/canopy /emergent)	Food resource	Fauna	Interaction
1	*Bridelia tomentosa*	shrub/treelet	yes	Straw-headed Bulbul	Food source (Fruit)
2	*Dillenia suffruticosa*	shrub/understorey	yes	Frugivorous birds (General)	Food source (Fruit)
				Thick-billed Green Pigeon	Food source (Fruit)
				Peninsula Rock Gecko Lowland Dwarf Gecko	Refuge site
3	*Ixonanthes reticulata*	canopy	yes	Banded leaf monkey	Food source (Fruit)
4	*Macaranga bancana*	understorey	yes	Blue-crowned Hanging Parrot; Yellow-eared Spiderhunter; Red-eyed Bulbul; Black-headed Bulbul; Leafbirds; and migratory flycatchers.	Food source (Fruit)
5	*Macaranga gigantea*	mid-canopy	yes	Malayan Colugo	Forage
				Frugivorous birds (General)	Food source (Fruit)
6	*Macaranga heynei*	mid-canopy	yes	Nesting material for birds	
7	*Mallotus paniculatus*	shrub	yes	Red-crowned Barbet	Food source (Fruit)
8	*Melastoma malabathricum*	shrub	yes	Red-crowned Barbet	Food source (Fruit)
9	*Trema tomentosa*	shrub	yes	Frugivorous birds (General)	Food source (Fruit)
10	*Alstonia angustiloba*	canopy		Frugivorous birds (General)	Food source (Fruit)
11	*Artocarpus elasticus*	canopy	yes	Banded leaf monkey	Food source (Fruit)
				Long-tailed Macaque	Food source (Fruit)
12	*Campnosperma auriculata*	canopy	yes	Malayan Colugo	Food source (Leaves)
13	*Cinnamomum iners*	understorey	yes	Red-crowned Barbet	Food source (Fruit)
14	*Cratoxylum formosum*	mid-canopy		Birds (General)	Nesting material
15	*Elaeocarpus ferrugineus*	mid-canopy	yes	Red-crowned Barbet	Food source (Fruit)
16	*Elaeocarpus mastersii*	mid-canopy	yes	Red-crowned Barbet	Food source (Fruit)
17	*Elaeocarpus pedunculatus*	mid-canopy	yes	Red-crowned Barbet	Food source (Fruit)
18	*Elaeocarpus petiolatus*	mid-canopy	yes	Red-crowned Barbet	Food source (Fruit)
19	*Ficus caulocarpa*	mid-canopy/strangler	yes	Red-crowned Barbet; Thick-billed Green-pigeon; Leafbirds; Hornbills; Bulbuls; Asian-Fairy-bluebird; and migratory birds.	Food source (Fruit)

No.	Species	Habit (shrub; trees of understorey/ mid canopy/canopy /emergent)	Food resource	Fauna	Interaction
20	*Ficus fistulosa*	understorey	yes	Frugivorous birds (General)	Food source (Fruit)
21	*Ficus microcarpa*	mid-canopy/strangler	yes	Red-crowned Barbet; Oriental Pied Hornbill; Asian Fairy-bluebird	Food source (Fruit)
				Malayan Colugo	Food source (Leaves)
22	*Ficus virens*	mid-canopy/strangler	yes	- Thick-billed Green Pigeon - Blue-crowned Hanging Parrot	Food source (Fruit)
23	*Gynotroches axillaris*	canopy	yes	Malayan Colugo	Food source (Leaves)
24	*Ilex cymosa*	mid-canopy	yes	Malayan Colugo	Food source (Leaves)
25	*Litsea elliptica*	canopy	yes	Banded leaf monkey	Food source (Fruit)
26	*Litsea firma*	canopy	yes	Banded leaf monkey	Food source (Fruit)
27	*Prunus polystachya*	canopy	yes	Sunda Slow Loris	Food source (Sap)
28	*Rhodamnia cinerea*	mid canopy	yes	Horsfield's Flying Squirrel	Food source (Fruit)
				Malayan Colugo	Food source (Leaves)
29	*Syzygium grande*	canopy	yes	Frugivorous birds (General)	Food source (Fruit)
				Malayan Colugo	Food source (Leaves)
30	*Syzygium lineatum*	mid canopy	yes	Malayan Colugo	Food source (Leaves)
31	*Syzygium polyanthum*	understorey	yes	Red-crowned Barbet; Asian Fairy-bluebird; Leafbirds; migratory birds	Food source (Fruit)
32	*Vitex pinnata*	mid canopy	yes	Malayan Colugo	Food source (Leaves)
33	*Knema malayana*	understorey	yes	Banded leaf monkey	Food source (Fruit)
34	*Nothaphoebe umbelliflora*	canopy	yes	Banded leaf monkey	Food source (Young leaves)
35	*Pellacalyx axillaris*	mid-canopy	yes	Banded leaf monkey	Food source (Fruit)
36	*Syzygium palembanicum*	canopy	yes	Malayan Colugo	Food source (Leaves)
37	*Lophopetalum multinervium*	emergent	yes	Banded leaf monkey	Food source (Fruit)
38	*Agelaea macrophylla*	Climber	yes	Banded leaf monkey	Food source (Fruit)
39	*Tetracera indica*	Climber	yes	Banded leaf monkey	Food source (Fruit)
40	*Bauhinia semibifida*	Climber	yes	Banded leaf monkey	Food source (Leaves and flowers)
41	*Fagraea fragrans*	canopy	yes	Banded leaf monkey	Food source (Leaves)
42	*Litsea castanea*	canopy	yes	Banded leaf monkey	Food source (Leaves)
43	*Fibraurea tinctoria*	Climber	yes	Banded leaf monkey	Food source (Flowers)
44	*Adinandra dumosa*	mid-canopy	yes	Banded leaf monkey	Food source (Flowers)
45	*Xanthophyllum ellipticum*	understorey/tree	yes	Banded leaf monkey	Food source (Fruit)

No.	Species	Habit (shrub; trees of understorey/ mid canopy/canopy /emergent)	Food resource	Fauna	Interaction
46	*Xanthophyllum eurhynchum*	understorey/shrub	yes	Banded leaf monkey	Food source (Leaves)
47	*Nephelium lappaceum*	understorey/shrub	yes	Banded leaf monkey	Food source (Fruit)
				Blue-crowned Hanging Parrot; Yellow-eared Spiderhunter	Food source (Fruit)
48	*Palaquium xanthochymum*	mid-canopy	yes	Banded leaf monkey	Food source (Fruit)
49	*Buchanania arborescens*	canopy	yes	Malayan Colugo	Food source (Leaves)
				Sunda Slow Loris	Food source (Sap)
50	*Calophyllum soulattri*	canopy	yes	Malayan Colugo	Food source (Leaves)
51	*Macaranga pruinosa*	mid-canopy	yes	Malayan Colugo	Food source (Leaves)
52	*Peltophorum pterocarpum*	mid-canopy	yes	Malayan Colugo	Food source (Leaves)
53	*Saraca thaipingensis*	understorey/tree	yes	Malayan Colugo	Food source (Leaves)
54	*Artocarpus kemando*	mid-canopy	yes	Malayan Colugo	Food source (Leaves)
55	*Oncosperma tigillarium*	understorey/shrub	yes	Malayan Colugo	Food source (Leaves)
56	*Caryota mitis*	understorey/tree	yes	Red-crowned Barbet	Food source (Fruit)
57	*Durio sp.*	mid-canopy	yes	Yellow-eared Spiderhunter	Food source (Nectar)
58	*Pouteria obovata*	mid-canopy	yes	Sunda Slow Loris	Food source (Nectar/floral parts)
59	*Chisocheton macrophyllus*	mid-canopy	yes	Sunda Slow Loris	Food source (Sap)
60	*Mangifera griffithii*	mid-canopy	yes	Sunda Slow Loris	Food source (Sap)
61	*Buchanania sessifolia*	mid-canopy	yes	Sunda Slow Loris	Food source (Sap)
62	*Reinwardtiodendron humile*	mid-canopy	yes	Sunda Slow Loris	Food source (Sap)
63	*Dacryodes rugosa*	mid-canopy	yes	Sunda Slow Loris	Food source (Sap)
64	*Anacardium occidentale*	understorey/tree	yes	Sunda Slow Loris	Food source (Gum)
65	*Artocarpus heterophyllus*	mid-canopy	yes	Sunda Slow Loris	Food source (Fruit)
				Long-tailed Macaque	Food source (Fruit)
66	*Pometia pinnata*	canopy	yes	Sunda Slow Loris	Food source (Fruit)
67	*Ixonanthes icosandra*	mid-canopy	yes	Sunda Slow Loris	Food source (Fruit)
68	*Rhodomyrtus tomentosa*	understorey/shrub	yes	Sunda Slow Loris	Food source (Fruit)
				Frugivorous birds (General)	Food source (Fruit)

Annex 16.0

Risk Assessment Methodology

(Note, 'MRSP' as mentioned herein refers to 'MPH')

Mandai Safari Park – Quantitative Risk Assessment (QRA) for Water Quality - Method Statement

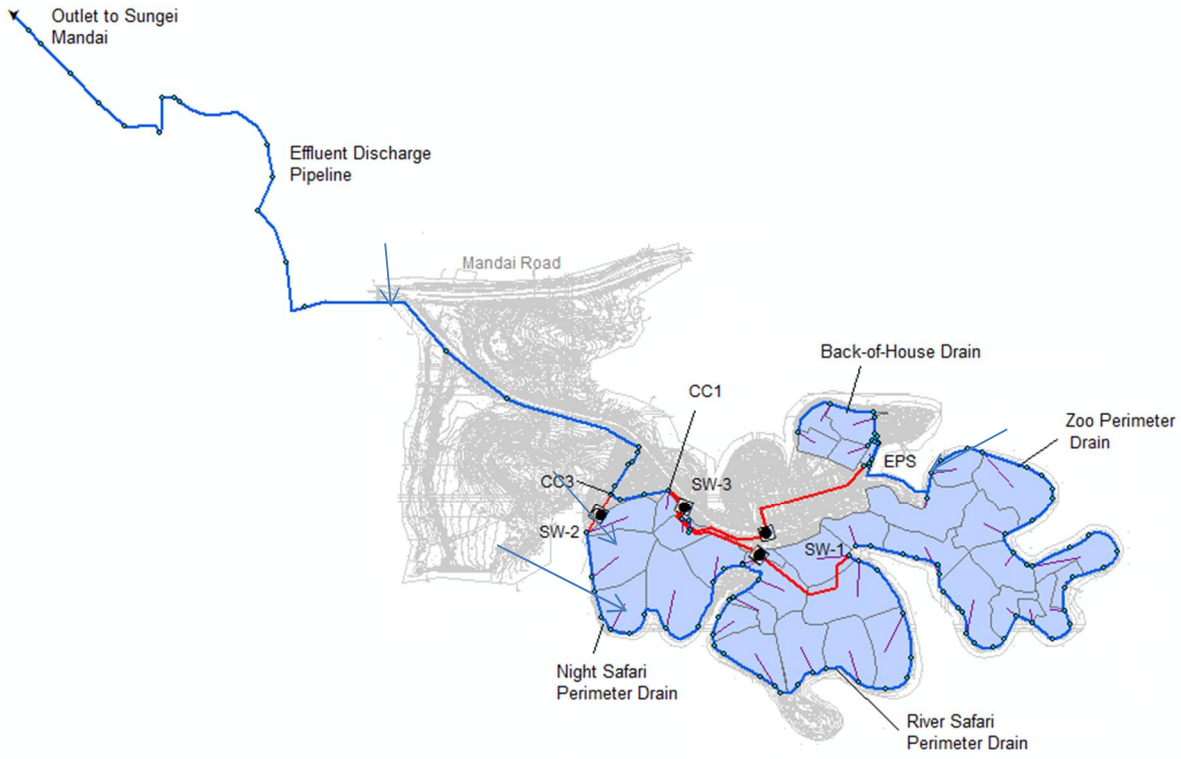
Introduction

1.1 Overview of Existing Drainage System

Currently, stormwater runoff from the majority of the existing attractions (Zoo, Night Safari and River Safari) is collected in 4 open channel Perimeter Drains (Night Safari, River Safari, Zoo and Back-of-house), which convey runoff to 3 stormwater pumping stations SW2, SW1, EPS respectively. A small drainage system near the entrance to the Night Safari also drains to a fourth pumping station SW3. Within the existing attractions, a limited number of exhibits contain enclosures or wet moats where runoff is drained to the sewer and conveyed to the existing Sewage Treatment Plant (STP) at the Zoo Back-of House (BOH). A plan showing the existing stormwater system layout and catchment areas is provided in Figure 1.

Treated wastewater effluent (human and animal waste) from the existing STP is also conveyed to the EPS for discharge off-site together with stormwater runoff from the Zoo. The EPS, SW1 and SW3 pump via separate pressure mains to collection manhole CC1, and SW2 pumps to collection manhole CC3. The downstream "Effluent Discharge Pipeline" (EDP) is a 700mm diameter gravity system which is partly pressurized along Mandai Lake Road, due to its undulating vertical alignment. The EDP conveys runoff and treated effluent over approximately 3.2km, discharging into a large drainage canal which ultimately discharges to Sungei Mandai. This system currently serves a total catchment area of approximately 62 ha.

Figure 1 –Layout of Existing Zoo Stormwater and Effluent Discharge System



Some portions of the proposed development site currently drain to Upper Seletar Reservoir (USR) or separately to Sungei Mandai. The existing car parking area, buffer zones outside the perimeter drain systems and some sections of Mandai Lake Road drain directly to Upper Seletar

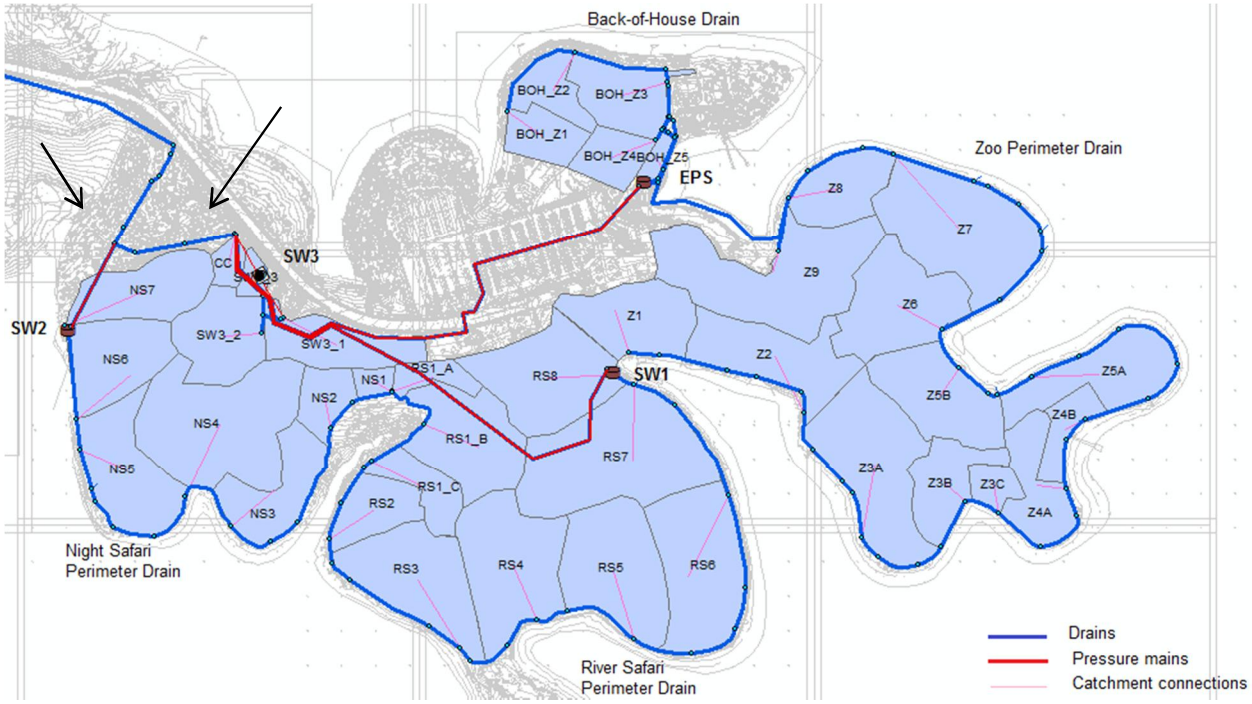
Reservoir. The proposed Bird Park site currently drains to Sungei Mandai via the rural stream at Track 15 or via roadside drains along Mandai Lake Road.

1.2 Mandai Stormwater System Hydraulic Model

A hydraulic model of the Mandai Stormwater system has been developed in MIKE URBAN to assess existing system capacity and assess future system upgrade options. The model was calibrated using available flow monitoring data provided by WRS. This model will be utilized for this water quality risk assessment through use of the add-on Pollutant Transport module.

The entire Perimeter Drain systems in each of the three existing attractions, including pumping stations, pressure mains and the downstream Effluent Discharge Pipeline to Sungei Mandai have been included in the model based on the available topographic survey, additional as-built drawings, photographic records provided by CPG, site visits and data provided by WRS. The model layout for existing attractions, including subcatchment delineation and load points, is shown in Figure 2. Modelled load points represent junctions of major internal drains with the Perimeter Drains. For more details of hydraulic modelling, refer to Zoo Stormwater and Effluent Management – Hydraulic Modelling and Options Assessment, (AECOM, May, 2016).

Figure 2 –Model Layout – Existing Attractions



1.2 Water Quality Risk

When the hydraulic capacity of the existing Perimeter Drains and pumps are exceeded, runoff will overflow from a number of locations along the drainage systems to the Upper Seletar Reservoir (USR), which is an impoundment for drinking water supply. Recent hydraulic assessment of the existing stormwater system has indicated that the current overall system capacity is likely to be less than a 2 year ARI, due to the limited capacity of the pumping stations in all 3 perimeter drain catchments (EPS, SW-1 and SW-2), and also due to conveyance capacity limitations in the Zoo

perimeter drain and localized capacity issues in the RS, NS and Zoo BOH Perimeter Drains[1]. Determining a suitable design system containment standard requires a comparison of the predicted overflow pollutant loads to the USR against levels considered acceptable by PUB.

Prediction and assessment of water quality risk to USR will require an understanding of the current concentrations and loads of pollutants of concern generated and transported by the drainage systems, and the spatial and temporal variation in these due to rainfall and catchment characteristics. The quantity of pollutants entering the USR from predicted drainage system overflows will depend on the containment standard implemented, the relationship between concentrations and rainfall intensity/frequency/duration, including any first flush effects, and the composition of the catchment, in terms of types of exhibits, animals and their populations.

No historical water quality data is available for the existing stormwater drainage systems at the existing attractions. However, it is understood that MRPS is deploying two autosamplers in the existing system to capture water quality data for a range of parameters agreed with PUB, for a minimum of three significant storm events for analysis.

1.3 Pollutant Transport Modelling Approach

Detailed modelling of pollutant transport in stormwater drainage systems is an extremely complex process, and typically requires a large amount of data to account for the highly variable hydrological and pollutant generation parameters, spatially and temporally [2]. Processes initially involve the build-up and wash-off of pollutants from catchment areas, which varies with rainfall, and then the transport of these pollutants in drainage systems. In addition, pollutants may be both dissolved and/or particulate, and may be transported as dissolved, suspended material or bed load. It is assumed that contaminants of concern for the USR are primarily (fine) suspended or dissolved solids and micro-organisms such as fecal coliforms. The very fine suspended pollutants behave essentially as dissolved.

An alternative approach is to utilise the hydraulic models to analyse the transmission of tracers (hypothetical load/concentration of a pollutant injected at single or multiple sources, concurrently or at various times) along a system. The dominant mixing process in linear drainage systems is longitudinal dispersion. Generally the short timeframe of conveyance of storm events through a drainage system makes other processes such as first order decay and diffusion relatively insignificant. The PT module of MIKE URBAN enables coupling of the hydrodynamic simulations to advection-dispersion of dissolved pollutants or fine suspended solids.

2.0 Objective

The objective of this QRA is to provide PUB with an assessment of current water quality parameters plus predicted locations and relative magnitudes of pollutant loads in system overflows for future 10 and 25 year design system containment standards. These findings will enable PUB to determine an appropriate design standard to be applied to the Mandai Development. The objective will be achieved by the following two independent tasks:

[1] AECOM, May 2016. Zoo Stormwater and Effluent Management – Hydraulic Modelling and Options Assessment (Draft), prepared for MRSP.
[2] MOUSE Pollutant Transport Reference Manual, DHI 2014.; Modelling of Hydraulics and Pollutant Transport in Sewers, Kowalska B & D, 2013.

- Analysing the data from two autosamplers located within the existing attractions stormwater system
- Estimating the relative concentrations and loads of a conservative pollutant that would enter the USR in storm events exceeding each design containment standard, by tracer analysis.

3.0 Methodology

3.1 Task 1 - Water Quality Data Analysis

It is understood that two autosamplers will be deployed within the perimeter drain system of existing attractions, and that the final locations will be agreed between the engaged contractor and MRSP, taking into consideration the potential backwater effect from the pumping stations and potential blockage of trash racks within the drains. These autosamplers will include level/velocity monitoring and rain gauges to capture concurrent rainfall data. A minimum of three significant storm events will be captured overall for the parameters listed in Table 1.

Table 1 – Water Quality Parameters of Concern

Parameters – Minimum 3 sets of storm data to be collected	**Units**	**Parameters – Minimum 1 sets of storm data to be collected**	**Units**
Turbidity	NTU	*Vibrio Cholera*	per L
Conductivity	uS/cm	*P. aeruginosa*	per 100mL [1]
pH	Unit	Coliphage (male-specific)	per 100mL [1]
Total Organic Carbon (TOC	mg/L	Coliphage (somatic)	per 100mL [1]
Total Suspended Solids (TSS)	mg/L	*Cryptosporidium sp.*	per 10L [2]
Ammonia (as N)	mg/L	*Giardia lamblia*	per 10L [2]
Nitrate (as N)	mg/L		
Chloride	mg/L		
Sulphate	mg/L		
Dissolved Phosphorus (as P)	mg/L		
Total Phosphorus (as P)	mg/L		
Total Nitrogen (as N)	mg/L		
COD	mg/L		
BOD	mg/L		
Total Coliforms	per 100mL		
E.coli	per 100mL		
Enterrococcus	per 100mL		

Notes: 1. Acceptable instead of 1L; 2. Acceptable instead of 20L (1 storm event is sufficient)

Once the two autosampler sites are confirmed, the contributing catchment areas will be estimated, together with a summary of land use breakdown (impervious/pervious area) and types of exhibits within the catchments, including number of herbivore, carnivore and omnivore exhibits and current animal populations in these exhibits.

AECOM will process the data collected from the autosamplers, flow monitors and rain gauges to develop the following for each sampling site:

- Hydrographs and associated Pollutographs of each parameter for each storm event – plots of discharge and pollutant concentration over time
- Event mean concentrations (EMC) (mg/L) - flow-weighted averages of pollutant concentration
- Event pollutant loads per unit area (EPL) (kg/ha)
- Mass first flush ratio (MFFn) – plots of MFFn versus cumulative runoff for each storm event. This will identify any first flush effects and indicate the magnitude of first flush up to a certain percentage of the runoff.
- Qualitative assessment of event pollutant loads and animal composition of each autosampler catchment – to verify assumptions on pollutant generation by animal type (herbivore, carnivore, omnivore).

Further qualitative analysis of the data will include an assessment of potential correlation between EMC and rainfall/storm magnitude, and EPL with rainfall intensity/runoff. This task will be dependent on the potential range of storm data able to be captured by the autosamplers in the limited time allocated. It is assumed that there will be inadequate data to assess the potential impact of antecedent dry days (ADD) on EMCs and EPLs.

3.2 Task 2 - Water Quality Tracer Modelling

3.2.1 Scenarios

AECOM propose to utilise the existing 1D MIKE URBAN model of the stormwater collection system for existing attractions to simulate pollutant transport from multiple source locations along the Perimeter Drains, using a single tracer representing a hypothetical dissolved pollutant. The following scenarios and simulations will be modelled:

- Scenario 1: Baseline Conditions (existing drains and pumping stations – no upgrades)
- Scenario 2: Future Conditions, 10 year ARI System Capacity
- Scenario 3: Future Conditions, 25 year ARI System Capacity

For all scenarios, it will be assumed that there are no trash rack blockages within any of the perimeter drain systems. However, a separate assessment by WRS is recommended to improve the current approach to trash/debris management within the drainage system to minimise the risk of blockages.

3.2.2 Future Conditions

The existing Zoo catchment will be modified to include additional areas from the East Node, RE/SSR, Ecolodge and some sections of Mandai Lake Road, which will drain to EPS in the future. The SW1 catchment is assumed to be unchanged from its current conditions in the future, with the exception of the SW1 catchment which will be modified to include runoff from the Giraffe exhibit in the future.

The proposed Rainforest Park 2 (RFP2) area currently encompasses a large proportion of existing Night Safari, with additional area to the north draining to roadside drains some of which currently drain to USR. The SW2 and SW3 catchment will be modified to reflect the future encroachment of

the RFP2 into the Night Safari area and SW3 catchment, and additional catchment area from Mandai Lake Road.

The proposed Rainforest Park 1 (RFP1) area on the northern side of Mandai Lake Road, currently drains to Sungei Mandai. The proposed Bird Park and West Node existing sites currently generally drain to the west to the Track 15 natural stream and the north to roadside drains in Mandai Lake Road. These areas do not drain directly or overflow to USR, but overflow to drains that discharge to Sungei Mandai upstream of PUB's abstraction point that pumps runoff of this catchment towards USR. As such, similar subsequent considerations in drainage design should be made for the new proposed Bird Park and West Node.

Future stormwater system upgrades will be as per the 10 and 25 year System Schematics provided to MRSP on 21 May, 2016. Therefore it is assumed that only one future system option will be modelled for each Return Period.

3.2.3 Design Storms

Scenarios will be modelled as follows, for the range of hydrological inputs [3]:

- 10 year ARI Design Storm - Scenario 1 only
- 25 year ARI Design Storm - Scenario 1 and 2 only
- 50 year ARI Design Storm – Scenarios 1, 2, and 3
- 100 year ARI Design Storm – Scenarios 1, 2 and 3

3.2.4 Modelling approach

Pollutant Loads

For tracer simulation, pollutant loads will be injected at all current subcatchment load points representing lateral internal drain discharge points to the Perimeter Drains or pumping stations. Each load point will have a weighted pollutant loading based on the proportion of each subcatchment area housing the three different types of animals (herbivores, Carnivores, omnivores) areas within each subcatchment, multiplied by the following tracer load factors:

- Carnivores – x 1
- Omnivores – x 2
- Herbivores – x 3.

It has been assumed that Task 2 would precede Task 1 due to the time required to collect adequate water quality samples, ahead of any data analysis. As such, any findings regarding variation of EMCs or EPLs with storm magnitude would not be able to be incorporated. Therefore the same weighted concentrations for tracer injections will be applied to the range of design storms. Should Task 1 findings indicate that EMCs vary with storm magnitude, then the application of an additional factors to the Task 2 results, will be discussed with MRSP and PUB. However, should Task 1 findings indicate the presence of a first flush effect, consideration of this should be factored into the pollutant loads, potentially in the form of a time varying load concentration, rather than a constant

[3] Scenario 2 has a 10 year design standard and therefore will only overflow for design storms in excess of 10 year ARI. Scenario 3 has a 25 year design standard and therefore will only overflow for design storms in excess of 25 year ARI.

concentration. The needs for any additional simulations with modified load assumptions, after completion of Task 1 and the QRA, will be discussed with PUB, but have not been allowed for in this Method Statement.

Model Refinement

The existing MIKE URBAN model will be refined as follows:

- Model calibration [4] - available monitoring data will be used to calibrate the hydraulic model of existing attractions, to provide the required level of confidence in the model's predictive capability for the design storm simulations. Additional calibration of SW3 system to be included.
- Subcatchment modification to include exhibit areas discharging to sewer above their estimate containment capacity for discharging to sewer. Runoff from these areas will be discharged out of the system (representing sewer discharge) up to the adopted containment capacity of the sewer collection system. For storms in excess of this capacity, overflow will be conveyed to the internal drainage system and/or direct to the Perimeter Drains
- Refinement of perimeter drain systems to include additional drain data points (as nodes with IL, channel wall top level and additional overflow weirs to USR representing channel overtopping at potential spill locations), to ensure data points at less than 50m spacing where topographic survey data permits.
- Confirmation of the "overspill weirs" and overflow structures on the Night Safari/ River Safari and Zoo Perimeter Drains, based on additional topographic survey.
- Modification of model links to include adequate intermediate computational grid points to facilitate pollutant transport simulation.
- Refinement of Future Conditions model to reflect proposed modifications to the overall catchments and drainage systems, where future development impacts potential hydrological and water quality loading to the systems, as outlined in Section 3.2.2.
- Setting up of 50 and 100 year ARI design storms – design rainfall hyetographs for these additional design storms will be added to the model, and associated catchment loading scenario alternatives set up.
- Add weighted tracer loading to the subcatchment load points for existing and future scenarios (potentially different for different design storms as outlined above)
- Add Advection-Dispersion coefficients.

Each system scenario will be modelled for the proposed range of storm events. Predicted active overflow locations will be identified on each stormwater system and the corresponding pollutant concentrations and loads at each overflow quantified.

4.0 Limitations for Decision Making / Exclusions

The findings of the two separate QRA tasks will be submitted to MRSP and PUB for their subsequent assessment to determine a suitable system containment design standard. The impacts of predicted localized overflows of a certain concentration of pollutant into the USR will need to be

[4] A hydraulic model calibration has been undertaken ahead of this QRA, for the purposes of presenting model development, calibration and system capacity assessment to PUB, for their review and approval to proceed with the QRA. The calibration was required earlier to demonstrate the robustness of the hydraulic model for the purposes of the water quality tracer simulations. The model calibration was not part of the original C&S scope of services and was undertaken primarily for use in this QRA. Refer to the report "Zoo Stormwater and Effluent Management: Hydraulic Modelling and Options Assessment Report – Appendix C" (AECOM, May 2016).

assessed based on the design frequency of each scenario together with an understanding of the potential fate of the pollutant overflow in the reservoir water body, subject to in-lake mixing and dispersion and other processes.

No analysis of USR water quality data is included in this QRA.

No allowance has been made to correlate observed and predicted pollutant transport of specific parameters as part of the tracer modelling.

Due to the relative timelines of tasks, interpretation of Task 1 findings will not influence pollutant load assumptions under Task 2, however, findings will be made available to PUB regarding any potential variability of pollutant EMC or EPL with increasing storm magnitude, or any first flush effect evident (however, this may vary between parameters sampled).

The findings of Task 2 will indicate the proportion of a conservative pollutant that is predicted to overflow to the USR at various locations, for defined system capacities and the range of design storm events. They will not represent predictions of concentrations/loads of any particular pollutant discharged to USR. Only advection-dispersion pollutant transport processes are included in the tracer modelling. Therefore results will not represent the pollutant transport of sediment or any sediment-bound pollutants.

The constant concentrations or rating curves derived from data for such a limited sampling period is often difficult to apply beyond the storm magnitude range of the collected dataset. Unless adequate data is collected to determine the frequency distribution of the range of parameters of concern, then there is a risk of very large potential errors when this data is used to extrapolate to different conditions (ie. extreme storms, 50 and 100 year Return Period). The effects of dilution in such large storm events may not be evident with limited sampling data.

Annex 17.0

Candidate Relocation Refuge Areas

No.	Target Species Groups	Species	Requirements for Candidate Refuge Areas	Habitat Types where Species is Found	Candidate Refuge Areas [1]				
					1. CCNR (south)	2. Special Use Land to the west	3. CCNR (north) [2]	4. Water Edge Habitats	5. WRS Site
1	Ground Dwelling Mammal	Sunda Pangolin	- Sites with mature large trees to provide tree hollows for den sites (in tree or at tree base) - Availability of ant and termite nests (food source)	Primary and secondary forests	✓	✓			
2	Ground Dwelling Mammal	Lesser Mousedeer	- Sites with availability of fruiting trees and shoots - Does not strictly require mature forests	Primary and secondary forests	✓	✓			
3	Arboreal Mammal	Banded Leaf Monkey	- Availability of fruiting trees and young leaves - Shy species that requires mature forest that is buffered from urban environments	Primary and secondary forests	✓		✓		
4	Arboreal Mammal	Malayan Colugo	- Forests with taller trees - Forests with diverse flora composition for generalist diet - Mature trees to provide cavities for refuge and rest	Primary and secondary forests	✓	✓			✓
5	Arboreal Mammal	Sunda Slow Loris	- Mature forests with closed canopies - Availability of tree species that produce nectar, gum and sap	Primary and secondary forests	✓	✓			✓
6	Arboreal Mammal	Horsfield's Flying Squirrel	- Availability of tree holes for nesting	Primary and secondary forests	✓	✓			✓
7	Forest Dwelling Herpetofauna	Twin-barred Tree Snake	-	Primary and secondary forests	✓	✓			✓
8	Forest Dwelling Herpetofauna	Red-tailed Racer	- Availability of mature forests	Primary and secondary forests	✓	✓			✓
9	Forest Dwelling Herpetofauna	Lowland Dwarf Gecko	-	Primary and secondary forests	✓	✓	✓		✓
10	Forest Dwelling Herpetofauna	Yellow-striped Tree Skink	- Availability of mature forests	Primary and secondary forests	✓	✓	✓		✓
11	Forest Dwelling Herpetofauna	Black Bearded Flying Dragon	- Availability of mature forests	Primary and secondary forests	✓	✓	✓		✓
12	Forest Dependent Bird Species	Chestnut-bellied Malkoha	- Requires connectivity in canopy as it is often reluctant to fly across gaps	Primary and secondary forests	✓	✓			✓
13	Forest Dependent Bird Species	Blue-eared Kingfisher	- Moves along forested riparian/streamside habitats - Availability of sandy stream banks for burrow construction and nesting	Primary and secondary forests; Forested Freshwater	✓	✓		✓	✓
14	Forest Dependent Bird Species	White-rumped Shama	- Shy skulking understorey bird that requires connectivity in understorey layer - Availability of tree cavities for nest construction, although it can also construct it on low branches of trees	Primary and secondary forests	✓	✓			
15	Forest Dependent Bird Species	Chestnut-winged Babbler	- Shy understorey bird that requires connectivity in understorey layer	Primary and secondary forests	✓	✓			
16	Aquatic Dependent Bird and Herpetofauna Species	Golden-eared Rough-sided Frog	- Swampy forested areas	Forested Freshwater	✓		✓		✓
17	Aquatic Dependent Bird and Herpetofauna Species	Lim's Black-spotted Sticky Frog	- Layer of leaf litter to forage within	Forested Freshwater	✓		✓		✓
18	Aquatic Dependent Bird and Herpetofauna Species	Spotted Tree Frog	- Requires arboreal water-filled cavities or small pools in rotting logs where it lays its eggs	Primary and secondary forests	✓	✓	✓		✓
19	Aquatic Dependent Bird and Herpetofauna Species	Mangrove Pitta	- Highly restricted to mangrove areas - Availability of crabs as a food source	Primary and secondary forests	✓				

No.	Target Species Groups	Species	Requirements for Candidate Refuge Areas	Habitat Types where Species is Found	Candidate Refuge Areas [1]				
					1. CCNR (south)	2. Special Use Land to the west	3. CCNR (north) [2]	4. Water Edge Habitats	5. WRS Site
20	Aquatic Dependent Bird and Herpetofauna Species	Malesian Frog	- Shallow, gentle streams and swampy areas	Forested Freshwater	✓		✓		✓
21	Aquatic Dependent Bird and Herpetofauna Species	Yellow-ringed Cat Snake	- Presence of pools and streams for hunting ground	Forested Freshwater	✓			✓	✓
22	Invertebrates	Bronze Flutterer	- Marshes, swamps, well-vegetated ponds	Forested Freshwater	✓	✓	✓	✓	✓
23	Invertebrates (Odonate)	Grey Sprite	- Presence of forested streams	Forested Freshwater	✓	✓	✓	✓	✓
24	Invertebrates (Odonate)	Banded Skimmer	- Tree-lined, slow flowing water bodies	Forested Freshwater	✓	✓	✓	✓	✓
25	Invertebrates (Odonate)	Handsome Grenadier	- Leafy ponds in swamp forests	Forested Freshwater	✓	✓	✓	✓	✓
26	Invertebrates (Odonate)	Line Forest-skimmer	- Lentic forest habitats, preference for shaded muddy forest pools	Forested Freshwater	✓	✓	✓	✓	✓
27	Invertebrates (Odonate)	Sultan	- Shallow stagnant waters	Forested Freshwater	✓	✓	✓	✓	✓
28	Invertebrates (Butterfly)	Courtesan	- Availability of host plant *Trema tomentosa*	Primary and secondary forests	✓	✓	✓		✓
29	Invertebrates (Butterfly)	Malayan Six Ring	- Grassy areas, usually shaded	Grassland			✓		✓
30	Invertebrates (Butterfly)	Pgymy Posy	- Availability of food source *Leea indica*	Primary and secondary forests	✓	✓	✓		✓
31	Freshwater Fish & Macroinvertebrate Species	Johnson's Freshwater Crab	- Slower parts of shaded streams, with muddy substrates and leaf litter	Primary and secondary forests; Forested Freshwater	✓		✓		✓
32	Freshwater Fish & Macroinvertebrate Species	Marbled Gudgeon	- Waterbodies with little or no water movement - Has adapted to reservoir and canals	Forested Freshwater	✓		✓	✓	
33	Freshwater Fish & Macroinvertebrate Species	Croacking Gouramy	- Availability of streams and ponds with dense vegetation - Adapted to waterbodies in scrub and rural areas	Forested Freshwater	✓	✓	✓		✓
34	Freshwater Fish & Macroinvertebrate Species	Common Snakehead	- Availability of stagnant muddy water and grassy banks - Has adapted to reservoir and canals	Forested Freshwater; Water edge habitats	✓	✓	✓	✓	✓
35	Freshwater Fish & Macroinvertebrate Species	Einthoven's Rasbora	- Availability of shallow, slow-flowing and shaded streams	Forested Freshwater	✓		✓		✓
36	Freshwater Fish & Macroinvertebrate Species	Siam Stream Goby	-	Forested Freshwater	✓		✓		
37	Freshwater Fish & Macroinvertebrate Species	Sunda Pygmy Halfbeak	- Adapted to ponds and small streams in both forest and exposed areas	Forested Freshwater	✓	✓	✓	✓	✓

NOTES

(1)

Area	Habitat types available	Direction, distance and area available
CCNR (south)	- Primary and secondary forests - Forested freshwater	- Immediately south of project area - Approx 1,006,410 m^2 (~100 ha) available
Special use land to the west	- Primary and secondary forests - Forested freshwater	- Immediately west of project area - Approx 773,100 m^2 (~77 ha) available
CCNR (north)	- Primary and secondary forests - Forested freshwater	- Immediately north-east of the Project area between Mandai Lake Road and Upper Seletar Reservoir - Approx 238,040 m^2 (~100 ha) of habitat is
Water edge habitat	- Water edge habitats - Forested freshwater - Open freshwater	- Immediately east of project area - Approx 22,350 m (2.35 km) length of water edge habitats available
WRS site	- Primary and secondary forests - Forested freshwater	- Immediately east of project area - Approx 645,040 m^2 (~65 ha) available

(2) CCNR (north) is a non-preferred refuge location given size constraints and location immediately adjacent to Mandai Road.

Annex 18.0

Wildlife Protection Plan

Wildlife Protection Plan

1 Introduction

This plan has been developed to ensure adequate protection for wildlife during the pre-construction, construction and operation phases of the Project. It sets out specific requirements and actions needed to address the Project's potential impacts on wildlife as assessed in the EIA.

Mandai Park Holdings (MPH) will have overall accountability for the implementation of this plan and for the compliance of Contractors in relation to the requirements contained herein.

2 Legislative Requirements

Table 2.1 identifies local legislation relevant to the protection of wildlife in Singapore. These legislations will be adhered to, in addition to the requirements set out in this plan.

Table 2.1: Legislative Requirements

Environmental Aspect	Relevant Local Legislation
Habitat Protection/ Conservation of Protected Areas	• *Parks and Trees Act, 2006* • *Parks and Trees Regulations, 2006* • *Parks and Trees (Preservation of Trees) Order, revised 1998*
Wildlife Protection and Welfare	• *Wild Animals and Birds Act, 2000* • *Wild Animals and Birds (Bird Sanctuaries) Order, 1992*
Importation of Animals and Plants • Disease • Endangered Species • Animal Welfare	• *Endangered Species (Import and Export) Act, 2008 (Chapter 92A)* • *Animals and Birds Act, 2002 (Chapter 7)* • *Control of Plants Act, 2000 (Chapter 57A)* • *Control of Plants (Plant Importation) Rules*
Vectors and Pesticides Management	• *Control of Vectors and Pesticides Act, 2002*

3 Wildlife Shepherding Prior To Construction

3.1 Guiding Principles

Shepherding of wildlife from the Project area will have to be sensitively carried out before the commencement of construction activities.

The guiding principles relating to the strategy for wildlife shepherding are:

a) minimizing the risk of road hazards and road kills from the displacement of terrestrial fauna from the Project area and onto adjacent roads;
b) encouraging movement of wildlife into appropriate safe refuge habitats which are external to the Project boundary; and,
c) ensuring continued connectivity, particularly for terrestrial fauna, at all times during the Project's construction phase.

3.2 Target Species Under Consideration

In order to implement the wildlife shepherding strategy, a focus list of fauna species has been developed based on the findings of the EIA. This list was developed with the following considerations:

a) probable presence of species in the Project area prior to construction;
b) risks to species from being in close proximity to construction activities;
c) practicality of relocating species from the construction site;
d) conservation significance of species; and,
e) risk of road kill, road hazard and/or human-wildlife conflict arising from uncontrolled species displacement from the Project area.

In addition, as hoarding that will be used to enclose the construction sites will have a height of 2.4m, it is expected that access for arboreal and aerial species to the Project area shall not be limited. Therefore, the list of target species that shall be of focus during wildlife shepherding will primarily comprise terrestrial fauna. The list is contained in Table 3.2.1 and target species have been categorized into two groups (i.e. A and B) depending on the approach which will be required to relocate species from the site.

Table 3.2.1: Target Species

Category	Species	Diurnality / Nocturnality
A	J Sambar Deer J Lesser Mouse Deer J Wild Boar	J Crepuscular, nocturnal J Crepuscular, nocturnal J Diurnal and nocturnal
B	J Sunda Pangolin J King Cobra J Blue Malayan Coral Snake J Malayan Racer J Banded Malayan Coral Snake	J Nocturnal J Diurnal J Nocturnal J Diurnal J Diurnal

3.3 Identified Refuge Areas

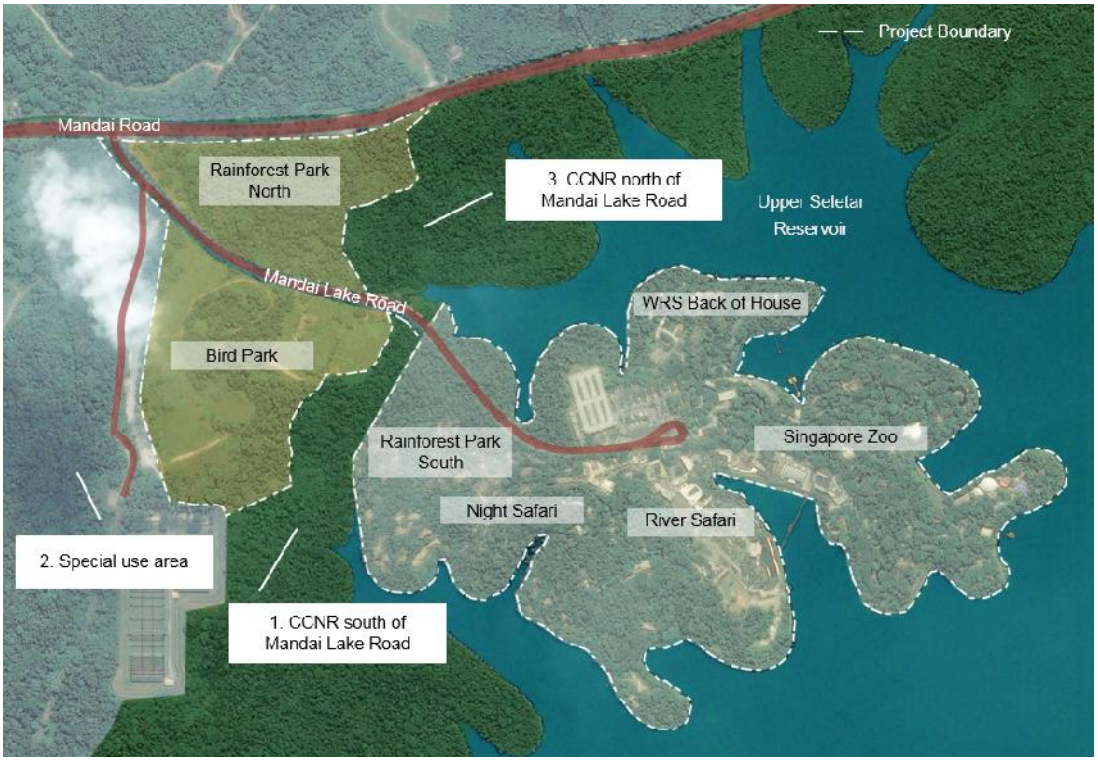
Based on a study of habitat availability in the vicinity of the Project area undertaken during the EIA, suitable refuge areas that may be utilized by wildlife, which may be displaced from the Project area prior to and during construction, have been identified. These refuge areas are listed in Table 3.3.1 and their locations in relation to the Project area are indicated in Figure 3.3.1.

Table 3.3.1: Refuge Areas

Refuge Area	Habitats	Description	Fauna Species Groups
1. CCNR south of Mandai Lake Road	• Primary and secondary forests • Forested freshwater	An area of approximately 100 ha immediately east / south-east of the Bird Park site.	• Terrestrial Mammals • Arboreal Mammals • Grassland Dependent Birds and Bats • Forest Dwelling Herpetofauna • Forest Dependent Birds • Aquatic Dependent Birds and Herpetofauna • Invertebrates
2. Special use area to the west of the Project area	• Primary and secondary forests • Forested freshwater	An area of approximately 77 ha immediately west / south-west of the Bird Park site.	

Refuge Area	Habitats	Description	Fauna Species Groups
3. CCNR north of Mandai Lake Road	• Primary and secondary forests • Forested freshwater	An area of approximately 24 ha immediately east of the Rainforest Park North site.	

Figure 3.3.1: Locations of Refuge Areas



3.4 General Approach

MPH will assemble a team comprising ecologists, veterinarians, local wildlife experts, wildlife handlers and hoarding Contractors to carry out the wildlife shepherding activities. In addition, there is the possibility of involving volunteers from nature groups in this effort.

All personnel involved will be briefed on the details of this plan and their respective roles before field activities begin. Personnel will also be equipped with

mobile communication devices on the field to ensure that lines of communication are maintained during field activities and that the appropriate persons (e.g. veterinarians, wildlife handlers) are able to respond to exigencies in a timely manner.

The general approach to wildlife shepherding that will be undertaken is a combination of the following activities, which may be scheduled during daylight hours only (i.e. 8am to 6pm):

i) installation of hoarding, which will function as a drift fence to guide target terrestrial fauna in the intended direction of movement and as a barrier to prevent wildlife displacement onto adjacent roads;
ii) systematic pattern of walking through the site, starting from the area furthest from and then gradually moving towards the identified refuge area, in order to shepherd wildlife in an intended direction of movement towards adjacent refuge habitats, and;
iii) in conjunction with (ii), the site will be carefully surveyed to check for the presence of target fauna species and any active dens.

In order for the above-described approach to be effective, it is recommended that activities (ii) and (iii) be carried out repeatedly over a course of up to three weeks for a site no larger than twenty hectares. At the end of this duration, the site has to be inspected by an ecologist to ensure that no target fauna and active dens remain. Thereafter, gaps in the hoarding shall be closed as soon as practicable so as to prevent target terrestrial fauna from returning to the site.

In the event that any target fauna listed in Section 3.2 are encountered during this process, the following actions which have been developed with the consideration of reducing stress to fauna while ensuring the effectiveness of the shepherding exercise shall be taken:

i) Fauna from Category A: Category A comprises highly mobile fauna for which a passive shepherding approach is expected to be effective. Therefore, when fauna from Category A are encountered, personnel should remain in place to allow fauna to move on their own accord. Generation of mild human noise disturbance (e.g. talking loudly) may be used to encourage fauna movement. However, no attempt should be made to capture or handle these species, unless the animal is visibly

injured in which case experienced wildlife handlers will carefully capture the animal for immediate veterinary attention. If any individual fauna does not move on its own after sufficient time (i.e. up to one hour) has passed, the area where the individual is located should be GPS-marked and left overnight to provide additional opportunity for the individual to move on its own accord. Personnel shall return to the GPS-marked location on the following day to inspect the area. This process will be repeated until the individual has moved.

ii) Fauna from Category B: Category B comprises fauna for which a passive shepherding approach is expected to be unsafe and/or ineffective in guiding the individual fauna to move in an intended direction. Therefore, a capture-and-release approach will be needed to ensure safe relocation of these fauna from the site prior to construction. In the event that fauna from Category B are encountered, experienced wildlife handlers will carefully capture the animal for subsequent assessment and microchipping (where safe and possible) by a veterinarian. Where sensitive fauna (i.e. Sunda Pangolin) and venomous snakes from Category B are concerned, their capture shall only be carried out by designated wildlife handlers who have been trained in the appropriate handling techniques. Thereafter, the animal shall be released in a suitable habitat within the CCNR south of Mandai Lake Road, subject to the approval of NParks.

As stated in Section 3.2, the above-described approach will apply to target terrestrial fauna. Existing culverts across Mandai Lake Road will be maintained throughout the hoarding activities. In addition, it is envisaged that arboreal and aerial species shall generally be able to continue utilizing remnant habitats on the site during construction, and will not be excluded by the installed hoarding that will have a height of 2.4m. However, in the event that any trees are identified for removal or relocation, subject to prior approval from NParks, specific actions need to be taken to check for the presence of arboreal mammals and herpetofauna, birds and bats before each individual tree may be felled or transplanted. These actions are as follows:

i) An ecologist shall inspect the tree for the presence of fauna, inhabited tree hollows, and nests.

ii) In the event that the presence of arboreal mammals and herpetofauna, birds and/or bats are detected on the tree, tree felling or transplanting must be postponed until the animal has left the tree on its own accord.

iii) In the event that an inhabited tree hollow is identified, tree felling or transplanting must be postponed until the animal has left the hollow on its own accord and the entrance to the hollow has been sealed to prevent re-entry.

iv) Tree felling or transplanting shall not occur during the prime breeding season for local avifauna, i.e. the months from approximately mid-March to July annually. In any case, if active nests are detected on the tree, nests shall be left undisturbed until nesting activities have been completed (i.e. the young have left the nest). In addition, inactive nests shall be removed to minimize the possibility of a new nesting attempt. Tree felling or transplanting shall occur only when no active nests are present on the tree.

v) Notwithstanding the aforementioned actions, after tree felling has occurred, an ecologist shall thoroughly search the fallen tree for any injured or trapped fauna that may have gone undetected. In the event that injured or trapped fauna are found, immediate veterinary attention shall be administered.

Through the undertaking of the general approach described in this Section 3.4, a register shall be maintained to record i) the activities that were carried out, ii) the species, numbers, GPS locations, dates, timings, and actions taken (if any) for each target fauna which was identified, and iii) the description, GPS location, and actions taken (if any) for each den, inhabited tree hollow and nest that was identified.

3.5 Detailed Strategy

While shepherding of wildlife from the Project site prior to construction is intended to mitigate potential impacts from construction activities on wildlife, it is recognized that shepherding in itself could also have undesirable effects due to the introduction of disturbance to the site if wildlife are displaced from their habitat at critical times during their life cycle. With this consideration in mind,

wildlife shepherding shall be scheduled to avoid the prime breeding season for local avifauna, i.e. the months from approximately mid-March to July annually. The bird breeding season is considered to be a sensitive period during which habitat disturbance should be minimized due to the importance of breeding territories and the presence of vulnerable young. In addition to the avoidance of sensitive timing windows, wildlife shepherding shall also be undertaken in parcels so as to phase out and reduce the scale of habitat disturbance.

Figures 3.5a to 3.5n[1] illustrate the planned phasing and indicative[2] schedule for wildlife shepherding and construction activities. These activities may be conducted during daylight hours only (i.e. 8am to 6pm) and a minimum of one rest day (i.e. Sunday) per week shall be provided to reduce disturbance to wildlife.

Figure 3.5a: Beginning in late-3Q2016, hoarding (as indicated by the solid red lines) shall first be installed along a segment of Mandai Road and followed by Mandai Lake Road to prevent terrestrial fauna from accessing the roads in these areas. As shown in Figure 3.5a, the hoarding in this area will comprise two rows of hoarding (as opposed to a single row which will be the approach taken for other work areas) as the area enclosed between these two rows of hoarding will be used for construction access. The outer row closer to the roads will be constructed before the interior row. As the area enclosed between the two rows of hoarding is narrow, wildlife shepherding will not be required for the construction of this hoarding. Nonetheless, the construction provisions with regard to wildlife protection shall apply. In addition to the construction of hoarding adjacent to the roads, a low speed zone (as indicated in purple shading) shall be established along a stretch of Mandai Lake Road. A speed limit of 20kmph shall be enforced in this zone through the use of road signage and speed bumps.

[1] Excludes the Boardwalk component as hoarding shall not be required for the construction of the Boardwalk.
[2] Finalization of the schedule is subject to planning approvals from the regulatory authorities.

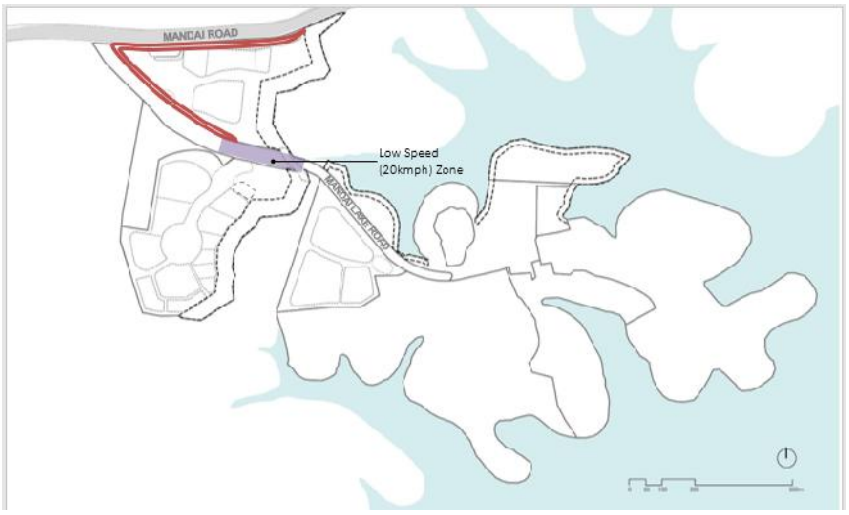


Figure 3.5b: Between late-3Q2016 and 4Q2016, hoarding (as indicated by the solid red lines) shall be installed along the western, followed by northern, and then eastern boundary of the West Arrival Node site. The southern end of this site shall remain open for wildlife shepherding to occur in the direction indicated by the broken green arrow. In 4Q2016, hoarding (as indicated by the solid purple line) shall be installed along the eastern boundary of the Bird Park site.

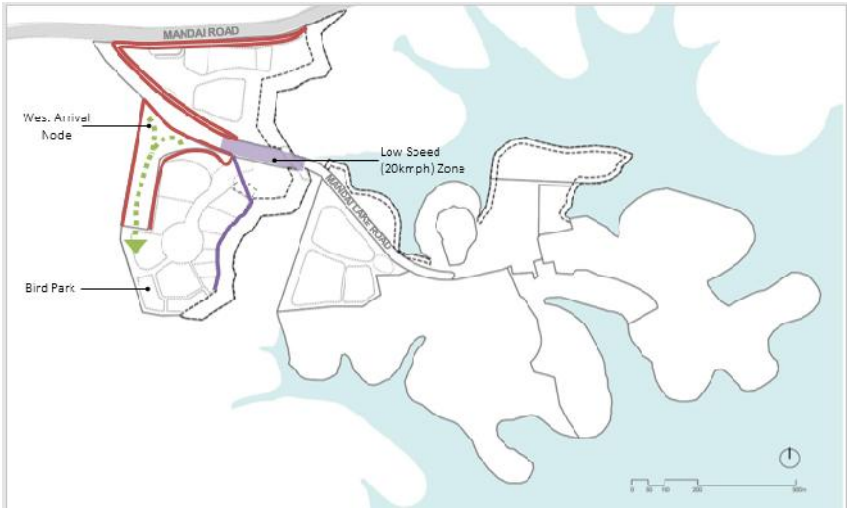


Figure 3.5c: By end-4Q2016, wildlife shepherding from the West Arrival Node site is expected to be completed and hoarding shall be installed at the southern end of the site thereby enclosing and preventing re-entry of target fauna into the site. Construction of the West Arrival Node will commence in 1Q2017 and is expected to take until 2Q2020.

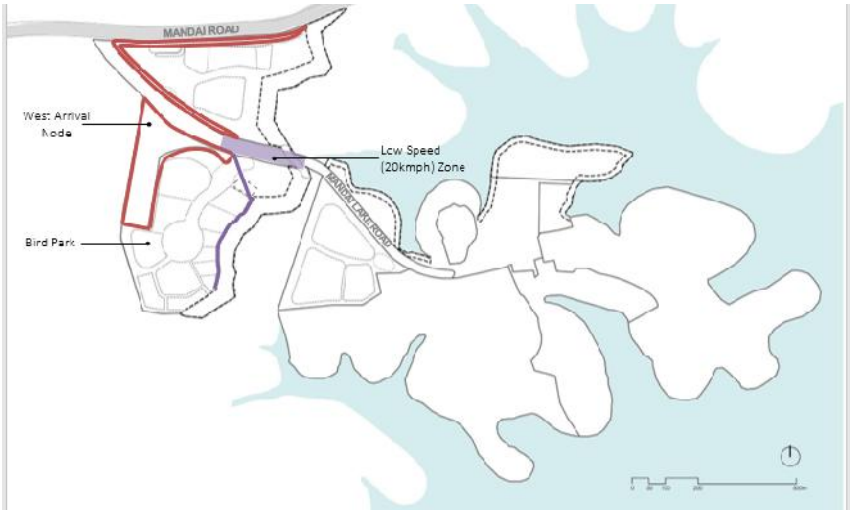


Figure 3.5d: Between end-4Q2016 and mid-1Q2017, hoarding (as indicated by the solid purple lines) shall be added to the west and south of the Bird Park site. Two openings shall be maintained to the south-east and south-west, and wildlife shepherding will occur in the direction indicated by the broken green arrows.

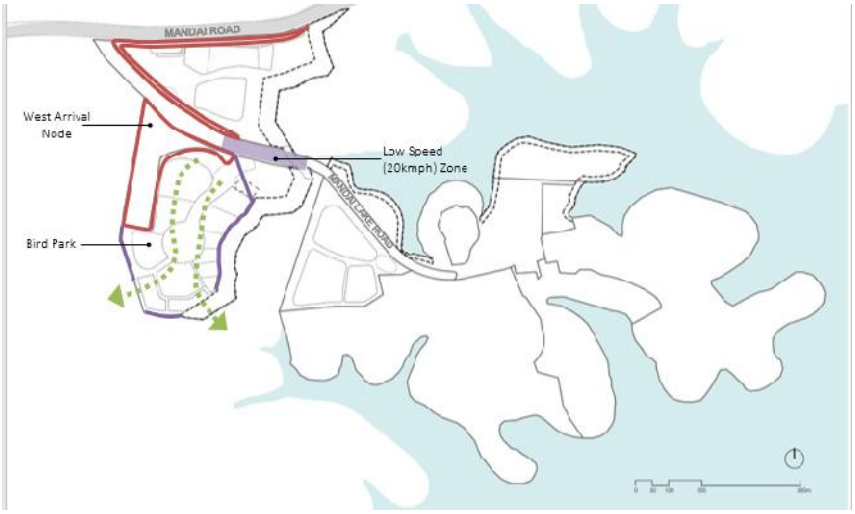


Figure 3.5e: By mid-1Q2017, wildlife shepherding from the Bird Park site is expected to be completed and hoarding shall be installed at the south-east and south-west corners thereby enclosing and preventing re-entry of target fauna into the site. Construction of the Bird Park will commence in end-1Q2017 and is expected to take until 2Q2020.

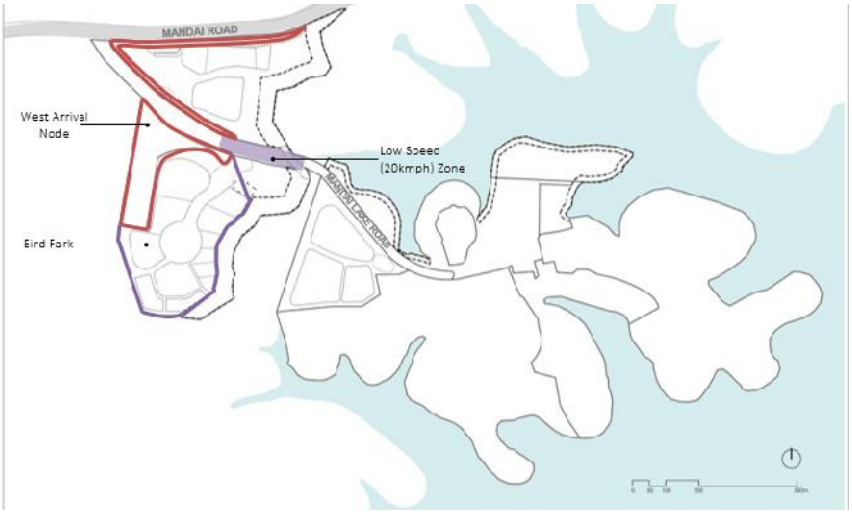


Figure 3.5f: From 2Q2017, hoarding (as indicated by the solid blue lines) shall also be installed around the boundaries of the Eco-Link and Quarantine sites. It is envisaged that wildlife shepherding will not be required in these sites due to the small land area. Nonetheless, an ecologist will supervise the installation of hoarding and the construction provisions with regard to wildlife protection shall apply. Construction of the Eco-Link and Quarantine will commence by 3Q2017 and immediately upon completion of hoarding installation. Construction of the Eco-Link shall be prioritized in the construction schedule and is expected to complete by 1Q2019.

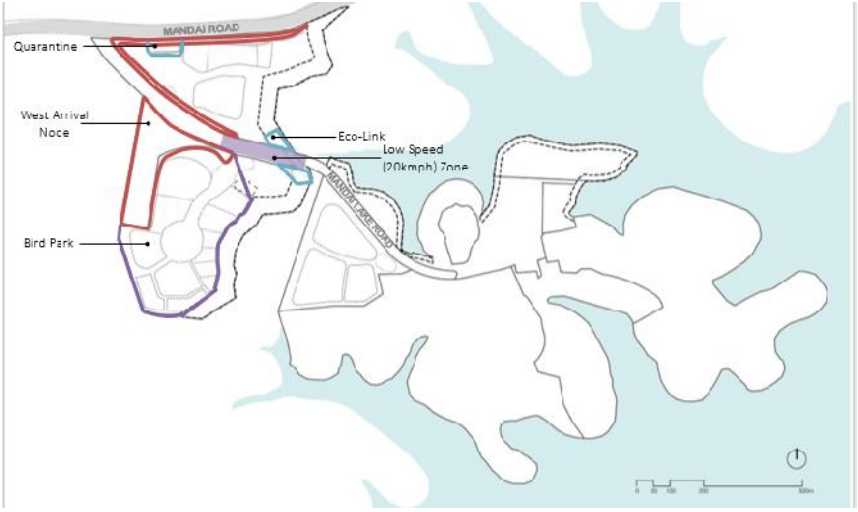


Figure 3.5g: Between 4Q2017 and mid-1Q2018, hoarding (as indicated by the solid green line) shall be installed along a portion of the eastern boundary of the Rainforest Park North site. Two openings shall be maintained in the south-east

corner of the site adjacent to the forest buffer and low speed zone, and wildlife shepherding will occur in the direction indicated by the broken green arrows.

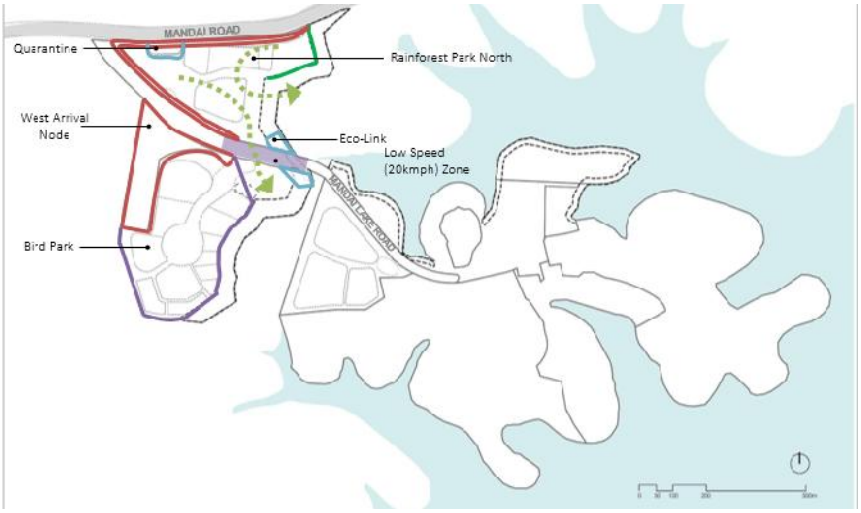


Figure 3.5h: By mid-1Q2018, wildlife shepherding from the Rainforest Park North site is expected to be completed and hoarding shall be installed along the south-east boundary thereby enclosing and preventing re-entry of target fauna into the site. Construction of the Rainforest Park North will commence in mid-1Q2018 and is expected to take until 2Q2020. In order to ensure that ground-level movement of terrestrial fauna may continue during the time when construction of the Eco-Link, Bird Park and Rainforest Park North are overlapping, an unobstructed zone with a width of at least 50m at its narrowest point shall be set aside within the Bird Park and Rainforest Park North sites. The ground-level corridor provided by this unobstructed zone is indicated by the solid green arrow.

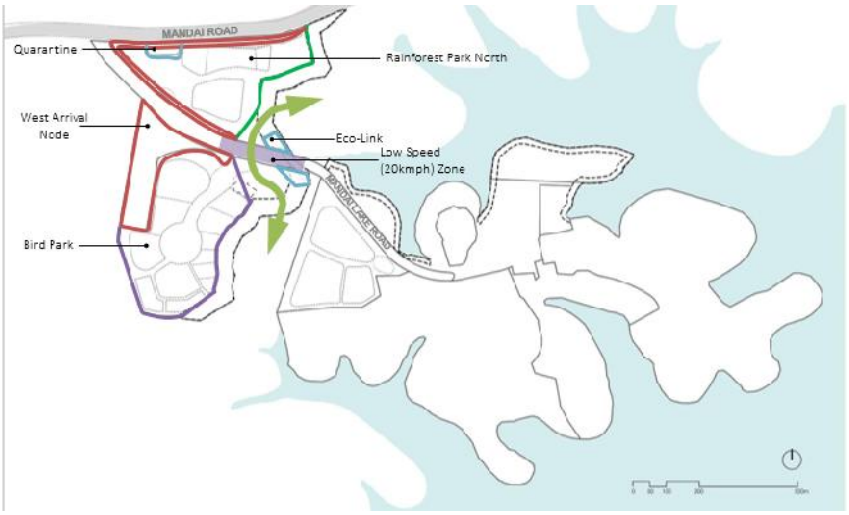


Figure 3.5i: From 3Q2018, pre-construction activities will commence in the eastern half of the Project site beginning with the installation of hoarding (as indicated by the solid pink lines) along the eastern stretch of Mandai Lake Road. A minimum setback of 15m (as indicated by the broken black lines) from the reservoir edge for any hoarding and/or construction shall apply to allow for continued fauna movement east-west and across the land-water interface.

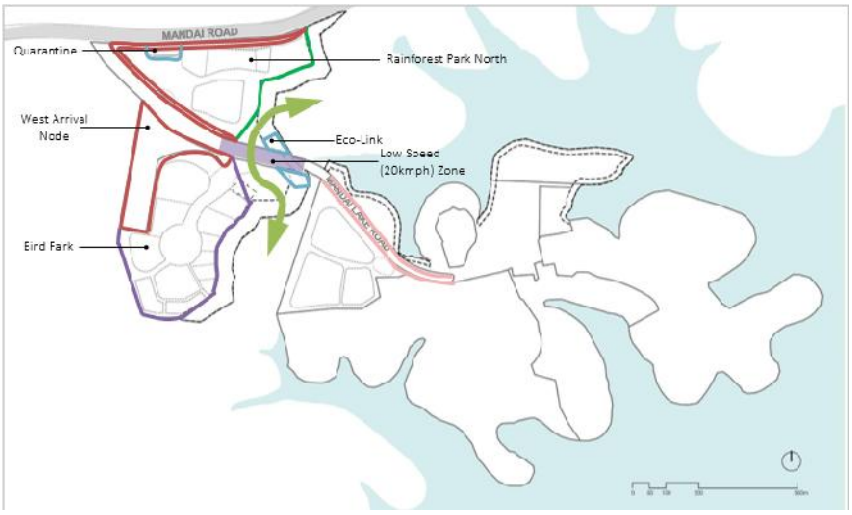


Figure 3.5j: Between 3Q2018 and 4Q2018, hoarding (as indicated by the solid pink lines) shall be installed along the boundaries of the East Arrival Node site. It is envisaged that wildlife shepherding will not be required in this site as the area is presently largely built-up with components such as an open-air carpark and back-of-house facilities. Nonetheless, an ecologist will supervise the installation of hoarding and the construction provisions with regard to wildlife protection shall apply. Construction of the East Arrival Node will commence in 1Q2019 and is expected to be completed in 3Q2021.

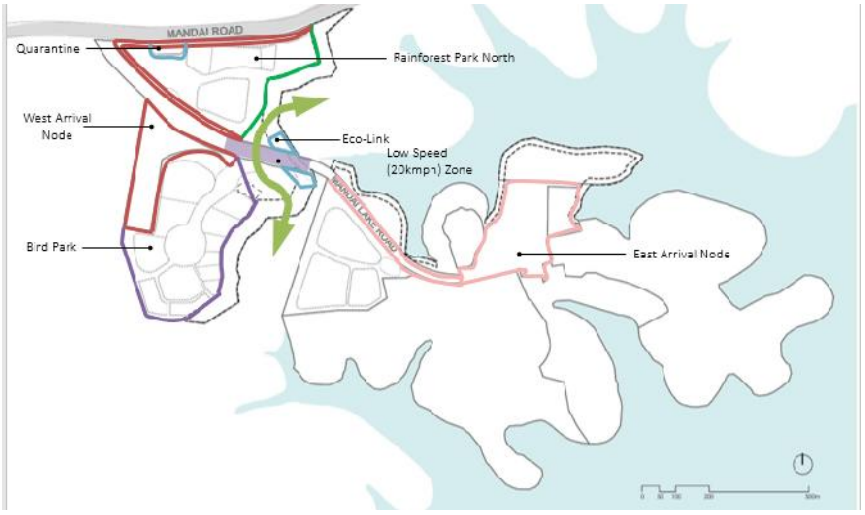


Figure 3.5k: Between 3Q2019 and 4Q2019, hoarding (as indicated by the solid yellow line) shall be installed along the boundary of the PE/SSP site. It is envisaged that wildlife shepherding will not be required in this site as the area is presently a multi-storey carpark. Nonetheless, an ecologist will supervise the installation of hoarding and the construction provisions with regard to wildlife protection shall apply. Construction of the PE/SSP will commence in 1Q2020 and is expected to be completed in 2Q2022.

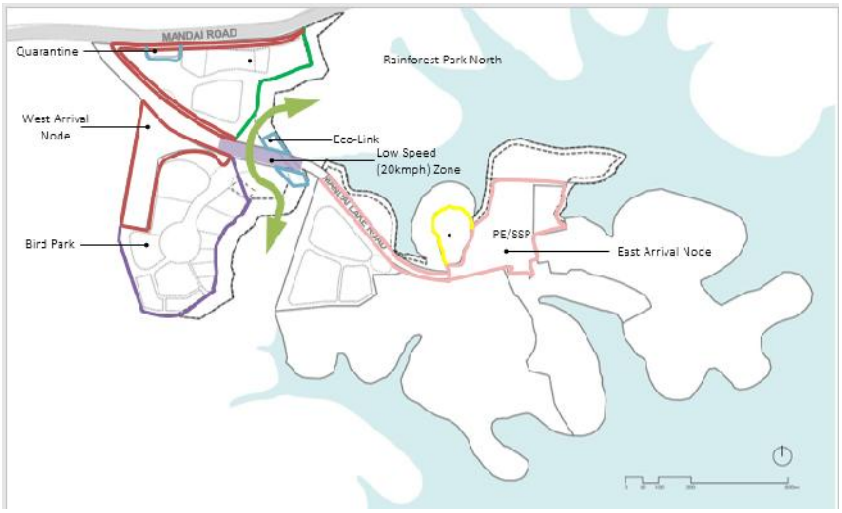


Figure 3.5l: In 4Q2019, the previously established low speed zone shall be removed. Hoarding (as indicated by the solid dark blue lines) shall be installed along the boundaries of the previously unobstructed portions of the Bird Park and Rainforest Park North sites, and construction in these sites is expected to take place up till 2Q2020. It is envisaged that wildlife shepherding will not be required

in these sites due to the small land area. Nonetheless, an ecologist will supervise the installation of hoarding and the construction provisions with regard to wildlife protection shall apply. Hoarding up of these previously unobstructed sites is planned to commence only in 4Q2019 based on the assumption that a minimum of 6 months would have passed since the Eco-Link's construction completion in 1Q2019 so as to allow for fauna acclimatization and planting establishment such that the Eco-Link is operational as a ground-level corridor.

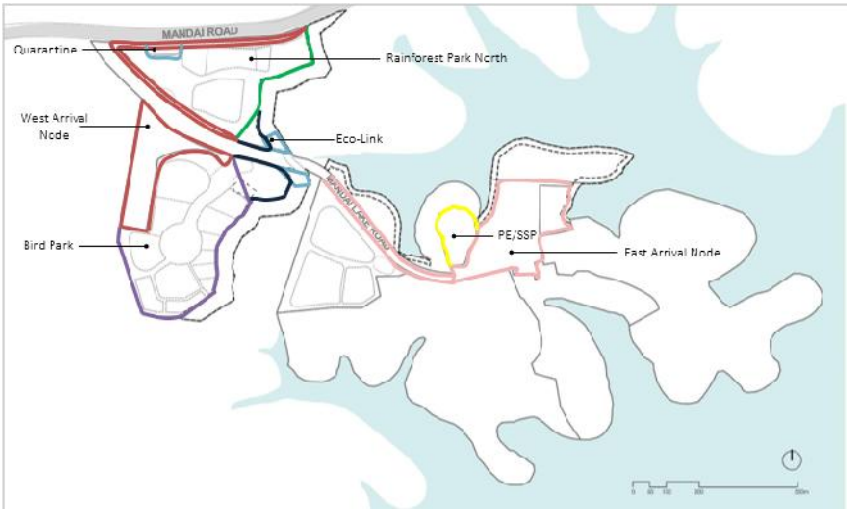


Figure 3.5m: Between 4Q2019 and 1Q2020, hoarding (as indicated by the solid orange line) shall be installed along the boundary of the Eco-Lodge site. It is envisaged that wildlife shepherding will not be required in this site as it is an area currently occupied by back-of-house facilities. Nonetheless, an ecologist will supervise the installation of hoarding and the construction provisions with regard to wildlife protection shall apply. Construction of the Eco-Lodge will commence in 2Q2020 and is expected to be completed in 2Q2023.

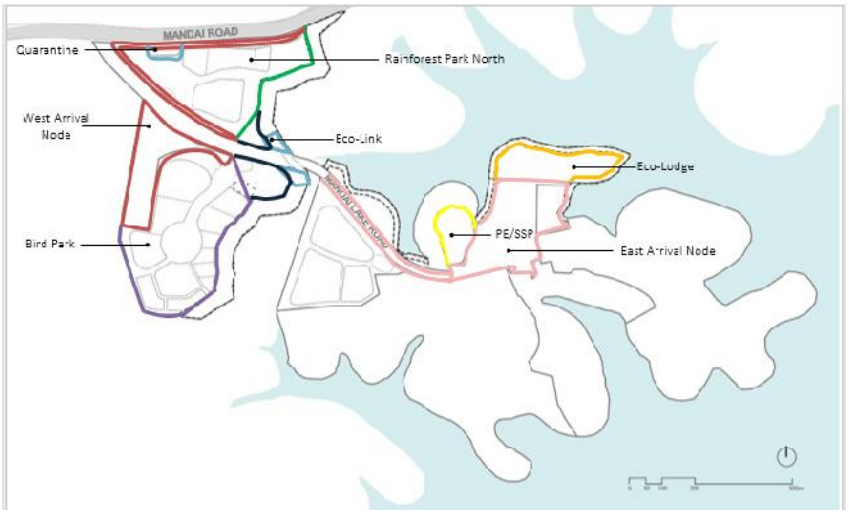
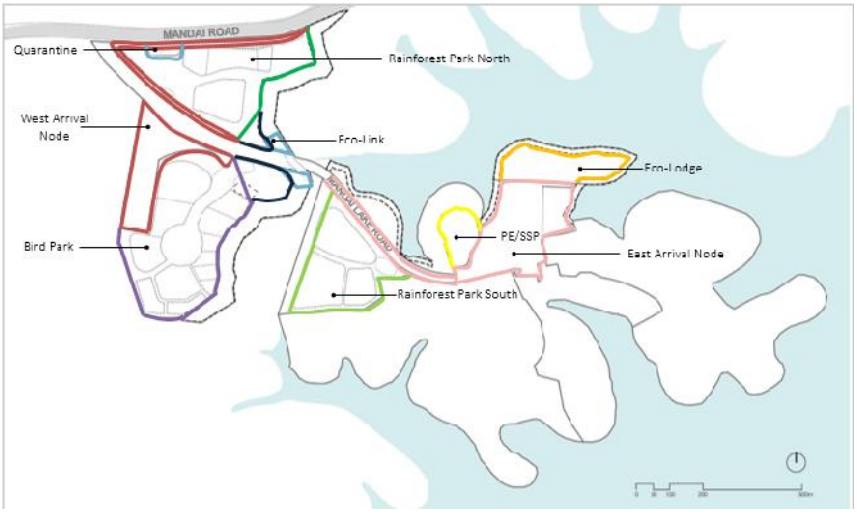


Figure 3.5n: Between 3Q2020 and 4Q2020, hoarding (as indicated by the solid light green lines) shall be installed along the boundary of the Rainforest Park South site. It is envisaged that wildlife shepherding will not be required in this site as it is an area currently occupied by the Night Safari. Nonetheless, an ecologist will supervise the installation of hoarding and the construction provisions with regard to wildlife protection shall apply. Construction of the Rainforest Park South will commence in 1Q2021 and is expected to be completed in 2Q2023.



Upon the completion of construction for each of the sites described in Figures 3.5a to 3.5n, the hoarding installed along the boundaries of each respective site will be carefully removed in accordance with the construction provisions for wildlife protection.

3.6 Adaptive Management

Wildlife shepherding will be managed using an adaptive management framework. The requirements for monitoring of the wildlife shepherding activities, as well as potential corrective actions which may be taken in consultation with NParks if monitoring produces adverse findings, are set out in Table 3.6.1.

Table 3.6.1: Monitoring of Wildlife Shepherding

Monitoring	Corrective Action
Camera traps shall be placed at approximately 50m intervals parallel to and on both sides of Mandai Lake Road within the ground-level corridor indicated in Figure 3.5h	Data from the camera traps will be analysed fortnightly to check for the presence of terrestrial fauna along the ground-level corridor. If it is found that terrestrial fauna utilization of the ground-level corridor is poor due to insufficiency of the ground-level corridor provision, hoarding may have to be adjusted to provide a wider corridor and supplemental planting along the corridor may be required.
Camera traps shall be placed at the landing points of and at approximately 50m intervals along the length of the Eco-Link	Data from the camera traps will be analysed fortnightly beginning from the time when construction of the Eco-Link is complete to check for the presence of terrestrial fauna on the Eco-Link. If it is found that terrestrial fauna have not begun to utilize the Eco-Link 6-months after the Eco-Link's construction completion, removal of the low speed zone and hoarding as indicated by the solid dark blue lines on Figure 3.5l will have to be delayed to ensure continued provision of the ground-level corridor until the Eco-Link may be considered operational. Planting efforts on the Eco-Link may have to be intensified.
Reports of wildlife-related road hazard or road kill incidents	If the public reports at least one incident of wildlife-related road hazard or road kill along Mandai Lake Road or along Mandai Road within 500m from the Project boundary, wildlife shepherding activities will have to stop until the following actions are carried out: J check for the structural integrity of hoarding installed along Mandai Road and Mandai Lake Road, and repair any damages;

	- retrieve the (if any) carcass or injured fauna where possible for veterinary assessment and/or treatment; and, - investigate the probable cause of the incident based on information collected through the above-described actions as well as recorded data relating to the location, date and time of incident as well as fauna species and numbers concerned. If wildlife shepherding activities are identified as the probable cause of the incident, the wildlife shepherding strategy will have to be reviewed in consultation with NParks before activities may resume. In addition, if it is found that fauna are accessing Mandai Lake Road through the un-hoarded segment to the west of the Project boundary, MPH shall engage the relevant landowner or regulatory authority to explore installing barriers along the road which is external to the Project boundary.
Reports of wild boar-related vegetation damage in the CCNR	If NParks reports wild boar-related damage to vegetation in the CCNR due to an overpopulation of wild boars, MPH shall work with NParks to investigate if the overpopulation arose due to species displacement from the Project area and population control measures (i.e. neutering) may be required. Any population control measure can only be initiated with prior permission obtained from NParks and AVA.

4 Provisions For Wildlife Protection During Construction

The provisions set out in this plan shall be included in construction tender documents and the construction Contractor shall be responsible for the compliance of construction staff. MPH shall appoint a site inspector to supervise the construction works and the Contractor shall be liable to monetary penalties for any breach of these provisions by construction staff.

In order to ensure that the wildlife protection measures are clearly understood and appropriately implemented, MPH shall provide a briefing for the Contractor prior to the start of construction. In addition, a laminated handout summarizing key information on wildlife protection and types of wildlife which may be encountered shall be kept on site at all times for reference by construction staff. The handout shall include the contact information for the MPH Environmental Manager as well as relevant emergency numbers.

<u>General</u>

- Access to the construction site for construction vehicles and staff is permitted only from 8am to 6pm, Mondays to Saturdays, except under extraordinary circumstances which shall be subject to MPH and NParks' approval.
- Only authorized construction vehicles may access the site and their operation shall comply with speed limits and be restricted to the designated routes.
- All activities, vehicles and materials shall be restricted to designated work spaces, and areas identified for retention shall be undisturbed.
- The aforementioned designated vehicle access routes and work spaces shall be identified in the Contractor's Method Statement, which is subject to MPH and NParks' approval.
- Any artificial lighting used at the construction site shall be directed away from the nature reserves and pole lights will not be permitted. There shall be no usage of artificial lights after 6pm, except under extraordinary circumstances which shall be subject to MPH and NParks' approval.

- There shall be no smoking, use of joss sticks, burning of any religious offerings, and cooking or heating of food within the construction site and in the adjacent forested areas at all times.

Food and Waste Management

- There shall be no storage, display, consumption and/or disposal of food in non-designated areas.
- Consumption of food and disposal of food waste shall occur only at designated, enclosed areas within the construction site.
- There shall be no littering of food waste and other garbage.
- All food waste shall be disposed securely in wildlife-proof bins. In addition, food waste shall be promptly removed by 6pm on every work day, and neither food nor food waste shall be permitted to be left overnight.
- Do not feed any wildlife or leave food out where it could attract them. This includes food which are intended as religious offerings.

Wildlife Encounters

- The construction work area shall be visually inspected for wildlife prior to the start of construction activities on each work day.
- Hoarding and/or similar protective fencing shall be visually inspected weekly for their integrity and continued function. In the event that any damage is detected, maintenance and repair works will have to be undertaken on a timely basis.
- Immediately upon detection of any dead or injured animal, construction activities in that immediate area shall stop and the MPH Environmental Manager shall be notified. No attempt shall be made by construction staff to handle the animal. The MPH Environmental Manager shall promptly arrange for on-call wildlife handlers and veterinarians to attend to the animal as soon as practicable. Construction activities in the immediate area may resume only after notice has been received from the MPH Environmental Manager that it is safe to continue with the work.
- In the event that any target terrestrial fauna as specified in Section 3.2 are encountered within the construction site, construction staff shall stop activities in that immediate area and allow the animal to leave the site. Construction staff shall not be permitted to handle and/or harass the

animal, and shall promptly notify the MPH Environmental Manager. The MPH Environmental Manager shall provide notice to resume construction work only after it has been ascertained that the individual fauna is no longer present on the site.

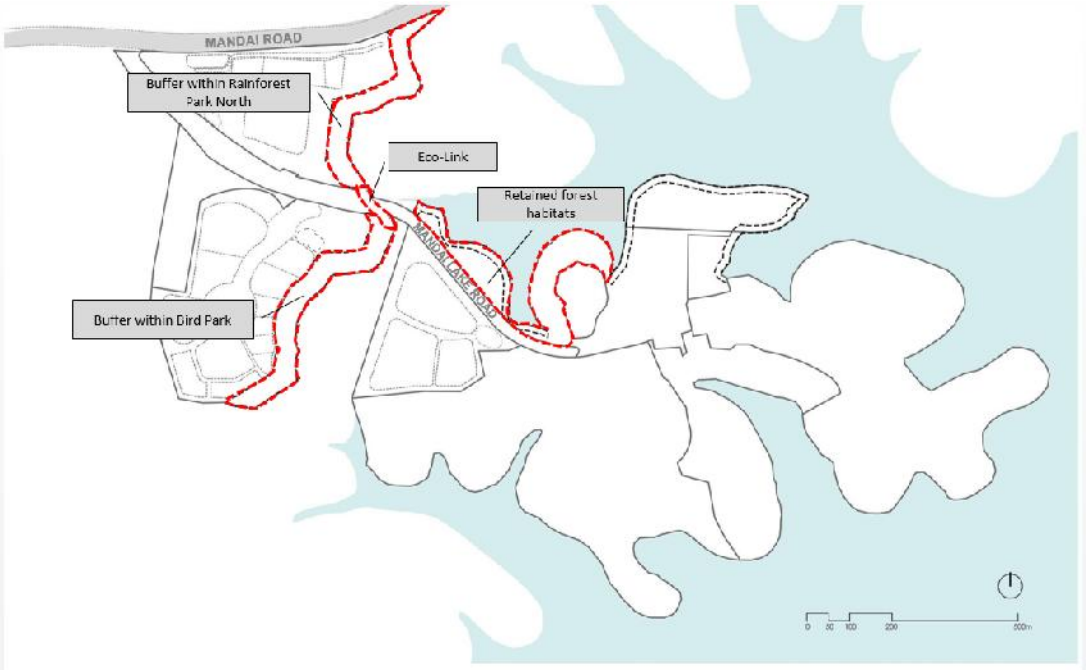
- Under all circumstances and for any reason including food and self-defense, construction staff shall not be permitted to kill, injure, capture and/or harass any wildlife. For the avoidance of doubt, wildlife refers to all living creatures in the forest including insects, spiders, fish, frogs, turtles, snakes, birds, and mammals such as monkeys and wild boars.
- Offences, such as hunting and poaching, which contravene the Wild Animals and Birds Act will be reported immediately to AVA.

5 Guidelines For Wildlife Protection During Operations

MPH (or the future appointed Operator of the Project components) shall be responsible for the protection of wildlife which may be found within the Project boundary in accordance to the guidelines set out in this section during the Project's operation phase.

Operator Guidelines

- There shall be no activities for the general public and paying visitors planned within the areas indicated in Figure 5a.
  Figure 5a: Areas where visitor activities are prohibited are indicated by the red dotted lines.



- Indicative hours of operation for each Project component have been identified in the EIA and are reproduced in Table 5.1. In the event that any changes to the operating hours are proposed and/or occasional commercial activities are planned that may extend beyond the operating hours indicated in Table 5.1, approval from NParks will need to be obtained.

Table 5.1: Project Operational Hours

Attraction / Activity	Operational Hours
Rainforest Park	07.00 – 19.00 daily
Bird Park	09.00 – 18.00 daily
Eco-Lodge	24 hours / day
Planet Explorer and Sri Seletar Point	08.00 – 21.00 daily
East Arrival Node	06.00 – 24.00 daily
West Arrival Node	06.00 – 19.00 daily
Nature Trails and Boardwalk	06.00 – 19.00 daily

- Artificial lighting shall not be directed towards the CCNR under all circumstances. Use of artificial lighting shall be reduced during after-hours to the minimum necessary for general safety and security.
- Barriers installed to prevent human incursion into prohibited areas and to prevent wildlife movement onto adjacent roads shall be visually inspected on a weekly basis to check for integrity and continued function. In the event that any damage to the barriers are detected, maintenance and repair works will have to be undertaken on a timely basis.
- Wildlife-proof rubbish bins shall be provided throughout the Project area, including the attractions, public arrival nodes and boardwalk. These rubbish bins shall be inspected and emptied at least twice daily. Waste collection points within the Project area shall be within enclosed and locked storage facilities.
- The Operator shall proactively educate visitors (for e.g., via the use of signage and panels installed throughout the Project area, opportunistic orienting of visitors at the attractions and Eco-Lodge etc.) on the role that they can play with regard to wildlife protection. Draft guidelines recommended for communication to visitors are included in Table 5.2.

Table 5.2: Visitor Guidelines

Guidelines on Offences
▪ Wild animals and plants are protected by law. ▪ It is an offence to kill, injure and disturb any animal in the forest. These include insects, spiders, fish, frogs, turtles, snakes, birds, and mammals such as monkeys and wild boars.

- It is an offence to collect or damage plants.
- It is an offence to damage, pollute or contaminate the environment, including forests and streams, where animals and plants live.
- Offenders may be fined, imprisoned, or both.

Guidelines on Wildlife Protection

- Do not kill, injure, harass or capture any animal (large or small, including insects, fishes, frogs, birds) that you encounter.
- Walk away from and do not kill or attack potentially dangerous animals such as snakes, lizards, spiders, bees and wasps.
- Do not feed monkeys or other animals. Walk away from monkeys as they may become aggressive if they feel threatened.
- [For overnight visitors at the Eco-Lodge] Keep night-time noise levels to a minimum as many animals are sensitive to noise.

Guidelines on Habitat Protection

- Do not release pets or other animals in the wild.
- Throw waste in rubbish bins as litter can harm animals and damage the environment.
- Do not pour water or throw any waste into the streams.
- Do not smoke except in designated smoking points.
- Do not walk off trail as many saplings (young plants) of rare trees can be destroyed when trampled on.
- Do not collect flowers, seeds, fruits and other parts of plants.
- Do not cut wood or break branches in the forest.

6 Monitoring Requirements

This section identifies the minimum requirements for monitoring which MPH is responsible for fulfilling. MPH may opportunistically conduct additional monitoring which may go beyond the minimum requirements set out in Table 6.1, depending on factors such as the availability of specialist resources and research interest.

Table 6.1: Monitoring Requirements

Monitoring	Description
Camera Traps (Eco-Link)	Camera traps placed at the landing points and along the length of the Eco-Link (as described in Table 3.6.1) shall be maintained throughout the Project's construction and operation phases. Data from the camera traps shall be collected and analysed on a fortnightly basis to monitor animal trails. While these camera traps are initially used primarily to detect the presence of terrestrial species on the Eco-Link, additional camera traps will progressively (as vegetation is established) be placed on trees to also detect the presence of arboreal species. The data collected will be used to assess wildlife utilization of the Eco-Link and inform if any additional or corrective actions (e.g., placement of drift fences, planting of suitable flora to attract fauna) are needed to improve the effectiveness of the Eco-Link.
Camera Traps (Buffers)	Camera traps shall be placed at approximately 100m intervals along hoarding (during construction phase) and security fencing (during operation phase) which are installed at the boundary of the buffers within the Rainforest Park North and Bird Park. Camera traps shall be positioned to face forested areas and in the direction of the CCNR. Data from the camera traps shall be collected and analysed fortnightly during the construction phase and monthly during the operation phase. The data collected will be used to detect the presence and distribution of wildlife, assess wildlife utilization of the buffers, and as a comparison against the baseline.
Fauna Survey	Transect surveys shall be carried out within the Project area during the construction and operation phases at a frequency to be determined in consultation with the relevant technical agencies. The objective of the transect surveys shall be to detect the presence, distribution and abundance of the following fauna species groups:

Monitoring	Description
	▪ Birds (diurnal surveys, during the prime bird breeding season) ▪ Herpetofauna (diurnal surveys) ▪ Mammals (diurnal and nocturnal surveys) In addition, streams within the Project area will be surveyed (at a frequency to be determined in consultation with the relevant technical agencies) to document the diversity and abundance of fish and decapod crustaceans. The data collected will be used to assess the presence of species of conservation significance as well as species requiring potential management within the Project area, and as a comparison against the baseline.
Vegetation Survey	Survey walks within the buffers of the Rainforest Park North and Bird Park shall be carried out at a frequency to be determined in consultation with the relevant technical agencies during the Project's construction and operation phases to characterize the vegetation, record the presence of vascular plant species, abundance of mature native trees, and locate species of conservation significance as well as invasive, exotic species. Data collected will be used to assess the presence, distribution and abundance of terrestrial flora and as a comparison against the baseline.

Annex 19.0

Tree Protection Guidelines

[camphora]
natura in minima maxima

TREE PROTECTION GUIDELINES

By

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Lead Arborist
Camphora Pte Ltd
ISA certified
SG-0117A

CONTENT REQUIREMENTS

This document outlines specific measures to protect trees during construction or other site disturbance. The content and scope of the document will vary based on the site, type of construction, tree species, tree location and other factors.

TREE PROTECTION AND CONSERVATION GUIDELINES

This section outlines the general provisions for tree protection before, during and after construction. Additional measures may be added by the attending arborist on a case-by-case basis.

PRE-DEMOLITION/PILING/CONSTRUCTION

1. Pre-Construction Meeting

   The attending arborist shall attend a pre-construction meeting with the project contractor or construction supervisor to explain the tree protection and monitoring requirements as outlined in this document.

   In addition, the project contractor or construction supervisor shall complete the 'VERIFICATION OF TREE PROTECTION CHECKLIST' as attached in Annex A before the onset of the construction.

1.1 Tree Protection Zone

Prior to any site clearing (demolition works), piling works, grading, trenching or other soil disturbance, a tree protection zone (TPZ) must be installed as follows:-

i. Type
   The barriers should be temporary, made of a hard material, 1.8m tall and firmly installed into the ground.

ii. Ground protection
   Mulching material (can be compost or woodchips) at 100mm thick to be laid within the TPZ. If woodchips are used, termicide treatment is necessary to prevent the introduction of harmful termites.

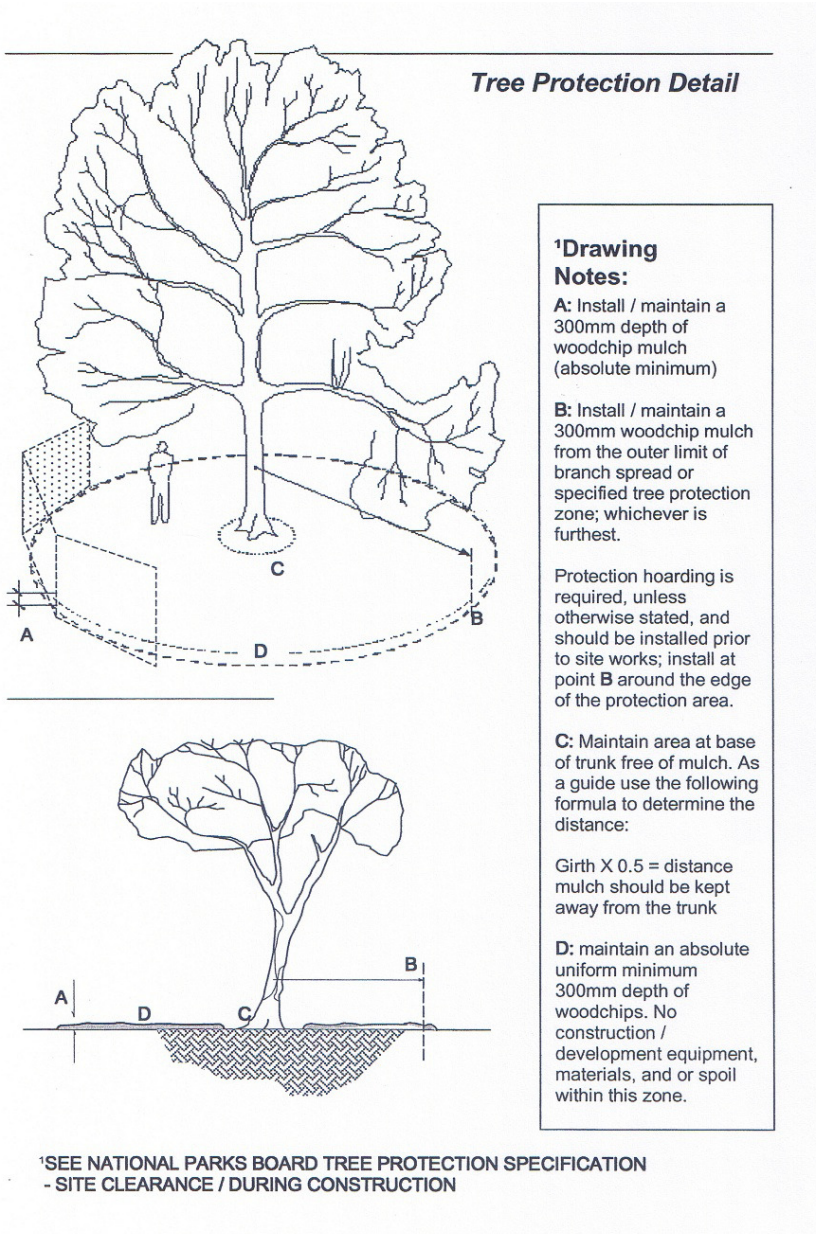
   Apply complete fertilizer (N:P:K 15:15:15) upon or together with the application of mulch.

iii. Signage
   A readily-visible and waterproof sign shall be installed on all sides of the fencing around each individual protected tree. The size of each sign must be a minimum of 300mm wide and must contain the wording below:

KEEP OUT!
TREE PROTECTION ZONE
Entry prohibited. This fence shall remain in place throughout the entire construction period.

iv. Fencing installation
Installation must be approved by the attending arborists and/or the approved authority prior to construction.

A diagrammatic representation of a proper Tree protection zone is presented below.



1.2 Tree pruning and removal

Various trees may need to be pruned away from structures or proposed construction activity. ***Construction or contractor personnel shall not attempt pruning or removal.*** Consultation and written approval with attending arborist must be obtained prior to pruning.

Removal of trees adjacent to trees that are to be retained requires planning and skilled arboriculture workers. Trees should not be removed by pushing with excavators/heavy machinery or with lumberjack (one cut) methods. Directional felling methods (notch and back-cut) should be deployed during removal of trees.

Removal of trees that extend into branches or roots of protected trees shall not be attempted by the demolition or construction crew, or by grading or other heavy equipment. Before removing tree stumps, the project manager shall seek the advice of the attending arborist determine if roots are entangled with trees that are to remain. If so, these stumps shall have their roots severed before extracting them.

1.3 Site Clearance

To avoid lumber jack felling of trees that may severely damage the canopy of conserved trees, it is recommended that qualified Arboriculture contractors be engaged to fell trees adjacent to protected trees to ensure that the trees (when cut) fall away from the protected trees and their associated TPZs.

Contractors carrying out tree felling works near assigned TPZs of conserved trees should

i. Employ directional felling through the use of notch and back cuts

ii. Deploy cranes to tension trunks in the direction of the drop

iii. Carry out pruning of canopy branches to remove entangling branches

iv. If trees to be removed are taller than neighbouring trees to be retained, removal of branches should be carried out in a controlled manner using ropes and cranes to avoid damaging canopy of the lower trees.

v. To avoid pruning of conserved trees at the proximity unless consultation and approval from attending arborist has been obtained.

vi. No tree should be removed by pushing with an excavator or heavy machinery.

DURING DEMOLITION/PILING/CONSTRUCTION

2. Tree Protection Zone Restrictions

- No ground disturbance, grading, trenching or other construction activities shall occur within the TPZ except as specified and/or approved by the attending arborist or authority.
- No construction material, debris, machinery (e.g. generators) or other construction waste shall be stored within the TPZ. Weight and presence of these materials increases soil compaction and reduces the area exposed for water infiltration and gaseous exchange.

Figure 1: Construction material and heavy machinery are prohibited within the TPZ

- Excavation works within the TPZ are strictly prohibited. Unless otherwise specified by the attending arborist, all work done within the TPZ shall be completed with manual trenching with hand tools or other hand held power tools that will not cause any root/tree damage.

  If roots need to be cut, it shall be done using proper equipment (e.g. pruning saw, chain saw) under the supervision of the attending arborist.

Figure 2: Trial trench by skilled workers using hand tools exposing root architecture

- Nailing, tying or pasting of materials on trees is prohibited. The tree shall not be used as an anchor for supporting structures during the construction.


Figure 3


Figure 4

Figure 3: Using tree as anchor may damage its bark

Figure 4: No nails shall be driven into the tree as it promotes infiltration of pests/diseases

- Phytotoxic materials such as fuels, oils, cement, chemicals, and paint shall be kept away and stored/mixed at least 2.5m from the tree protection zone. Such chemicals can significantly change the cation exchange capacity and pH of the soil, rendering nutrient uptake inefficient and creating an environment too toxic for the roots to grow.

  Construction slug especially from piling works should not be deposited within the TPZ. Such sludge is usually high in clay content and when layered over and within the TPZ could significantly alter the water infiltration and gaseous exchange rates of the root absorption area of the tree.

  Canvass sheets/Eco-mat must be laid on the existing soil near the tree in view of soil protection during the demolition, drilling or other construction activities pertaining to concrete structures.


Figure 5: Construction cement deposited at tree base


Figure 6: Tree showing signs of decline overtime

- Lowering the grade around trees can have an immediate and long-term effect on trees. Typically, most roots are within the top 1m of soil, and most of the fine roots active in water and nutrient absorption are in the top 300mm.

  A) Grade changes within the TPZ are not permitted.

  B) Grade changes outside the TPZ shall not significantly alter drainage.

  C) Grade changes under specifically approved circumstances shall not allow more than 200mm of fill soil or allow more than 150mm of existing soil to be removed from natural grade, unless mitigated.

  D) Grade fills over 200mm or impervious overlay shall incorporate an approved permanent aeration system, permeable material, or other approved mitigation.

  E) Grade cuts exceeding 150mm shall incorporate retaining walls or an appropriate transition equivalent.

  No removal of the TPZ will be permitted under any circumstances.

Figure 7: Inappropriate installation/maintenance of TPZ during construction

2.2 Proximity of Heavy machinery/vehicles

Heavy vehicles and machinery (e.g. excavators, piling cranes, 10 wheelers) movement should be limited near TPZs. Temporary access/passageways should be planned to avoid conserved trees.

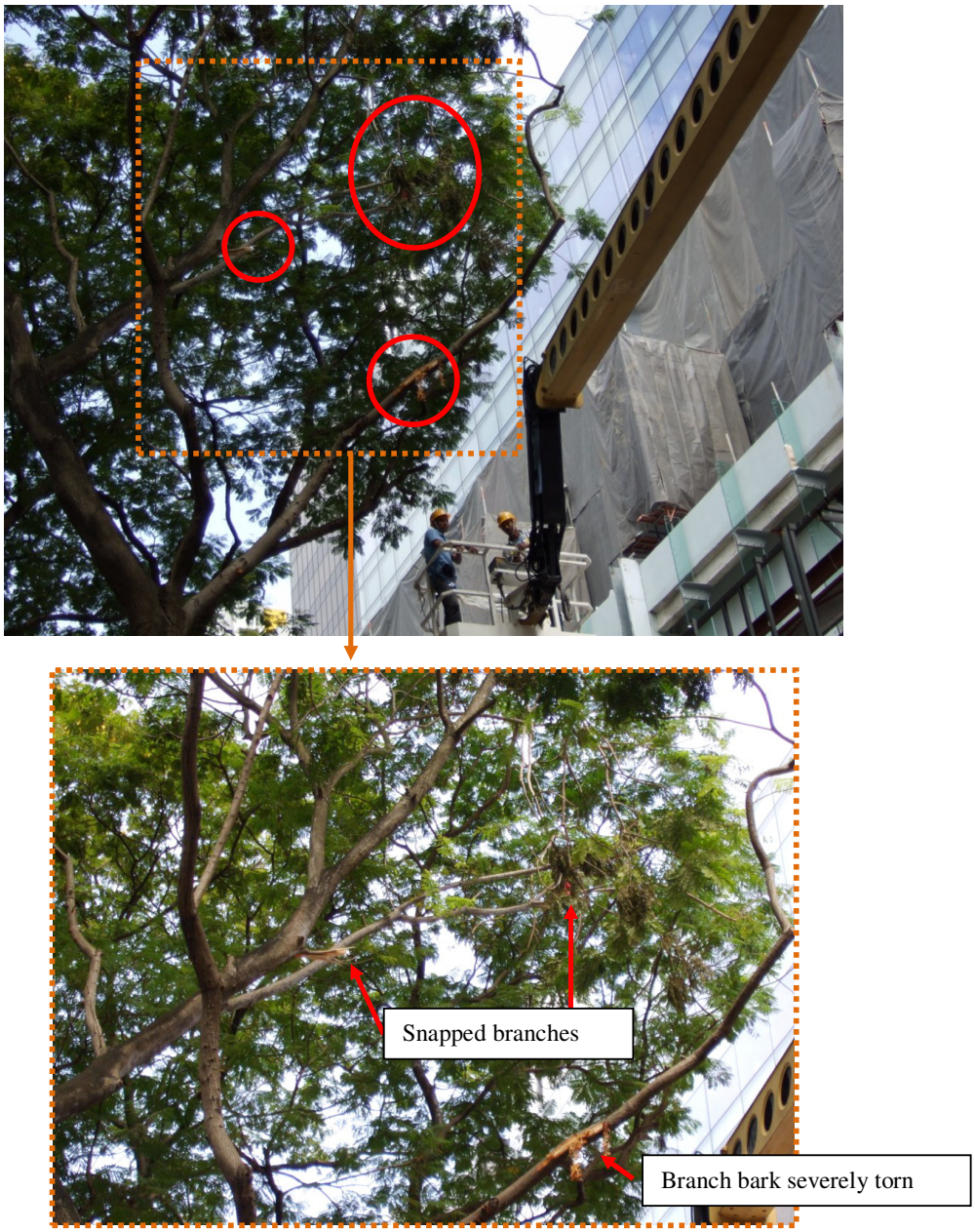


Figure 8: Tree branches were severed due to the negligence of the crane operator

2.3 Drainage Considerations

In the event that water ponding conditions develop in the course of construction due to change in grade/platform levels, construction events or any other unforeseeable factors, the contractor is required to improve drainage around or within the TPZ in consultation with the attending arborist.

2.4 Trenching, Excavation and Equipment use

Trenching, excavation or boring within the TPZ shall be limited to activities approved by the architect and/or attending Arborist. Explore alternatives for trenching outside the root zone. Avoid exposing roots during hot, dry weather. Backfill trenches as soon as possible with soil and soak with water the same day. Small roots can die in 10 to 15 minutes and large roots may not survive an hour of exposure. If the trench must be left open all roots must be kept moist by wrapping them in peat moss and burlap.

i. Root Severance
No roots greater than 0.2m in diameter shall be cut without approval of the attending Arborist. Tunneling under roots is the approved alternative. Prior to excavation for foundation/footing/walls, or grading or trenching within the TPZ, roots shall be severed cleanly outside the TPZ to the depth of the planned excavation. When roots must be cut, they shall be cut cleanly with a sharp saw to sound wood and flush with the trench site.

Figure 9: Tunneling under roots

ii. Excavation
Any approved excavation, demolition, or extraction of material shall be performed with equipment that is placed outside the TPZ. Hand digging, hydraulic, or pneumatic excavation (e.g. air spading) are permitted methods for excavation within the TPZ.

Root exploratory works using an air spade. Air spading avoids damage of structural and even feeder roots of the tree.

iii. Heavy Equipment
Use of backhoes, Ditch-Witches, steal tread tractors or other heavy vehicles within the TPZ is prohibited unless approved by the attending Arborist. If allowed, a protective root buffer is required.

2.5 Tree Care

In the course of construction, the following measures may be necessary to reduce the effects of construction stress on protected trees. Quantum, duration and extent to be advised by attending arborist.

(A) Fertilization

A1 Vertical trenches and Nutrient Sinks

Create vertical trenching and nutrient sinks. These nutrient sinks should go down to at least 300mm deep and should be filled with high grade compost and 12% Humic acid (dilution 1:100). These sinks will act to reduce construction stress by conditioning the soil, increasing soil microbiological activity and increasing organic matter At least 24 numbers of vertical trenches / nutrient sinks are required for trees greater than 2m in girth. Vertical trenches for trees under 2m in girth will be determined empirically by the attending arborist and will take into account site conditions, tree species and its pre construction vigor. Top up nutrient sinks every 3 months.

A2 Soil Injection of Biostimulants

Mandatory if TPZ has been infringed into, soil compaction has occurred, tree condition has observed to have declined (indicators: reduction in Live crown ratios, twig die back at canopy and change in leaf colour/size/density)

- **Purpose:** To de-compact soil using a hydraulic pressurized delivery of biostimulants that both hydrates and aerates at the same time. Aim to reduce compaction to less than 400psi in the first 500mm of the soil.

- Mixed bio stimulants – serves 2 functions
  Decompaction
- Humic acid – as soil conditioner and chelating agent (Nutrients are mobilized in forms that the plants can accept), facilitate release of nutrients and reduces leaching. Also improves water holding capacities of soil.
- Liquid gypsum / Dolomite – soil conditioner, improve soil structure and facilitate release of nutrients in clay soils typical of local conditions.

  To feed and increase soil microbiology to increase tree vigor post damage. Soil microbiology helps nutrient uptake and encourages healthy root growth critical to prevent construction stress.

- Mollases – High CE for immediate uptake,
- Fish Kelp – Protein source. Organic fertilisers
- Slow release fertilizers (Osmocote)

(B) Watering
- Water supplement during periods of drought.
- Watering duration and extent depends on site conditions and species.
- Watering is carried out until first signs of inundation are observed (i.e. water infiltration observe to slow down significantly).

(C) Myconate treatment
- To trigger and stimulate growth of existing mycorrhizae.

(D) Pesticide treatment
- To control pest (e.g. termites, borers, caterpillars etc) when it occurs.
- Fungicide or bacteriocide as required or as determined by attending arborist to control microbe pathogens.

(E) Additonal pruning
To be carried out in consultation with the attending Arborist. Trees are living things and may require some form of pruning during the course of the development.

- Crown cleansing- Prune to remove dead branches that may have developed through time.
- Crown lifting- Prune to lift crown to avoid new amenities.
- Crown thinning- Prune to reduce canopy branches and loading.

Structural pruning (including crown reduction) to remove branches that may obstruct new amenities and/or movement of critically necessary equipment may require the planning and standing supervision of the attending arborist.

2.6 Infringement

Instilling discipline and awareness amongst workers and crane/excavator operators is key to reducing damage to protected trees during the course. Contractors should include reminders of tree conservation guidelines within their daily briefings to their workers and crane/excavator operators.

To instill site discipline and discourage unnecessary damages to trees, the following fines will be implemented in event of damage to trees due to negligence.

Contractor should also note that they will become fully liable for the full amount of any fines impose by NParks in event of unauthorized damage to trees within the Tree Conservation Area.

Damage to Roots

Root Size	Fine Amount per event
<0.2m girth	$500
0.2-0.5m girth	$1000
0.5-0.8m girth	$1500
>0.8m girth	$2000

Damage to Branches

Branch Size	Fine Amount per event
<0.5m girth	$500
0.5-0.8m girth	$800
0.8-1.0m girth	$1200
>1.0m girth	$2000

Damage to Trunk

Trunk Size	Fine Amount per event
<0.5m girth	$300
0.5-1.0m girth	$600
1.0-1.5m girth	$900
1.5-2.0m girth	$1200
>2.0m girth	$1500

Removal of TPZ without prior written approval from architect or attending arborist.

S$5000/event

2.7 Engaging Arboriculture Contractors

All arboriculture works should be carried out by skilled and trained arboriculture teams. As such, it is preferred that only Arboriculture contractors which have at least 8 years working experience and must show previous work experience in developments of similar size or complexity. Arboriculture contractors should meet NParks' safety requirements for work at height, LTA's requirements for temporary works along roadsides (where necessary) and have a certified arborist to supervise the pruning/felling/planting works.

All arboriculture workers engaged in tree climbing and chainsaw work shall possess a valid basic tree climbing certification base upon demonstrated competence in the WSQ module conducted by CUGE or an equivalent WSQ approved training organization.

Each Arboriculture crew shall possess the following VALID competences,
Operation of chainsaw for ground work (LS-MT-103E-1)
Chainsaw safety and maintenance (LS-MT-102E-1)
Perform formative pruning of young trees (LS-MT-114E-1)
Provide Arboriculture support on site (LS-MT-116E-1)
Workplace safety and health – operators (ES-WSH-101G-1)
Respond to Emergency (LS-HM-208E-1)
Perform advance rigging and climbing techniques (LS-HM-308S-1)
Perform aerial tree access and aerial rescue skills (Ls-HM-204S-1)
Implement and apply appropriate risk and safety management to sector practices (LS-BP-301S-1)
Prepare risk assessment report (LS-HM-406S-1)
Operate and work from an elevated work platform (CUGE-ARB-3501)

POST-CONSTRUCTION

3. Soft Landscaping

Ground works, site preparation and implementation of all landscaping near protected trees must be undertaken carefully.

TPZ barriers can only be removed at this juncture for the purpose. However, when working near trees, cultivation of soils in these areas must be cautiously handled using hand tools. Planting of shrubs shall be at a distance of at least 300mm away from existing root collar.

Avoid changes to ground levels or unnecessary compaction of soils within proximity to existing trees during the course.

Figure 10: New plantings at a minimum distance of 300mm (all round) from root collar

ANNEX A

VERIFICATION OF TREE PROTECTION CHECKLIST

Note: The project contractor or construction supervisor shall verify in writing that all **preconstruction** tree preservation conditions have been met as follows:

Submitted by: _____

Company/Project: _____

Date/Time: _____

S/N	Action	Checked (✔)	Remarks
1	Installation of tree fencing around identified trees within/near site (hard material at 1.8m tall)		
2	Tree protection zone (TPZ) dimensions meets specifications (from NParks and/or attending arborist)		
3	Warning signs prominently displayed on all sides of the fencing, including designated tree number		
4	Removal of construction material (ie machinery, debris, tools etc) within TPZ		
5	Mulching of high grade compost of 100mm thick around identified trees		
6	Completion of tree pruning (if necessary) under the supervision/written approval with the attending arborist		
7	Establishment of a tree maintenance schedule according to arborist recommendations (to be submitted to attending arborist)		

Verified by (attending arborist): _____

Date/Time: _____

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