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Appendix L.	Impact Assessment on Habitat Receptors
Appendix M.	Impact Assessment on Flora Receptors
Appendix N.	Impact Assessment on Fauna Receptors
Appendix O.	Tree Protection and Conservation Guidelines
Appendix P.	Guidelines for Sapling Harvesting and Tree Transplantation and Tree Maintenance
Appendix Q.	Wildlife Incident Form
Appendix R.	Baseline Surface Water Quality Report
Appendix S.	Baseline Groundwater Water Quality
Appendix T.	Impact Assessment on Drinking Water Reservoir (Upper Seletar Reservoir)
Appendix U.	Baseline Airborne Noise Monitoring Report
Appendix V.	Equipment Inventory List
Appendix W.	List of Airborne Noise Ecological Receptors

List of Acronyms

ALARP	As Low As Reasonably Practicable
ASEAN	Association of Southeast Asian Nations
BIA	Biodiversity Impact Assessment
BTdpg	Dairy Farm Granite-microgranite Pluton
CBD	Central Business District
CS	Conservation Significance
DO	Dissolved Oxygen
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EMMP	Environmental Management and Monitoring Plan
EU	European Union
HASP	Health and Safety Plan
IBS	Identified Biodiversity Site
LNAPL	Light non-aqueous phase liquids
MSS	Meteorological Service
NAS	National Archives of Singapore
NMDS	Non-Metric Multidimensional Scaling
NSRs	Noise Sensitive Receptors
NTU	Nanyang Technological University, Singapore
NUSLHMSG	NUS Libraries Historical Maps of Singapore
PM	Particulate Matter
PUB	Public Utilities Board, Singapore
RL	Reduced Level
SHD	Singapore Height Datum
SINGLAS	Singapore Laboratory Accreditation Scheme
SLM	Sound Level Meter

Acronym	Definition
SRDB	Singapore Red Data Book
SVOCs	Semi-Volatile Organic Compounds
SWL	Stabilised Water Level
TA	Technical Agencies
TDS	Total Dissolved Solids
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solids
UHI	Urban Heat Island
UK	United Kingdom
uPVC	Unplasticized Polyvinyl Chloride
URA	Urban Redevelopment Authority, Singapore
US	United States of America
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compound
WHO	World Health Organisation

1 Executive Summary

Project Description and Objectives

AECOM Singapore Pte. Ltd. was appointed by the Housing and Development Board (HDB), through the Letter of Acceptance dated 17th February 2023 (Contract Number L/074/23), to provide *Specialist Consultancy Services for Environmental Impact Assessment at Woodlands N1*. An Environmental Impact Assessment (EIA) is required to understand the current environmental baseline conditions in Woodlands Neighbourhood 1 (N1), referred to as 'the Project'. This study will include an assessment of topography, biodiversity, airborne noise, and water resources (such as hydrology, surface water quality and groundwater). The EIA will predict and evaluate the potential impacts on biodiversity, including habitat degradation, mortality, and accidental injury. It will also assess the impacts caused by changes in other environmental baseline conditions, such as water resources and airborne noise, arising from and associated with the construction and operational phases of the proposed developments within the Project area.

The Project site spans across approximately 7.27 hectares (ha), and it is located in the northern part of Singapore. The Project site is bounded by Marsiling Road in the south, low-laying vegetation and Woodlands Centre Road in the west, Admiralty Road in the north and existing urbanised areas in the east (Woodlands Secondary School).

The proposed future developments within the Project will require: (1) the identification and understanding of baseline conditions of biodiversity, water resources (i.e., hydrology, surface water quality, groundwater), airborne noise, as well as topography of the Study Area; (2) the assessment of potential impacts on identified ecological receptors and other environmental conditions of the site; (3) the assessment of indirect potential impacts (i.e., due to changes in water resources and airborne noise) on ecological receptors and other environmental conditions of the site; (4) the proposal of mitigation measures to minimise potential significant adverse impacts; and (5) the development of an Environmental Management and Monitoring Plan (EMMP).

As shown in Urban Redevelopment Authority (URA)'s gazetted Master Plan 2019 [M-1], the Project site is zoned "Residential (Subject to Detailed Planning)" and "Road".

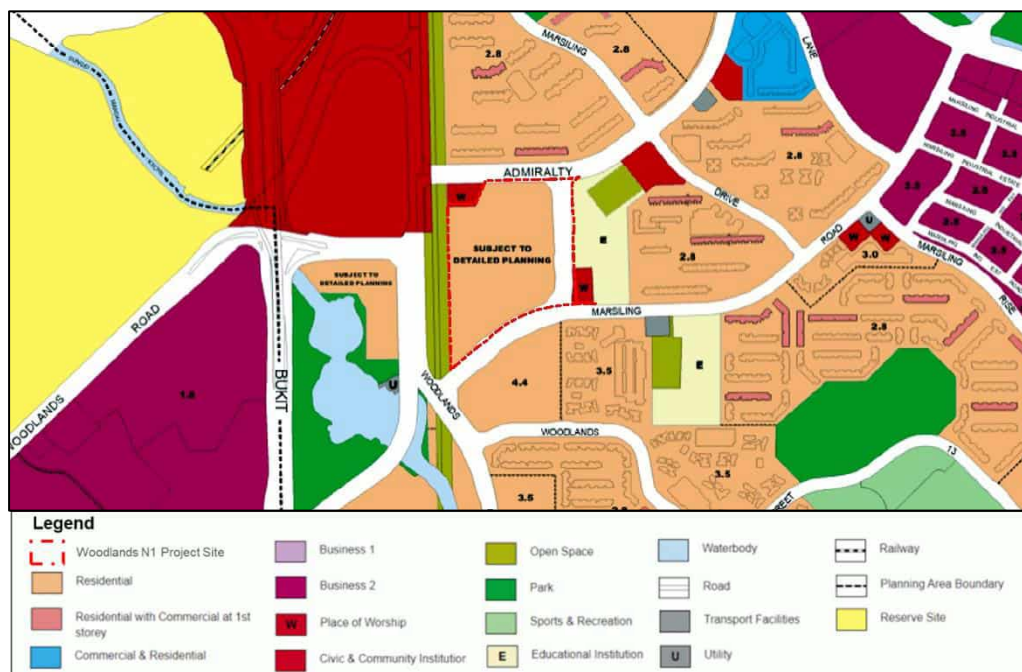


Figure 1.1 Proposed land use of the Project site and its surroundings (Source: URA's gazetted Master Plan 2019 [M-1])

Environmental Baseline Findings

Baseline studies on biodiversity, water resources (hydrology, surface water quality, groundwater quality and level) and airborne noise were conducted for the respective Study Areas. A summary of the findings is provided below, detailed information can be obtained from Section 6 of the Report.

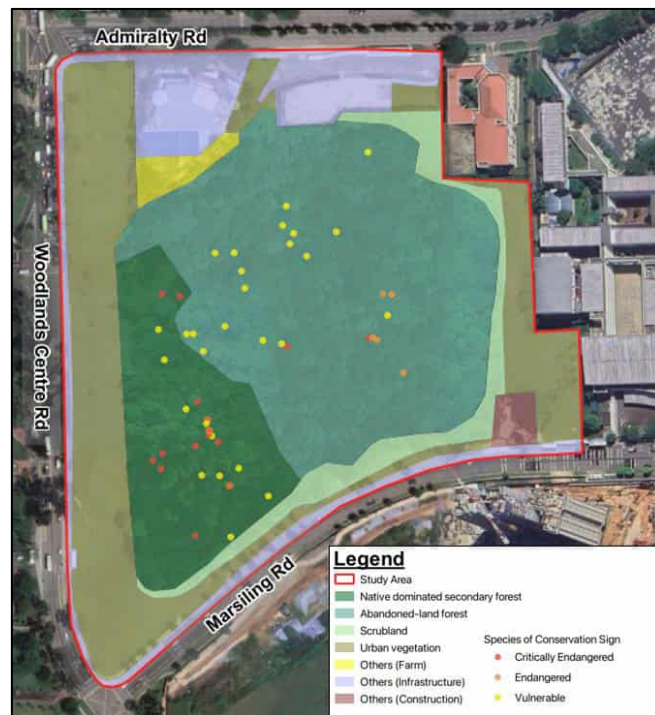


Figure 1.2 Habitat map of the biodiversity Study Area with distribution of flora species of conservation significance

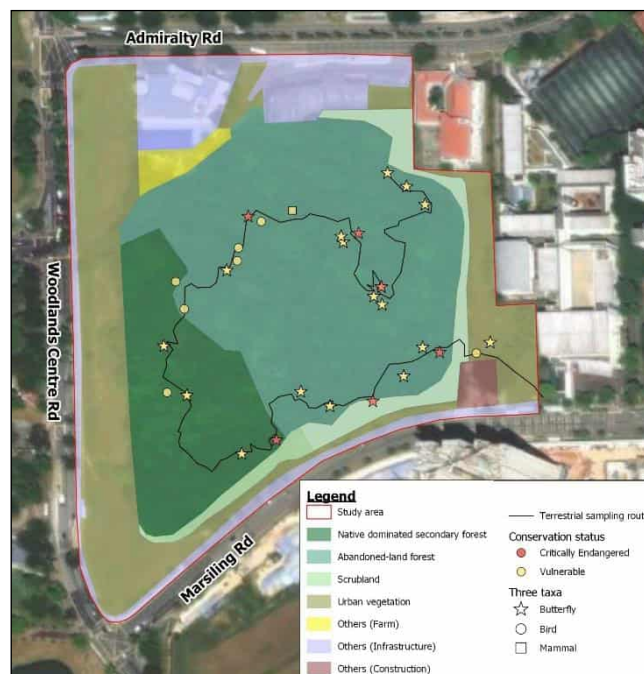


Figure 1.3 Habitat map of the biodiversity Study Area with location of faunal species of conservation significance

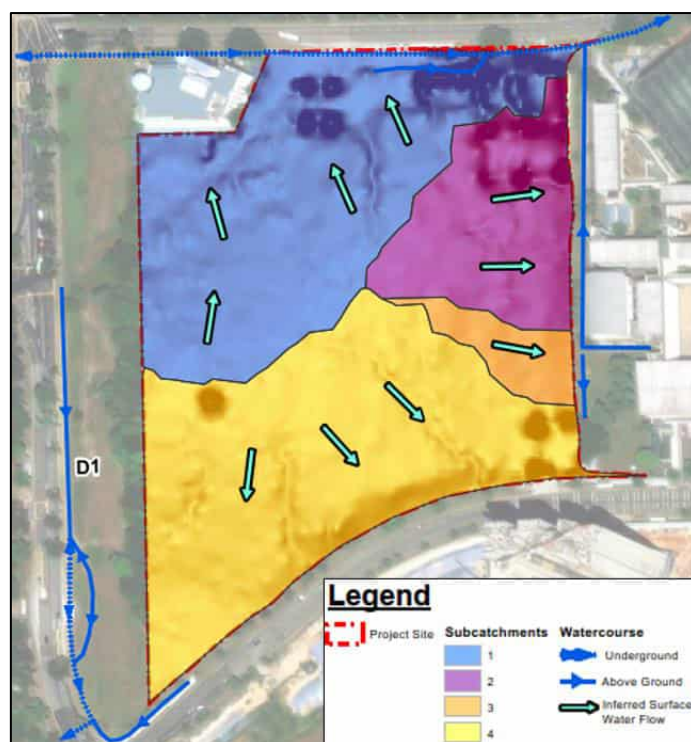


Figure 1.4 Catchment map of the Project site

- Habitats and Vegetation Distribution** (see Figure 1.2) – The Study Area currently consists of 4 vegetation habitats: abandoned-land forest (38.1%), urban vegetation (24.2%), native-dominated secondary forest (15%) and scrubland (5.5%). Other habitats include farmland (3.1%), infrastructure (13.2%) and construction area (1%). As there are no watercourses within the Study Area, no aquatic habitats were observed.
- Biodiversity, Flora, Large Plant Specimens and Other Specimens of Value** (see Figure 1.2) – In total, there are 195 species recorded, out of which 89 are native, 99 are exotic and 7 are cryptogenic. Ten species of conservation significance were recorded. These species include (1) *Aporosa falcifera*, (2) *Baccaurea polyneura*, (3) *Bouea oppositifolia*, (4) *Curculigo latifolia*, (5) *Dioscorea hispida*, (6) *Gymnacranthera farquhariana* var. *farquhariana*, (7) *Lindera lucida*, (8) *Litsea umbellata*, (9) *Microlepidia speluncae*, and (10) *Psychotria polycarpa*. In total 28 large specimens were recorded (9 native, 18 exotic and 1 cryptogenic). No bamboo bats were found during the roost emergence survey.
- Biodiversity, Fauna** (see Figure 1.3) – In total, 95 species were recorded, mainly dominated by birds and butterflies. Four species of conservation significance were recorded across 3 taxa (birds, mammals and butterflies). Bird species of conservation significance include Swinhoe's white-eye (*Zosterops simplex*). Mammal species of conservation significance include Cave nectar bat (*Eonycteris spelaea*). Butterfly species of conservation significance include sky blue (*Jamides caeruleus caeruleus*) and common birdwing (*Troides helena cerberus*).
- Hydrological Conditions** (see Figure 1.4) – No watercourses were observed within the Project site. The site is surrounded by opened/ partially opened drains in the north (i.e. along Admiralty Road), east (i.e. between the site and Woodlands Secondary School) and west (i.e. along Woodlands Centre Road). Catchment delineation shows that the site can be divided into 4 sub-catchments (northern, northeastern, eastern and southern). The water from northern, northeastern and eastern sub-catchments eventually gets discharged into the drain along Admiralty Road north of the Project site, while the surface runoff from the southern catchment gets channelled via roadside drains and culverts to the Marsiling Park Pond. In the northern end, the water from the Pond flows over the bund into the canal, eventually reaching Sungei Mandai Kechil. In addition, the water from the pond partially gets channelled and eventually reaches Upper Seletar Reservoir.
- Surface Water Quality** – The surface water sample was collected at one (1) water quality station, located at the junction of Drain D1 and the southern roadside drain. It is to be noted that drain D1 has ephemeral flow, hence the water sample was collected only during wet-weather conditions. All the tested surface water quality

parameters were within the adopted criteria (i.e. NEA Trade Effluent and Aquatic Life Criteria), except for aluminium which was above the adopted aquatic life criteria.

- **Groundwater Level and Quality** – The groundwater elevations within the site ranged from 18.17m reduced level (mRL) to 10.37 mRL, while the groundwater depths ranged from 5.26m below ground surface (mbgs) to 5.43mbgs. The groundwater seepage velocity was calculated to be around 1.1 m/yr., with inferred radial flow direction from the central portion of the site, generally flowing towards the southeast. The groundwater is moderately acidic, with low conductivity and TDS concentrations, indicating freshwater conditions. All of the detected parameters in groundwater were reported within their respective DIVs, where applicable.
- **Airborne Noise** – Baseline airborne noise monitoring was conducted at one (1) location to capture the ambient noise conditions experienced by ecological receptors in the vicinity of the Project Site. Baseline noise levels showed relatively low variation across weekends and weekdays, as well as during different times of the day—day, evening, and night.

Impact Assessment Methodology

Section 5 of this EIA Report discusses the methodologies used for impact identification, prediction and assessment on environmental parameters including biodiversity, water resources (surface water quality, groundwater quality and level) and airborne noise during the construction and operational phases of the Project.

Minimum Controls and Recommended Mitigation Measures

Table 1-1 lists the minimum controls and key mitigation measures that have been developed to minimise the adverse impacts throughout the course of the Project. More details can be found in Section 7 and 8 of the Report for proposed mitigation measures during the construction and operational phase respectively.

The main mitigation measures for biodiversity are implemented based on the mitigation hierarchy in the following order: (1) avoidance, (2) minimisation, and (3) enhancement/rehabilitation as well as compensation. Under avoidance, an area of high ecological value (AHEV) is recommended to be avoided from development. However, based on the recommendation in Section 7.4.4.1, not all of AHEV will be retained due to development plans. Ultimately, only about 90% of the AHEV (i.e., native-dominated secondary forest) will be retained. The area proposed to be retained also included a 15m buffer from the last line of native trees within the native-dominated forest patch. This helps to reduce the impact for habitat loss, plant mortality, loss of/reduction in habitats and food sources and overall connectivity for the fauna species.



Figure 1.5 Proposed area to be retained

Other measures were also recommended to minimise biodiversity impacts. For habitat, there should be infill planting within the 15 m buffer of the proposed retained area. The planting palette should take reference from native-dominated secondary forest species composition; planting species that would attract fauna such as butterflies and birds could reduce the impact of loss of/reduction in habitats and food sources. Threatened and/or rare flora species that will be impacted due to the site clearance should be transplanted or salvaged.

To minimise impact for accidental injury or mortality and human-wildlife conflict, directional site clearance to shepherd fauna during construction phase should be adopted together with road calming measures along the main road abutting the worksite. Other mitigation measures such as regular biodiversity awareness training, regular site inspections, good housekeeping controls should also be adopted within the construction site. To reduce impact for humans and light disturbance, other than no encroachment into proposed retained AHEV, a 6m noise barriers and light management plans should be implemented. Subsequently, with future plans for road widening works along Marsiling Road, further assessment should be undertaken to understand the impacts to biodiversity in the vicinity which includes the AHEV.

To minimise the impact due to the noise generated during the construction phase, the construction inventory list is to be analysed, and equipment causing high noise levels should be checked. Equipment with lower noise levels should be prioritized. Where source control is infeasible, acoustic enclosures or sheds are to be introduced to mitigate noise at the source by covering the machine as fully as possible. Noise barriers are proposed at the construction boundary fronting noise-sensitive receptors. If noise persists despite the recommended mitigation measures, proprietary noise barriers with high noise reduction capabilities should be implemented. The impacts due to traffic noise from Marsiling Road should be mitigated by reducing traffic speed through the installation of low-speed postings, speed humps, and speed limit signage.

Table 1-1 Summary of minimum controls and key recommended mitigation measures

Environmental Parameter	Minimum Controls and Key Recommended Mitigation Measures	
	During Construction Phase	During Operational Phase
Biodiversity	<u>Minimum controls</u> - Any trees that are to be retained within worksite would require a certified arborist to clearly mark out Tree Protection Zones where no works are allowed. The Tree Protection Zones should be set up in accordance with NParks guidelines (NParks, 2019) - Before vegetation clearance, pre-felling fauna inspection should be conducted by an Ecologist who is able to identify wildlife or nesting structures that are being actively used such as bird nests, tree hollows, burrows, and bamboos clusters; in compliance with Section 10 Wildlife Act - Soil erosion control measures (e.g. implementation of biodegradable erosion control blankets, ECM tanks etc) are to be executed once vegetation has been removed and soil is exposed as described in Section 7.3.2 under Water Resources - Implement dust control measures as defined by NEA's regulated Environmental Protection and Management Act and its regulations - Implement noise barrier as described in Section 7.3.3 under Airborne Noise - Proper storage of materials that are likely to leech harmful chemicals and fuel-powered equipment away from waterbodies or sensitive habitats as described in Section 7.3.2 under Water Resources - Installation of hoarding to delineate worksite - Execute wildlife response plan when a trapped/ injured/ dead/ dangerous animal is encountered around or within the worksite according to Section 10 of the Wildlife Act - Fogging is not recommended. To implement preventive measures against mosquito breeding by removing sources of stagnant water or water-bearing receptacles - Providing well-maintained pitched roof, clearing discarded items daily, store materials appropriately,	<u>Minimum controls</u> - Ensure noise levels are within approved limits (refer to Section 8.5 under airborne noise-related impacts) - Ensure dust levels are within approved limits as defined by NEA's regulated Environmental Protection and Management Act and its regulations <u>Mitigation measures</u> - Advisories can be displayed near HDB's lift lobbies or near-by bus stops to educate the residents on how to identify and respond to wildlife. Sign boards should include information on rescue hotline i.e., ACRES or NParks - Limit public accessibility to the proposed area to be retained

Environmental Parameter	Minimum Controls and Key Recommended Mitigation Measures	
	During Construction Phase	During Operational Phase
	level up ground depression/ uneven surfaces, ensure effective drainage flow - Daily checks by Environmental Control Officer on site. - Use only fully biodegradable erosion control blankets (ECB) to avoid trapping fossorial fauna such as snakes - In the event of night works, development of Light Management Plan to minimise light disturbance to sensitive receptors <u>Mitigation measures</u> - Infill planting within the 15m buffer. Planting palette should take reference from native-dominated secondary forest species composition and include plant species that would attract fauna such as butterflies and birds - Transplantation / salvaging of threatened and/or rare plant species that would be impacted - Directional site clearance to shepherd fauna to an area allowing them to leave by themselves or through rescue and relocation if needed - To minimise entry of fauna into the site, the integrity of hoarding must be maintained at all times. Gaps in hoarding facilitates entry of fauna into the construction site. Regular inspections should be conducted to ensure there are no gaps in hoarding at all times - Adopt road calming measures such as speed bumps and speed limits (15km – 20km/h) to minimise roadkill accidents - Conduct biodiversity awareness training to worksite personnel and educate on actions to take when encountering wildlife - Ensure good housekeeping controls such as provision of wildlife-proof bins and indoor eating areas - Conduct regular inspections to ensure contractor compliance to the EMMP and identify potential faunal entrapments - Conduct roost emergence prior to bamboo felling works, ecologist to be present during bamboo felling to ensure that any bamboo bats will not be injured in the process and bamboo bat translocation - No encroachment into proposed area to retain - Develop and implement light management plan as there will be night works	
Impacts on Biodiversity due to Changes in other Environmental Parameters		
Water Resources (Surface Water Quality)	- Finalise a full inventory of all anticipated wastewater streams and volumes before the onset of construction phase works - Maintain daily records of wastewater volume, as well as the volumes of sludge and other wastes produced onsite - Ensure containment ponds are made of impervious material and designed with sufficient capacity to hold volumes of wastewater produced on site, accounting for stormwater runoff and firefighting needs as well - Provide temporary storage volumes for overflow situations of untreated wastewater. This temporary storage should have sufficient capacity to capture any unexpected additional volumes, ensuring that untreated wastewater is not released to watercourses unless it complies with NEA guidelines on trade effluent discharge concentrations. - Equip containment ponds, as well as wastewater generating areas on site with spill clean-up kits.	- Geotechnical aspect of site's slope stability (such as Earth Retaining Stabilising Structure [ERSS]) to be included in detailed design engineering for the operational phase - Providing more softscape area should be considered in the design of the development which will help to reduce the peak flow and reduce flood risk at downstream area. Active, Beautiful, Clean (ABC) Water design approach can be considered to reduce the peak flow - Provide more pervious areas to increase the seepage of surface water into the soil - Adequate drainage, piping and/ or channelling of stormwater runoff to be assured through detailed design [e.g. ABC Water design approach] for

Environmental Parameter	Minimum Controls and Key Recommended Mitigation Measures	
	During Construction Phase	During Operational Phase
	- Design adequate drainage systems, including cut-off drains, sump pit, road kerb, piping and toe walls to channel construction process wastewater streams (e.g. wash water) and stormwater runoff separately through detailed design to capture and treatment in the containment pond(s)/ kerb(s). Where applicable, include oil-water separators. - Seek approval from relevant authorities (i.e. PUB and NEA) in accordance with PUB Sewerage and Drainage (Trade Effluent) Regulations, if the wastewater is planned to be disposed to public sewer, or NEA's Trade Effluent Discharge Limits to watercourse if disposal to surface watercourses is intended. If such discharges are not approved, the trade effluent will be stored, treated or recycled on site and finally disposed off-site. - Obtain comments and approval from relevant authorities (e.g., Singapore Civil Defence Force [SCDF] and NEA) for the use of treated wastewater for firefighting purposes. - Provide appropriate concrete washout areas, ensuring these are not located near watercourses. - All vehicles are to undergo a wheel washing process before leaving the site to prevent earth, mud, and debris from being disposed of on surrounding roads. The wastewater generated from this activity should be stored and removed for treatment and disposal offsite by an approved Waste Management Contractor. - Establish regular and dedicated procedures for the inspection and maintenance of wastewater collection, storage, and treatment infrastructure (e.g., pipes, oil-water separators). - Implement regular and dedicated procedures for the management of stormwater collection, settling, testing, and eventual discharge to watercourses. - Develop a training program for all onsite workers, including subcontractors, to educate them on their obligations regarding proper water quality management. - Prohibit the discharge of pumped groundwater from soil dewatering and other wastewaters into aquatic habitats. - Prohibit the unmanaged discharge of any wastewater stream. - No trade effluent other than the nature or type approved by the NEA Director-General will be discharged into any watercourse or soil. - Apply the principles of reduce, reuse, and recycle to wastewater management onsite. - Store hazardous wastewater, such as oil water, thinners, solvents, or paints, on a hard stand under shelter with a curb around the storage area. Ensure this wastewater is removed for treatment and disposed of offsite by an approved Waste Management Contractor. Handle hazardous liquids as Hazardous Waste. - Implement a construction Environmental Management and Monitoring Plan (EMMP) and ensure full preparation of associated plans and procedures.	capturing and treatment before discharge into receiving watercourses - Regular and dedicated procedures for the inspection and maintenance of stormwater collection, storage, and treatment infrastructure, such as pipes, oil water separation, silt screens, etc - Regular and dedicated procedures for the management of stormwater collection, settling, testing and eventual discharge of 'clean' water to surface waters, including associated measures required to prevent high sediment concentration stormwater drainage to surface waters - Prepare sufficient disposal bins surrounding the Project to avoid improper disposal of waste - Conduct regular inspection on wastes' storage system of the Project - Monitor the proposed watercourses and its surroundings with CCTV surveillance regularly to ensure no contamination occurred - Develop an Emergency Response Plan and conduct adequate training to maintenance workers to cope the accidental water contamination - Raise awareness of various stakeholders with community/ stakeholder engagement (e.g. signage boards, warning signs, etc.)
Water Resources (Groundwater)	- Install piezometers to monitor the changes in groundwater level in compliance with Building Control Regulations 2003 as part of its instrumentation and monitoring plan to be endorsed by the Qualified Professional - Conduct a construction risk assessment and prepare a comprehensive construction health,	- Incorporate more pervious surfaces in the development plan - Installation of recharge wells, if necessary - Ensure no trade effluent other than that of a nature or type approved by NEA Director-General shall be

Environmental Parameter	Minimum Controls and Key Recommended Mitigation Measures	
	During Construction Phase	During Operational Phase
	safety and environment plan. If health impacts to workers are foreseen due to the handling of such waste, necessary precautionary measures as per the safety data sheets (SDS) including personal protective equipment should be implemented on site	discharged into any watercourse or land; and Conduct regular inspections on waste storage system within the Project to prevent system's clogging and leachate entering the underlying soil and/or surrounding watercourses, if any.
Airborne Noise	<u>Best Management Practices</u> - Shut down machines (such as trucks) that may be in intermittent use between work periods or throttle down to a minimum - Label all machinery and equipment used with a weather-proof sticker clearly indicating its noise emission level (at source) under normal operating conditions - Utilize only well-maintained construction plants on-site, and service construction plants regularly during the entire construction period - Reduce the number of Powered Mechanical Equipment (PME) as far as practicable when carrying out construction works at areas close to the noise-sensitive receivers. - Utilize and properly maintain silencers or mufflers on construction equipment during the construction programme. - Ensure behavioural practices including no shouting, no loud stereos/radios on site, no dropping of materials from height, and no throwing of metal items. Restrict high noise-generating drilling activities only to continuous blocks not exceeding 3 hours each, with a minimum respite period of one hour between each block, if possible. - Conduct periodic noise monitoring by an independent third party to establish compliance with requirements and to advise on equipment causing concern, and additional potential mitigation measures. - Apart from advance works/site clearance approved by Agencies, minimise noisy works after 6pm to reduce noise disturbance to nocturnal animals. - Plan the layout of the site by considering the use of materials and other large structural equipment as noise barriers. - Orient construction plants that are known to emit noise strongly in one direction, wherever possible, so that the noise is directed away from the nearby noise-sensitive receptors. - Utilize material stockpiles and other structures effectively, wherever practicable, to screen noise from on-site construction activities. - Ensure all handheld percussive breakers and air compressors used on-site comply with local legislation and requirements. - Schedule activities to minimize noise generated at certain areas during periods particularly sensitive to noise. - Prohibit works using machines or vehicles that generate noise during the night and at dawn. - Personnel operating the plant or equipment should use appropriate hearing protectors, which must attenuate the user's exposure to sound pressure levels below 85dB (A). Put up signage to remind personnel to use hearing protection at work areas that emit excessive noise. Choose hearing	<u>Best Management Practices</u> Minimum Controls below should be applied at the prelim design stage of the development by the appointed M&E consultants. An appointed Noise consultant should validate the noise in accordance with the NEA ACMV Guideline, 2018 [R-37]. In addition, mitigation measures will be provided by the appointed Noise Consultants during the prelim design stage - Ensure that any exhaust outlet or intake from the mechanical ventilation system is designed to be adequately set back as far as possible from the boundary line of the development - Acoustic treatment if any to be designed and implemented - The building design should include provisions to ensure that the condensers of individual air-conditioning systems are positioned away from noise-sensitive areas - Acoustic enclosures for outdoor equipment - Consider road design as part of land use planning to minimise potential impact of land traffic noise on Noise Sensitive Receptors (NSRs) - Consider the use of low-noise pavement mix for sections of new road networks near NSRs - Consider alternative siting of new road networks away from noise sensitive receptors at pre-design stage - Mitigate traffic noise at drop-off points and parking areas with low-speed postings, speed humps and speed limit signages. The addition of these speed control measures will likely lower noise levels for traffic as the vehicles would be cruising at lower speeds Due to the lack of information at this juncture of reporting, assessment, minimum controls, and mitigation will be provided by the appointed Noise Consultant during the prelim design stage and in accordance with the NEA TNIA Guideline, 2016 [R-39] <u>Key Mitigation Measures</u> - Mitigate the impacts due to the traffic noise from Marsiling Road by reducing the traffic speed with the installation of low-speed postings, speed humps and speed limit signages

Environmental Parameter	Minimum Controls and Key Recommended Mitigation Measures	
	During Construction Phase	During Operational Phase
	protectors such as ear plugs (for < 100 dB (A)), earmuffs (for 100 dB (A) to 120 dB (A)), or ear plugs and earmuffs (for > 120dB (A)) according to various noise exposure levels. - Conduct noise awareness briefings regularly and highlight the noise mitigation measures such as positioning machinery, using portable noise barriers, and the dos and don'ts for using machinery at night. <u>Key Mitigation Measures</u> - Control of noise sources at the source from construction site – Analyse construction inventory list and check equipment causing high noise levels. Prioritize the equipment with lower noise level; and - Where controlling noise sources at the source is not feasible, acoustic enclosures or sheds are to be introduced to mitigate noise at the source. Typical acoustic enclosure covers the machine as fully as possible (with or without ventilation where applicable) to provide sound insulation - Noise barriers are proposed at the construction boundary fronting noise sensitive receptors; and - The construction of buildings of staggered heights with low-rise, mid-rise, and high-rise buildings should be considered - If noise remains an issue even after implementation of recommended mitigation measures such as noise barriers, contractor should consider implementation of proprietary noise barriers of high noise reduction capabilities to further reduce noise to acceptable levels	
Note: As current means of noise impact assessment were only performed qualitatively, quantitative noise impact assessment must be conducted by the developer/ developing agent at a later stage to assess noise impacts arising from the construction phase related activities applying a 3D simulating software such as SoundPLAN and CadnaA before the commencement of construction works as mandated by law at later stages of the Project.		

Summary of Impact Assessment

With the implementation of mitigation measures, the overview of impact evaluation for both construction and operational phases are summarised in Table 1-2.

Table 1-2 Summary of impact significance for construction and operational phases (range, if applicable)

Environmental Parameter	Impact Significance (with Minimum Controls/ Best Practices)	Residual Impact Significance (with Mitigation Measures)
<i>Impacts on Biodiversity</i>		
Biodiversity	<u>Construction Phase</u> Negligible to Major <u>Operational Phase</u> Negligible to Moderate	<u>Construction Phase</u> Negligible to Major <u>Operational Phase</u> Negligible to Minor
<i>Impacts on Biodiversity due to Changes in Other Environmental Parameters</i>		
Water Resources (Surface Water Quality)	Minor	Minor
Water Resources (Groundwater)	Negligible	Negligible
Airborne Noise	<u>Construction Phase</u> Moderate to Major <u>Operational Phase</u> Negligible to Moderate	<u>Construction Phase</u> Moderate to Major <u>Operational Phase</u> Negligible to Minor

2 Introduction

AECOM Singapore Pte. Ltd. was appointed by the Housing and Development Board (HDB), through the Letter of Acceptance dated 17th February 2023 (Contract Number L/074/23), to provide *Specialist Consultancy Services for Environmental Impact Assessment at Woodlands N1*. An Environmental Impact Assessment (EIA) is required to be undertaken to understand the current environmental baseline conditions, inclusive of biodiversity, water resources (i.e., surface water quality and groundwater quality and level), and airborne noise and impacts on the biodiversity directly or indirectly via other environmental parameters.

In addition, a topographic survey will also be conducted as part of this EIA to gather the baseline elevation as well as data about existing natural and man-made features of the land. This information will be used to support the impact assessment on the other environmental parameters.

It should be noted that, as advised during the scoping with the Agencies, this EIA will focus on assessing the impacts arising from, and associated with, the construction and operational phases of proposed developments within Woodlands Neighbourhood 1 (N1) (hereafter also referred to as 'the Project') on biodiversity (i.e., ecological sensitive receptors). As the site is partially within the catchment area of Upper Seletar Reservoir, this EIA will also assess the potential impact on surface water quality, with regards to this beneficial use of water on request of PUB which is an additional scope request added, even though it does not align to main objective of this EIA (i.e. impacts on biodiversity). Air Quality impact will not be included in this EIA as agreed with the agencies.

The Project consists of two main components:

- Residential development with accompanying infrastructure (e.g., internal roads, drains, sewers, etc.) and supporting facilities; and
- New road at the east portion of the Project site, connecting Admiralty Road and Marsiling Road.

The Project site for this EIA is approximately 7.27 hectares (ha) and it is located in the northern part of Singapore. The Project site is bounded by Marsiling Road in the south, low-lying vegetation and Woodlands Centre Road in the west, Admiralty Road in the north and existing urbanised areas in the east (Woodlands Secondary School). EIA Study Areas for each of the environmental disciplines are greater than the Project site and include the areas outside of the site/ development boundaries which are likely to be impacted by the development of the Project. Section 5.1.1 of this Report defines the Study Areas in relation to each of the disciplines studied in this EIA, such as biodiversity, water resources, and airborne noise.

The project site is one of the identified environmentally sensitive areas. Majority of the site is currently forested area with well-structured secondary forest, located next to Marsiling Park. National Parks Board (NParks) have highlighted that the flora and fauna of the forest as well as the ecological connectivity function provided by this forest would be significantly impacted due to land clearance and construction and therefore an environmental study was required to establish biodiversity baseline condition. In addition to the technical agencies, the Public Utilities Board (PUB) was also consulted in the Scoping meeting held on 22 March 2023. In this meeting, PUB recommended that hydrological impact assessment can be excluded from this EIA as there are no watercourses found within the Project site. However, they further informed that hydrological baseline should be established and analysed (i.e., catchment delineation and analysis) to understand how the surface water flows within the site as there is a substantial area which feeds to drinking water reservoirs. Such information is required to carry out impact assessment on surface water quality and consequently to ecological receptors. In addition, PUB requested for impact assessment to include the potential impacts to receiving reservoir (i.e. Upper Seletar Reservoir) with regards to potential changes in water quality.

Further, this Final Report provides a Project overview, identify relevant regulatory framework, detail the approach and methodology used for the assessment of potential impacts on identified ecological receptors by studying each individual environmental discipline, i.e., biodiversity, water resources (i.e., hydrology, surface water quality, groundwater level and quality) and airborne noise. In addition, the Report includes preliminary findings of the environmental baseline monitoring and evaluation of predicted environmental impacts from the development of the Project site. A preliminary Environmental Monitoring and Management Plan was also be outlined.

2.1 Scope of Work

The scope of this EIS was documented in the form of Inception Report Rev 01, which was submitted to HDB and related agencies on 5th June 2023. This EIS was progressed only after the acceptance of the Inception Report.

The services under this EIS include the following:

- Field surveys and monitoring, including topography survey, floral survey, faunal survey, hydrological survey, surface water quality sampling, groundwater level and quality survey and airborne noise monitoring
- Collation and analysis of environmental baseline findings, inclusive of both collected field survey data and secondary data
- Formulation of biodiversity inventory and distribution maps
- Prediction and evaluation of direct and indirect impacts (i.e., via water resources [both surface and groundwater] and airborne noise) on biodiversity
- Recommendation of mitigation measures and assessment of residual impacts
- Development of preliminary EMMP
- Presentation of the findings of all the above in an EIS Report (this Report)

This EIS assessed the development plan, design elements, construction methodology, Project components, and assumed operational activities available at the time of writing this Report. Understanding of the Project construction methods and operational activities has been stated in Section 7 and Section 8, respectively. Detailed additional assumptions, if any, are described in the individual assessment sections thereafter. Should the detailed design conducted at a later stage require modifications to these assumptions/ approaches, a revised impact assessment will be undertaken by developer/ developing agent to address these changes.

2.2 Report Structure

The structure of this EIS Report is as follows:

- **Section 1 – Executive Summary** provides a brief description of the Project, environmental baseline findings, as well as summary of preliminary EIS findings.
- **Section 2 – Introduction** of the Project outlines the scope of work, Report structure and the Study limitations, assumptions and constraints.
- **Section 3 – Project Overview** provides a general description of the Project's components, including the location of the Project site, planned activities during construction and operational phases and tentative Project schedule.
- **Section 4 – Environmental Legislation, Policies, Standards and Criteria** provides the legislative requirements relevant to the Project.
- **Section 5 – EIS Approach and Methodology** provides an overview of the methodology used for this impact assessment, detailing the Study Areas for different parameters, criteria used for categorisation of ecological sensitive receptors, the approach and methodologies for baseline studies (including the safety contingency plan) with the methods of data collection and analysis for each of the environmental parameters (i.e., biodiversity, water resources [hydrology, surface water quality, groundwater level] and airborne noise), methodology used for impact assessment of environmental impacts arising from construction and operational phases, and the preliminary EMMP for this Project.
- **Section 6 – Environmental Baseline Conditions** provides the details about historical and current land use, descriptions of the physical environment (i.e., geology, topography and regional climate) and baseline conditions of each of the environmental parameters (i.e., biodiversity, water resources [hydrology, surface water quality, groundwater level] and airborne noise).
- **Section 7 – Prediction and Evaluation of Impacts During Construction Phase** details minimum control measures assumed to be implemented during the construction phase of the Project, describes potential direct and indirect impacts to the biodiversity based on the proposed activities and identifies sensitive ecological receptors. This section also presents the evaluation of direct and indirect impacts during construction phase,

along with recommendations for mitigation measures, if any. Where applicable, residual impact (i.e., after mitigation measures) is also assessed.

- **Section 8 – Prediction and Evaluation of Impacts During Operational Phase** details minimum control measures assumed to be implemented during the operational phase of the Project, describes potential direct and indirect impacts to the biodiversity based on the proposed activities and identifies sensitive ecological receptors. This section also presents the evaluation of direct and indirect impacts during operational phase, along with recommendations for mitigation measures, if any. Where applicable, residual impact (i.e., after mitigation measures) is also assessed.
- **Section 9 – Preliminary EMMP** details the organisational framework, stakeholder roles and responsibilities, monitoring and management requirements.
- **Section 10** – Provides a conclusive **Summary** of the Final study outcomes.

2.3 Study Limitations, Assumptions and Constraints

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During this study, there will be inherent limitations associated with data acquisition in flora surveys due to the variability of vegetation communities across a site and changes to the detectability and presence of species with time (i.e., inaccessible areas due to the nature of arduous terrain that might be present). Therefore, it may be possible that some flora species occurring within the Project site, or perhaps not visibly present during the survey period, were not recorded. However, the surveys will be considered to be comprehensive as survey routes were strategically planned to cover ecologically and geographically representative samples of the Project site, and all plant species sighted will be identified and recorded to the best of the team members' abilities. Project team

members who will carry out the survey and identify the species post-survey have prior experience in conducting such flora assessments in Singapore.

As for the fauna surveys conducted, not all species present within the site could be captured via fauna field surveys due to the rapid nature of this study, as well as the activity patterns, weather conditions, seasonal variations and other factors. Species that were highlighted in the literature review were therefore considered to be potentially present in the site and were included in the baseline assessment. Professionals who carried out the fauna surveys are experienced field biologists and familiar with the local fauna.

Due to the above, the statements, conclusions and opinions contained in this report are approximations of the existing environmental conditions within the Project site, based on available literature, expert observations and opinion at the time of reporting. Reliance on the report after the date of issuance as an accurate representation of current site conditions shall be at the user's sole risk.

Government agencies will not be held liable for any claims arising from the conduct of the study.

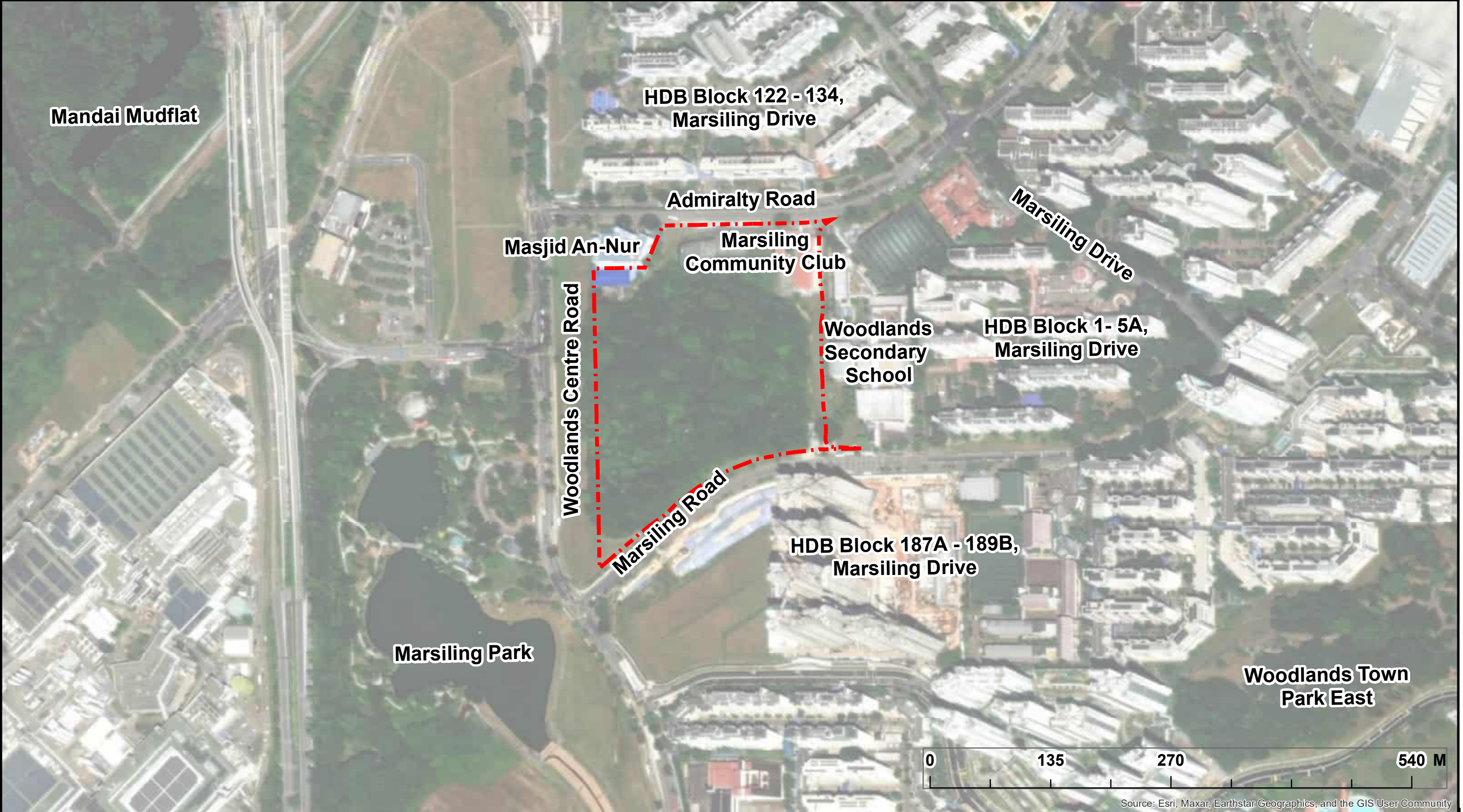
3 Project Overview

This Section provides a background overview of the Project in terms of its location, conceptual development plan, and proposed activities during construction and operational phases of the Project.

3.1 Project Location

The Project site for proposed Woodlands N1 developments is located in the north of mainland Singapore and it spans across an area of approximately 7.27 ha. It is bounded by Marsiling Road in the south with a HDB project (Marsiling Cascadia) undergoing construction nearby; Woodlands Centre Road with low lying vegetation in the west; Admiralty Road, Marsiling Community Club, and Masjid An-Nur in the north; and Woodlands Secondary School and more residential buildings in the east. Regionally, the site is situated in the vicinity of Marsiling Park (southwest of the site, across Woodlands Centre Road) as well as Mandai Mangrove and Mudflat and Woodlands Checkpoint (northwest of the site).

The Project site and its surroundings are shown in Figure 3.1.1.



Legend Project Site N						Qualified Person Endorsement : NA	Consultant : AECOM			Client: HOUSING & DEVELOPMENT BOARD					
								Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT WOODLANDS N1			Figure Title : Location of Project site and its surrounding land uses				
								Designed KRT			Checked SAG	Approved JAG	Figure No. : 3.1.1	Rev. 1	Sheet 1 of 1
									Drawn KRT	Date JUL 2024	CAD File Name : NA			A3	
							HDB Endorsement : NA								
	1	JUL 2024	KRT	Final Report	SAG	JAG									
	Rev.	Date	By	Description	Chk'd	App'd									

3.2 Project Description

As shown in the gazetted URA Master Plan 2019 [M-1] (Figure 3.2.1), the Project site is zoned “Residential (Subjected to Detailed Planning)” and “Road”.

Based on the updated proposed land use plan, the Project consists of the two main components:

- Residential developments with accompanying infrastructure (e.g. internal roads, drains, etc.) and supporting facilities.
- New road located at the east portion of the Project site which will connect Admiralty Road in the north and Marsiling Road in the south. Road widening of the existing Marsiling Road along the south boundary of the site will also be carried out.

The existing Marsiling CC will be demolished and relocated to another site. The Masjid An-Nur, although in close proximity of the developments, will be retained.

As the detailed planning is underway, the details of the development design for the Project cannot be included due to confidentiality of information. Nevertheless, the Project will consist of multiple high-rise residential buildings which may include common areas parks and landscaping, as well as road construction.

It should be noted that a previous environmental impact assessment (EIA) study carried out in this area (AECOM, 2022) also included the Project site for this EIA. The findings of the previous EIA suggested that the southwest portion of the site potentially has a high conservation value. These findings were confirmed during the biodiversity baseline studies as part of the current EIA, hence area to be conserved was proposed. Section 6.4.4 details the boundary of this area and additional recommendations.



Legend Land Use Residential Road W Places of Worship Civic and Community Institution Open Space E Educational Institution Transport Facilities Reserve Site Waterbody Park Project Site										N																			

3.3 Proposed Activities During Construction Phase

At the time of writing this Report, limited information were available regarding the construction phase activities planned during the development of the Project. For the purposes of this EIA, the activities expected to occur during the construction phase are further categorised into site preparation and pre-construction activities and main construction activities. It should be noted that the site preparation and pre-construction activities may take place concurrently with the main construction activities.

Identified site preparation and pre-construction activities, main construction activities and typical construction machinery and equipment to be utilised for each of the activities are summarised in the table below. More details regarding each for the assumed activities during the construction phase can be found in the subsequent sub-sections.

Table 3-1 Typical Project construction phase activities and construction machinery and equipment for each of the activities

Main Activities	Related Activities	Typical Construction Machinery and Equipment Used for the Activity
Site Preparation and Pre-Construction Activities		
Site Clearance	- Tree felling and removal of other vegetation (e.g., bushes, turf, etc.) not planned to be preserved; and - Demolition and removal of structures currently present on the site not intended to be preserved	- Excavators - Bulldozers - Lorries
Pre-Construction Earthworks¹	- Soil dewatering - Soil excavation, cut and fill - Site levelling to obtain planned platform levels - Soil excavation for foundations (i.e., excavation of soil to depth at which the foundations of the future structures will be placed)	- Temporary water pumps - Excavators - Bulldozers - Graders - Rollers - Lorries - Generators
Establishment of Temporary Structures and Infrastructure	- Construction of access roads and other infrastructure required for construction activities - Construction of temporary structures (e.g., dormitories) required for the construction phase of the Project	- Temporary water pumps - Excavators - Graders - Rollers - Lorries - Concrete trucks - Concrete vibrators - Generators
Main Construction Activities		
Foundation Works	- Delivery and erection of construction machinery (i.e., crawler crane for lifting operations and boring rig for soil drilling) - Soil dewatering - Installation of bore casings - Soil boring work - Installation of rebar cage and tremie pipe - Concreting works – construction of piles and pile caps	- Temporary water pumps - Mobile cranes - Crawler cranes - Bore pilling machines - Ready-mix concrete trucks - Breakers - Welding equipment - Trailers - Excavators (with and without lifting appliance)

¹ Including Soil Investigation (SI) Works

Main Activities	Related Activities	Typical Construction Machinery and Equipment Used for the Activity
	• Pile head hacking/ removal • Delivery of steel sections • Hot works – welding of steel beams, brackets, etc. • Stage excavation • Hoisting of walers and struts • Stage excavation with walers and struts • Spoil and slurry removal; • Installation of retaining wall	• Mini Excavators • Dump trucks • Generators
Superstructure Works (Prefab Installation)	• Soil dewatering (i.e., groundwater extraction and pumping of rainwater) • Establishment of power supply (e.g., for lighting, pumps, temporary ventilation fans) • Excavation below ground surface (e.g., for working platform, for preparing of lean concrete) • Spoil removal • Formwork construction and cleaning before casting • Rebar handling and positioning • Hoisting of falsework • Casting of concrete • Scaffolding • Finishing works (e.g., plastering, waterproofing, tiling, etc.)	• Temporary water pumps • Excavators • Mini excavators • Cranes • Mobile cranes • Air compressor • Dump trucks • Ready-mix concrete trucks • Concrete pumps • Generators
Superstructure Works (Road Construction)	• Adding of aggregate layers • Asphalt distribution • Rolling and pressing of asphalt	• Trucks • Pavers • Rollers
Landscape Works	• General landscaping activities • Construction of landscape amenities/ constructions (e.g., gazebos, pathways)	• Excavators mounted sheet pile vibrator • Mobile cranes • Welding and cutting equipment
Removal of Temporary Structures and Reinstatement	• Removal of Earth Retaining and Stabilising Structures (ERSS) • Reinstatement of the area to original (or required) condition	• Excavators mounted sheet pile vibrator • Mobile cranes • Welding and cutting equipment • Trucks

Table 3-2 Tentative Project's construction phase schedule

Construction Phase Activity	Tentative Duration
Site Clearance and Earthworks	Q1 2025 – Q2 2026
Road Construction	Q2 2024 – Q1 2028
Foundation Works	Q3 2025 – Q4 2026
Superstructure Works	Q3 2026 – Q2 2029
Landscape Works	Q3 2028 – Q2 2029

Construction Phase Activity	Tentative Duration
Removal of Temporary Works and Re-Instatement	Q3 2028 – Q2 2029

3.3.1 Site Preparation and Pre-Construction Activities

Site preparation and pre-construction activities will be carried out in the initial stages of the Project, with the main objective of preparing the site so that the main construction activities (i.e., foundation works, superstructure works) can be carried out. This phase will entail site clearance (i.e., demolition of existing structures within the site such as Marsiling Community Club), removal of existing trees and vegetation not intended to be preserved and removal of resulting debris, earthworks (i.e., soil excavation and filling within the site to achieve desirable platform levels required for the proposed developments). Furthermore, construction of accompanying temporary and/ or permanent infrastructure, such as access roads and other infrastructure for construction work machinery, establishment of temporary structures and infrastructure and utilities diversion is also planned to be carried out. It should be noted that the pre-construction activities can coincide with the main construction activities (e.g., foundation works, superstructure works, etc.).

3.3.1.1 Site Clearance

Site clearance is one of the first activities to be carried out as a part of site preparation for construction works. It will involve the demolition of existing structures and removal of trees and vegetation not deemed to be preserved.

Removal of the trees, turf and other vegetation and topsoil from the site is also planned to be carried out during site clearance as the majority of the site will experience land use change (i.e., construction of residential developments and accompanying infrastructure). This will be done by using excavators and/ or bulldozers. It should be noted that prior to removal of vegetation, arboriculture assessment of the trees should be carried out and selected trees should be transplanted. Furthermore, wildlife specialists should be consulted to develop and carry out and pre-felling inspection and wildlife shepherding, as necessary.

In addition to dust and noise, site clearance activities generally also generate substantial amounts of waste such as excavated topsoil (not intended to be reused, spoil material), organic material (e.g., trees, vegetation) and debris from demolished structures. Generated solid waste will be safely collected, stored and removed from the site by dump trucks and lorry cranes. Potential impacts arising from site clearance (and other potential construction phase impacts) were assessed in relevant sections of this Report.



Figure 3.3.1 An example of site clearance at construction worksite in Singapore (Construction Site near Bedok Reservoir, Digital Photograph)

3.3.1.2 Pre-Construction Earthworks

Following the demolition of existing structures and removal of existing vegetation and topsoil, earthworks will be carried out. This will include activities during which the soil will be excavated, transported, placed at the new location and compacted. The excess soil which is not used for backfilling will be permanently removed from the site. It should be noted that earthworks usually also require soil dewatering, to assure dry conditions of soil, which is especially important during foundation works.

3.3.1.2.1 Civil Engineering Earthworks

Civil engineering earthworks will be carried out prior to or concurrently with civil engineering works and they will include earthworks required for foundation works (refer to Section 3.3.2.1), as well as earthworks for construction of accompanying infrastructure (e.g., temporary and permanent roads, drainage and sewerage systems, etc.).

Internal temporary roads for movement of personal vehicles, heavy-vehicles and machinery are generally constructed from aggregate/ soil which is placed on the selected location and then compacted. Compaction of the material used for temporary roads may be carried out by machinery and equipment such as rollers or rammers. The information regarding the location of future site access(es) and the layout of temporary roads is not available at the time of writing this Report.

Other civil engineering earthworks (e.g., excavation of trenches for drainage and sewage systems, soil excavation for foundation) are usually carried out prior to the related main construction activity.

3.3.1.2.2 Site Levelling

Currently, the Project site is mostly vegetated, covered in managed trees and turf. The terrain is generally hilly and it will be levelled for the main construction activities to start. This will involve cutting of the areas where proposed platform levels are lower than the existing terrain levels (i.e. central areas) and filling and stabilising of slopes in areas which are currently lower than the proposed future platform levels (e.g. southern, northern areas). In this case, geotechnical engineers will develop Earth Retaining Stabilisation Structures (ERSS) schemes to stabilise the exposed slopes in their engineering design. Environmental Control Officer (ECO) considers measures to prevent

erosion of soil into the nearest watercourses (i.e., concrete drains in the vicinity of the Project site). This may or may not accompany ground improvement works depending on the nature of the soil in the area. One example of site levelling in a construction site is shown in Figure 3.3.2. Site levelling would involve large machineries such as excavator, lorry, concrete vibrator, grader, roller, etc.

The earthworks as described above may cause adverse impacts on biodiversity due to reduced habitats. Surface water flow conditions may be impacted due to changes in hydrology of the site (i.e., increased runoff due to decreased permeability into the soil) while the quality of the receiving watercourses may be impacted by potential contaminants from earthworks activities (e.g., silty water). Impacts on other environmental conditions also include elevated airborne noise due to operation of machineries. These potential impacts have been assessed in the Section 7 of this Report.



Figure 3.3.2 An example of site levelling at construction worksite in Singapore (AECOM®)

3.3.1.3 Establishment of Temporary Structures and Infrastructure

Following the earthworks, and prior to construction activities, the temporary structures and infrastructure will be set up within construction site. Usually, this entails construction and/ or installation of site features such as offices, toilets, storage areas (e.g., for materials, waste, equipment, chemicals, etc.), internal temporary roads for vehicular movement, site hoardings, noise barriers as well as waste management facilities. At the time of writing this Report no information regarding the establishment of temporary structures and infrastructure is available. However, the potential impacts arising from use of these structures (e.g., water contamination due to spills and leaks of chemicals) and related activities have been addressed in Section 7 of this Report.

3.3.2 Main Construction

Once the site preparation and pre-construction activities are completed, the main construction activities, such as foundation works, superstructure works, construction of proposed new road, widening of existing roads and laying of utilities/ services will take place.

3.3.2.1 Foundation Works

Once demolition works and site clearance are completed and temporary worksites are established, foundation works for substructures, including piles and pile caps will be carried out.

To begin the foundation piling process, erection of crawler crane and boring rig are required, and mobile crane may be used for lifting and transporting actions. After setting up the pile position, a temporary guide casing with an internal diameter same as pile diameter is installed using crawler crane to the pile centre of the marked position to prevent collapse of the surrounding soil. The temporary casing also serves as a guide in forming a uniform basis for the following boring works until the designed depth using a bored piling machine. This can be very intensive and generate noise and vibration. Thereafter, the reinforced bars (rebar) are installed using a crawler crane to enhance the strength of concrete pile, followed by the tremie pipe installation to better support the concreting works. The ready-mix concrete, transported by a concrete truck, is poured into the borehole using crawler crane. During circumstances when there is extra pile head after the completion of bored piling, pile head hacking is conducted using breaker and excavator.

To seal the pile foundation, a pile cap is necessary. For this, steel waler and struts are required to hold the temporary formworks to proceed with pile cap concreting. The steel is delivered with a 40-feet trailer where hot works (e.g., welding of steel beams, brackets, etc.) may be required with the usage of welding equipment. Hoisting of waler and struts is carried out using an excavator with lifting appliance.



Figure 3.3.3 An example of piling/ foundation works in Singapore (AECOM ©)

3.3.2.2 Superstructure Works and Road Works

Following the completion of foundation works, superstructures will be constructed for this Project. The on-site power supply for lighting, pumps and temporary ventilation fans operation will be provided by generators. Before the installation of superstructures, temporary water pumps are positioned to pump the water from ground or collected rain in order to prevent it from affecting the quality of concrete. To form the working platform, excavation below surface is conducted using an excavator, followed by the formation of lean concrete as the first ground layer for

waterproofing purposes. Crane is used for the spoil removal as well. To construct building until the designated height, temporary formwork is necessary at each level before casting, where air compressor will be used for cleaning. During this process, mobile crane is used to transport rebar and for the hoisting of falsework, formwork, scaffolding and the construction of temporary working platforms. A concrete truck is used to transport ready mix concrete to the site and concrete pump is used for the superstructure's concreting works.

The completion of residential superstructure is generally followed by finishing works, such as interior plastering, exterior plastering, waterproofing and tiling, mechanical/ electrical/ plumbing (MEP) rough-in a ceiling installation, painting, lift installation, exterior glass walls, windows and doors installation, as well as setting up building systems (i.e., electrical, plumbing, air-conditioning, etc.).

Following the appropriate earthworks (i.e. site levelling, preparation of subgrade), the road works (for the future road in the east) will include pouring of several layers of asphalt or bituminous material to overlay the subgrade. Usually, the road layers comprise of subbase (commonly crushed stone or dry concrete that are compressed by rollers), surfacing layer, and wearing layer (the topmost bituminous material). The common material used is asphalt.



Figure 3.3.4 An example of superstructure construction works in Singapore (AECOM ©)

3.3.2.3 General Landscaping Works

As part of the proposed development, it is expected that landscaping features will be developed in order to enhance sensory (e.g., visual) experience of the future users (i.e., parks, open areas for public, future permanent residents, general public, etc). These may include planting of trees and shrubs, lawn space, etc. Based on the latest land use plan green features (i.e., park) is proposed to be developed within the site. However, at the time of writing this Report, there are no detailed plans regarding the landscape enhancements planned to be incorporated into this green feature.

If needed, excavator and mobile crane will be used to remove patches of soil and relocate them or transport from the site. Welding and cutting equipment are commonly used to form landscape structures. The potential

environmental impacts associated with the general landscaping works will be assessed and incorporated as a whole in the relevant section of this Report.

3.3.2.4 Removal of Temporary Structures and Reinstatement of the Project Site

As the final step towards completion of construction activities, the developer and/ or contractor will remove all the temporary structures for the reinstatement of working area to its original condition and/ or required conditions. A well-reinstated and stabilised land will also enhance the landscape and visual amenity values to create a better living environment for the public and residents of this development. Therefore, the potential environmental impacts associated with the removal of temporary structures and reinstatement of the Project site will be assessed and incorporated as a whole in the relevant section of the Report.

3.4 Proposed Activities during Operational Phase

Following the reinstatement period, human activity will increase as the development area becomes operational. The Project site will see an associated increase in human activity such as traffic movement, lighting, and general activities. During the operational phase, the vehicular traffic volume in the vicinity and within the site is predicted to increase when the proposed public housing and its associated road network starts operating. These may cause potential noise nuisance, water pollution and disturbances to biodiversity within and in the vicinity of the development. In addition, more impervious surfaces are expected due to the potential change of natural landscape to urbanised area. This will reduce stormwater infiltration into the ground and increase surface water runoff.

The timeline and construction activities of other concurrent projects in the vicinity were also considered in the Impact Assessment study.

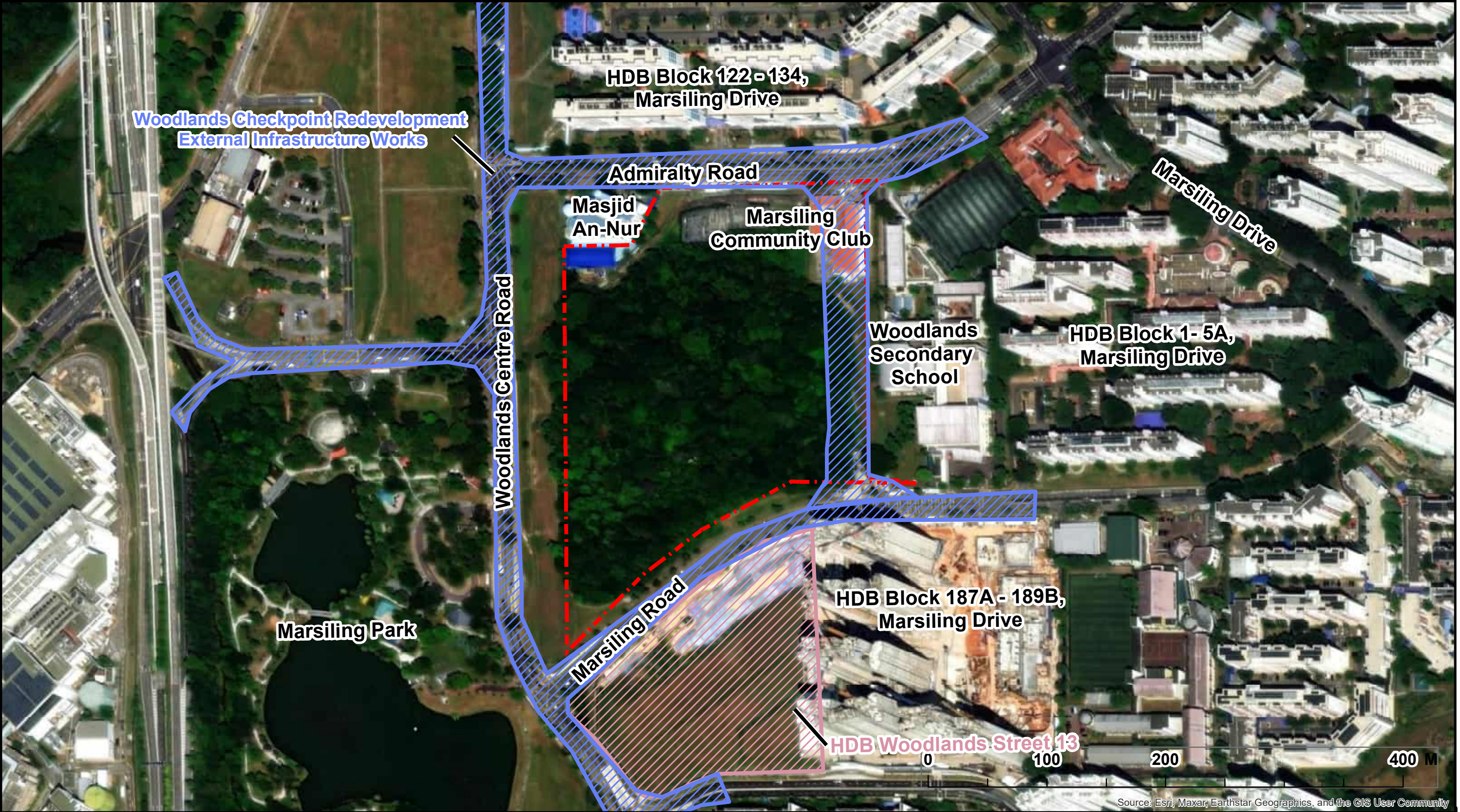
3.5 Concurrent Projects

During the construction phase, there will be concurrent projects in the vicinity of the Project site. Table 3-3 lists the concurrent projects and their respective timelines.

Table 3-3 List of concurrent projects and their timelines

Concurrent Projects	Project Timeline
HDB Marsiling Cascadia	Tentative completion in 2027 / 2028
Woodlands Checkpoint Redevelopment External Infrastructure Works	2026 onwards

The timeline and construction activities of these concurrent projects in the vicinity were also considered in the Impact Assessment study.



Legend

- Woodlands Checkpoint Redevelopment External Infrastructure Works
- HDB Woodlands Street 13
- Project Site

N

1	JUN 2024	KRT	Draft Final Report	SAG	JAG
Rev.	Date	By	Description	Chk'd	App'd

Qualified Person Endorsement :
NA

HDB Endorsement : NA

Consultant :
AECOM

Project Title :
SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT WOODLANDS N1

Designed KRT	Checked SAG	Approved JAG
	Drawn KRT	Date JUN 2024

Client:
 HOUSING & DEVELOPMENT BOARD

Figure Title :
Concurrent projects in the vicinity of Woodlands N1

Figure No. : 3.5.1	Rev. 1	Sheet 1 of 1
CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

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4 Environmental Legislation, Policies, Standards and Criteria

Indicative lists of relevant local and international legislative requirements applicable to the Project are provided in Table 4-1 and Table 4-2, respectively.

Table 4-1 Relevant regulatory framework in Singapore

Environmental Parameter	Applicable Legislation, Standards, and Guidelines	Key Points
General	Singapore Biodiversity Impact Assessment (BIA) Guidelines, 2021 [R-1]	- This document is published by NParks to provide a framework guiding biodiversity impact assessments in Singapore. It recommends methods for conducting baseline survey and impact assessment, and subsequently provide information on developing the biodiversity component of an environmental. Management and monitoring plan (EMMP) - Section 2 of this BIA Guidelines detailed the baseline study methods recommended for vegetation mapping, habitat mapping, hydrology (including waterbody mapping, water conditions, water quantity and water quality) - Section 4 of the BIA Guidelines detailed the impact assessment methods recommended for air, noise, soil, water related biodiversity impacts - Section 5 of the BIA Guidelines detailed the mitigation measures developing protocols, i.e., avoid, minimise, remedy/repair/restore, and compensate/offset - Section 6 of the BIA Guidelines outlined the requirements for developing an EMMP
	Singapore Environmental Protection and Management Act, 1999 (2020 Revised Edition) [R-2]	- An Act to consolidate the laws relating to environmental pollution control, to provide for the protection and management of the environment and resource conservation, and for purposes connected therewith - For surface water, it regulates the discharge of trade effluent, oil chemical, sewage or other pollution onto land and drains
	Singapore Environmental Public Health Act, 1987 (2020 Revised Edition) [R-3R-3]	- An Act to consolidate the law relating to environmental public health and to provide for matters connected therewith - With regards to waste management, it regulates removal of refuse, disposal and treatment of industrial waste, disposal facilities and general health requirements for buildings
	Singapore NEA Code of Practice (COP) on Environmental Health (2021 Revised Edition) [R-4]	- The COP on Environmental Health provides the guidelines for Qualified Professionals (QP) (e.g., architects, engineers, developers) on the environmental health concerns and requirements in the design of the buildings. It defines the objectives to be met and sets out the minimum design criteria - It stipulates the design requirements for various aspects of developments such as refuse storage and collection system, public toilets, ventilation, cooling towers, aquatic facilities, storage and anti-mosquito breeding
Biodiversity	Flora of Singapore: Checklist and Bibliography, 2022 [R-5]	Updated checklist of all flora of Singapore that is with reference to 'A Checklist of The Total Vascular Plant Flora of Singapore' by Lindsay et. Al., (2022) [P-1]

Environmental Parameter	Applicable International Guidelines and Standards	Key Points
		- Published by National Parks Board - Provides the scientific name, national conservation status and the bibliographical information of each plant listed
	Singapore Wildlife Act, (2020 Revised Edition) [R-6]	- An Act for the protection, preservation and management of wildlife for the purposes of maintaining a healthy ecosystem and safeguarding public safety and health, and for related matters - The Director-General may direct a person to implement, in respect of any development or works being carried out, or to be carried out, by or on behalf of the person, any wildlife-related measure that the Director-General considers necessary to safeguard the health, welfare or safety of any wildlife or class of wildlife; public health in relation to wildlife or health of ecosystem
	Singapore Parks and Trees Act, 2006 [R-7]	- An Act to provide for the planting, maintenance and conservation of trees and plants within national parks, nature reserves, tree conservation areas, heritage road green buffers and other specified areas, and for matters connected therewith - No tree with a girth exceeding one meter (when measured 1-m from the ground) located within tree conservation areas and vacant lands should be cut or damaged without the prior approval of the relevant authorities - No tree or plant will be cut or damaged if located within the heritage road green buffer
	Singapore Parks and Trees Act (Parks and Trees Regulations), 2006 [R-8]	Prohibitions and regulations on trees and animals within national park, nature reserve or public park
	Singapore Parks and Trees (Heritage Road Green Buffers) Order, 2006 [R-9]	Lists the areas designated as heritage road green buffers
	Singapore Parks and Trees (Preservation of Trees) Order, 1998 [R-10]	- Lists the designated tree conservation areas - No cutting or damaging of tree having girth of more than one metre
	Singapore National Biodiversity Strategy and Action Plan (NBSAP), 2019 [R-11]	- This document provides a framework to guide biodiversity conservation efforts in Singapore. It intends to establish both policy frameworks and specific measures to ensure better planning and co-ordination in the sustainable use, management, and conservation of biodiversity - A holistic approach has been adopted where the input of various public sector agencies and nature groups have been taken into consideration in the preparation of the document
	The Singapore Red Data Book (SRDB) [P-2], with updates from the Species List (Red Data Book List) by the National Parks Board [W-1]	- Lists the endangered plants and animals in Singapore - Published by Singapore's Nature Society - Provides the scientific name, common name, status, description, habitat, distribution, threats, scientific interest and potential value, as well as conservation measures for each plant and animal listed

Environmental Parameter	Applicable Legislation	Key Points
Water Resources (Surface Water Quality, Groundwater Quality and Level)	Singapore Sewerage and Drainage Act, 1999 (2020 Revised Edition) [R-12]	- An Act to provide for and regulate the construction, maintenance, improvement, operation and use of sewerage and land drainage systems, and to regulate the discharge of sewage and trade effluent - Regulates the protection, maintenance and provision of sewerage and stormwater drainage systems
	Singapore Sewerage and Drainage (Surface Water Drainage) Regulations, 1999 (2007 Revised Edition) [R-13]	Regulations that limit Total Suspended Solids (TSS) concentration of water to be discharged into stormwater drainage system and to put into effect COP on Surface Water Drainage (specifies minimum engineering requirements and control measures for surface water drainage)
	Singapore Sewerage and Drainage (Trade Effluent) Regulations, 1999 (2007 Revised Edition) [R-14]	Regulations that specify nature and type of trade effluent as well as allowable limits of certain chemicals in trade effluent to be discharged into public sewers. Any discharge of effluent into public sewer has to comply with these regulations
	Singapore Environmental Protection and Management (Trade Effluent) Regulations, 1999 (2008 Revised Edition) [R-15]	Regulations that specify nature and type of trade effluent as well as allowable limits of certain chemicals in trade effluent to be discharged into controlled watercourses and other watercourses. Any discharge of effluent into a watercourse and/ or controlled watercourse has to comply with the regulatory standards established in these regulations
	Singapore SS 593: 2013 – Code of Practice for Pollution Control (COPPC) [R-16]	- Provides guidelines for the appropriate discharge of any effluent into public sewer or watercourse - Provides guidelines for the appropriate storage and accidental release of oils & chemicals
	Singapore PUB COP on Surface Water Drainage, 2018 (2021 Addendum) [R-17]	Provides guidelines for measures to be implemented to protect the stormwater drainage system and manage surface water drainage (e.g., development and implementation of an Earth Control Measures [ECM] plan)
	Singapore NEA Allowable Limits for Trade Effluent Discharge to Watercourse or Controlled Watercourse [R-18]	Provides allowable limits for trade effluent discharge to watercourse or controlled watercourse in Singapore
	Singapore Biodiversity Impact Assessment (BIA) Guidelines, 2020 [R-1]	Provides standards for water quality in the context of biodiversity conservation in marine water
	Singapore PUB Circular on Preventing Muddy Water from the Construction Site, October 2015 [R-19]	All new construction sites with site area of 0.2 ha and above, sites with problematic ECM, and sites within sensitive areas are required to implement closed-circuit television (CCTV) including a Silty Imagery Detection System (SIDS) at the public drain to monitor the surface run-off discharges from the sites

Environmental Parameter	Applicable Legislation	Key Points
Airborne Noise	Singapore Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008 [R-23]	- Stipulates a set of maximum allowable noise limits for construction sites for different time periods of the day and for different types of premises affected by construction noise - Stipulates the correction factor that needs to be applied to the applicable noise criteria based on background noise levels
	Singapore SS 593: Code of Practice for Pollution Control (COPPC), 2013 [R-16]	Specifies recommended pollution control requirements and good practices for prevention of impacts to noise.
	Singapore SS602:2014 Code of Practice for Noise Control on Construction and Demolition Sites [R-24]	Specifies recommendations and good practices for prevention of noise impacts from construction and demolition activities
	Singapore Technical Guideline on Boundary Noise Limit for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings by National Environmental Agency (NEA); Code of Practice on Pollution Control by National Environment Agency [R-37]	Legislative requirements for boundary noise due to noise emissions from mechanical ventilation systems for non-industrial buildings during operational phase.
	Singapore Technical Guideline for Land Traffic Noise Impact Assessment from National Environment Agency (NEA) [R-39]	Provides the necessary guidance to conduct land traffic Noise Impact Assessment (NIA) for designated projects

Table 4-2 Relevant international standards and guidelines

Environmental Parameter	Applicable International Guidelines	Key Points
General	UK Biodiversity 2020: A strategy for England's wildlife and ecosystem services [R-36]	"Theme 3: reduce environmental pressures -integrate
Biodiversity	The International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species [R-25]	Provides taxonomic, conservation status and distribution information on plants, fungi and animals that have been globally evaluated
	The Hong Kong Environmental Impact Assessment Ordinance -	Sets out the principles, procedures, guidelines, requirements, and criteria for deciding whether the Project is environmentally acceptable

Environmental Parameter	Applicable Guidelines	International	Key Points
	Technical Memorandum (HK EIAO TM) ² [R-26]		
Water Resources (Surface Water Quality and Groundwater Quality and Level)	United States Environmental Protection Agency (USEPA) Water Quality Standards Handbook, 2017 [R-27]		Provides standards for water quality assessment relating to aquatic life for surface watercourses
	Strategic Plan of Action on Water Resources Management ASEAN (2005) [R-38]		Provides a consolidated framework for the classification of water resources and associated water quality standards for each class
	Australian & New Zealand Guidelines for Freshwater and Marine Water Quality, 2000 [R-28]		Provides standards for water quality assessment relating to aquatic life for surface watercourses
	Canadian Water Quality Guidelines for the Protection of Aquatic Life, 2007 [R-29]		Provides standards for water quality assessment relating to aquatic life for surface watercourses
	World Health Organisation (WHO) Water Quality Requirements [R-30]		Provides standards for water quality assessment relating to aquatic life for surface watercourses
	United Nations Economic Commission for Europe (UNECE) Standard Statistical Classification of Surface Freshwater Quality for the Maintenance of Aquatic Life, New York and Geneva 1994 [R-31]		Provides standards for water quality assessment relating to aquatic life for surface watercourses
	Philippines Mitigating Impact from Aquaculture (PHILMINAQ) [R-32]		Provides standards for water quality assessment relating to aquatic life for surface watercourses
	Malaysia Department of Environment (DOE) National Water Quality Standards [R-33]		Provides standards for water quality assessment relating to aquatic life for surface watercourses
	<i>Soil Remediation Circular</i> , 2013 [R-34]		- The soil remediation Dutch Intervention Values (DIV) indicate when the functional properties of the soil for humans, plant and animal life, is seriously impaired or threatened - They are representative of the level of contamination above which there is a serious case of contamination

² The HK EIAO TM was added as an applicable legislation for biodiversity because: (1) Singapore does not have an established standard for biodiversity assessment yet; (2) Singapore and Hong Kong share similar urban development setting; and (3) HK EIAO TM has previously been used for other environmental impact assessments in Singapore.

5 EIA Approach and Methodology

The overall EIA flow is shown in Figure 5.1 and the general approach to the EIA is listed as follows:

- Scoping of Project
- Baseline Data Collection and Analysis
- Prediction of Impacts
- Evaluation of Impacts
- Recommendations of Mitigation Measures
- Environmental Management and Mitigation Plan (EMMP)

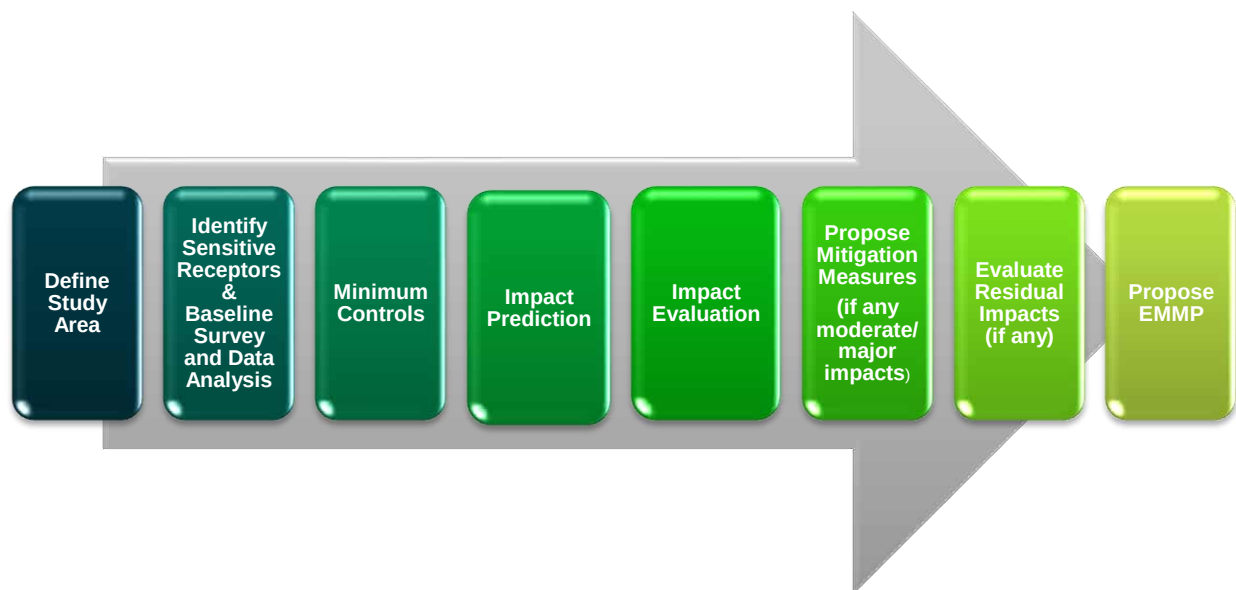


Figure 5.1 Overall EIA workflow

5.1 Scoping of Project

Referring to the Inception Report Rev 01, the environmental impacts resulting from the proposed activities during construction and operational phases of this Project are assessed in this EIA Report as follows:

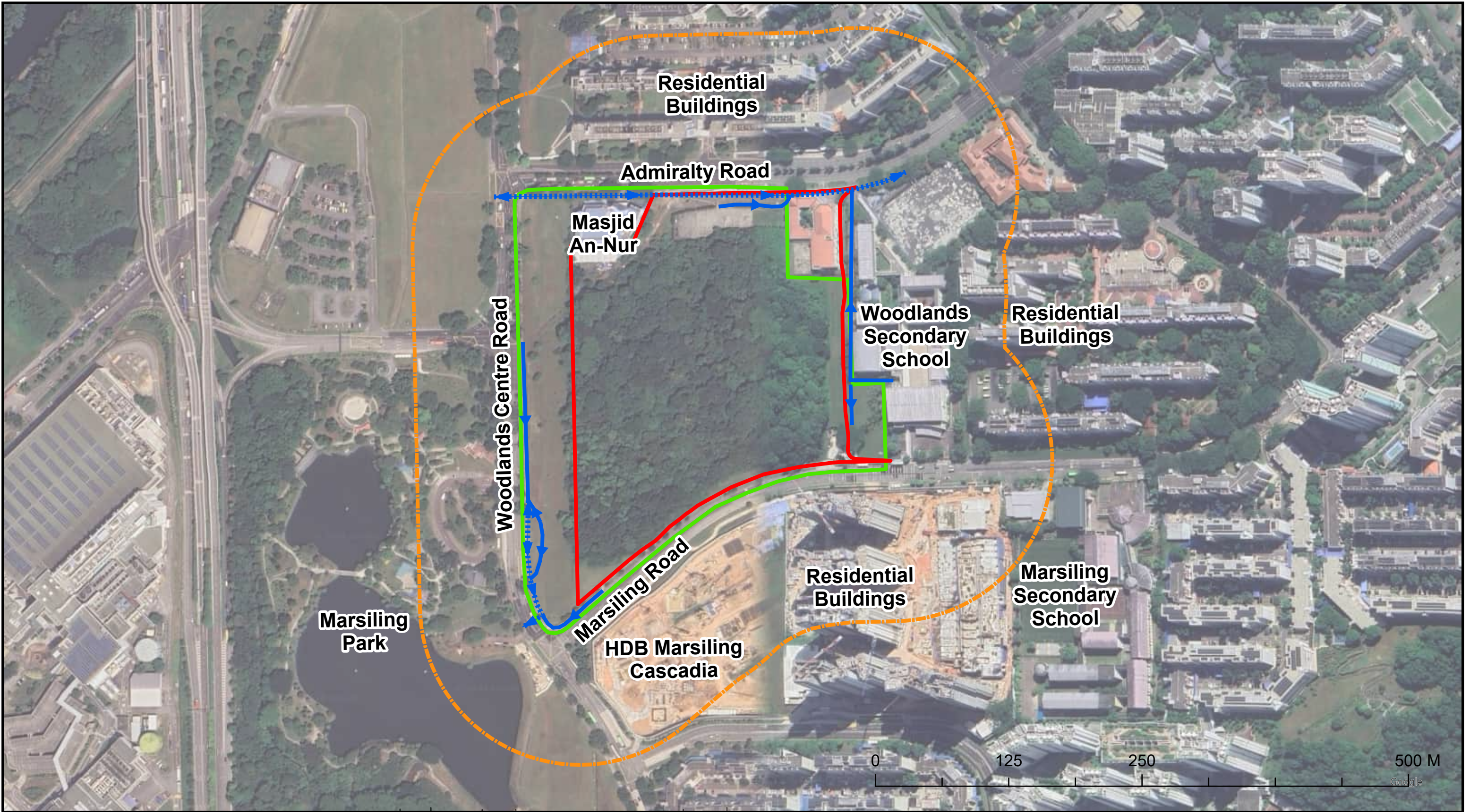
- Biodiversity
- Water Resources (i.e., surface water quality, groundwater quality and level)
- Airborne Noise

5.1.1 Identification of Study Areas

The environmental parameters that were proposed to be studied in the EIA and the extent of their respective Study Areas is summarized in Table 5-1 and shown in Figure 5.1.1.

Table 5-1 Environmental parameters assessed in this EIA and their respective Study Areas

		• Habitats • Flora • Fauna (including migratory birds) • Ecological Connectivity
Water Resources	The waterbodies/ watercourses with direct impact from the proposed developments.	• Surface Water Quality
	Groundwater underneath the Project site.	• Groundwater Quality • Groundwater Level
Airborne Noise	<u>Construction Phase</u> • 150 m around Construction Worksite Area. <u>Operational Phase</u> • Immediate boundary of the Operational Footprint	• Airborne Noise



Legend

Noise Study Area

Project Site

Biodiversity Study Area

Watercourses

Underground

Above

1 JUL 2024 KRT Final Report SAG JAG

Rev. Date By Description Chk'd App'd

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : **AECOM**

Project Title : **SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT WOODLANDS N1**

Designed KRT	Checked SAG	Approved JAG
	Drawn KRT	Date JUL 2024

Client: **HOUSING & DEVELOPMENT BOARD**

Figure Title : **Study Area for each of the environmental parameters**

Figure No. : 5.1.1	Rev. 1	Sheet 1 of 1
CAD File Name : NA		A3

5.1.2 Identification and Categorisation of Sensitive Receptors

Sensitive receptors are those receptors within or in the vicinity of the Study Area which may potentially be impacted by the activities intended for Project's construction and operational phases. Environmentally sensitive receptors are categorised into three categories: Priority 1, Priority 2 and Priority 3 (from the most sensitive to the least) as shown in the following table. The identification of sensitive receptors for each environmental parameter was developed based on the findings of the environmental reconnaissance surveys, baseline surveys and review of the proposed Study Area.

Table 5-2 Receptor sensitivity classification

Environmental Parameter	Receptor Sensitivity		
	Priority 1	Priority 2	Priority 3
Biodiversity	Flora, fauna, and habitats of high ecological value. (i.e., presence of conservation significant flora and fauna species; identified keystone species; flora species that is essential for the survival of threatened fauna species).	Flora, fauna, and habitats of moderate ecological value. (i.e., mainly native species of flora, fauna, and habitats).	Flora, fauna, and habitats of low ecological value. (i.e., mainly exotic, or cryptogenic flora, fauna and habitats; managed vegetation which can provide habitat for significant species).
Water Resources (Surface Water Quality)	Aquatic or semi-aquatic habitats and its biocenosis of high ecological value with low tolerance to changes in surface water quality.	Aquatic or semi-aquatic habitats and its biocenosis of medium ecological value with medium to high tolerance to changes in surface water quality.	- Aquatic or semi-aquatic habitats and its biocenosis of low ecological value with high tolerance to changes in surface water quality - All terrestrial habitats
Water Resources (Groundwater Quality and Level)	Habitats and/ or biocenosis of high ecological value that are dependent of groundwater level and/ or quality.	Habitats and/ or biocenosis of high ecological value that are partially dependent of groundwater level and/ or quality.	- Habitats and/ or biocenosis of high ecological value that are not dependent of groundwater level and/ or quality - Habitats and/ or biocenosis that are not of high ecological value
Airborne Noise	Areas inhabited by fauna Conservation Significance (CS)/ non-CS species that use sound for communication, foraging and breeding, and are known to have their behaviours disrupted by increase in baseline noise (e.g., due to immobility from impacted area such as raptor nests).	Areas inhabited by species of Conservation Significance (CS) that are less affected by airborne noise; or CS species which have the ability to move away temporarily to neighbouring areas which are not impacted by the construction noise.	Area inhabited by species that are less affected by airborne noise and are not of Conservation Significance.

5.2 Baseline Approach and Methodology

The baseline study aims to establish the extent and conditions of the existing environment that may be potentially affected by the execution of the proposed Project. The baseline study provides the basis for the prediction of

potential impacts of the Project across each environmental parameter. The collection of pre-construction baseline environmental status at the Study Area was conducted using both primary and secondary sources which helped to identify sensitive receptors.

The sample collection and survey locations were selected for baseline data collection based on their proximity to the project and receptor priority. These locations were confirmed during a site reconnaissance surveys. Site visits were undertaken as tabulated in the following Table 5-3.

Table 5-3 Site visits for data collection

Environmental Parameter	Site Visits
Biodiversity	<u>Sampling dates:</u> 11 th April 2023 – 8 th Aug 2023
Water Resources (i.e., Surface Water Quality and Groundwater Level)	<u>Site reconnaissance survey:</u> 18th January 2023 9th June 2023 <u>Sampling dates:</u> 16th November 2023 (wet weather conditions)
Airborne Noise	<u>Site reconnaissance survey:</u> 18th January 2023 <u>Sampling dates:</u> 21st July 2023 to 27th July 2023

It should be noted that as part of this study a topographic survey was conducted to gather the data about the elevation of points within the Project site. The purpose of a topographic survey is to collect survey data about the natural and man-made features of the land, as well as its elevations to support the impact assessment on the other environmental parameters.

5.2.1 Safety Contingency Plan

All on-site personnel shall be in general compliance with the requirements of the Health and Safety Plan (HASP) and Job Safety Risk Assessment developed for this site and which are respectively presented in Appendix A and Appendix B. All field surveys shall be conducted in accordance with AECOM safety procedures and requirements as documented in the HASP and Job Safety Risk Assessment.

All personnel completing the onsite baseline surveys shall be formally inducted with the HASP and Job Safety Risk Assessment. Subcontractors may follow the HASP and Job Safety Risk Assessment prepared by AECOM but it is expected that they have their internal policies and procedures in terms of health and safety. The subcontractors may adopt the HASP and Job Safety Risk Assessment prepared by AECOM at their own risk.

Potential hazards that may be encountered during the field surveys are enumerated in the HASP and Job Safety Risk Assessment. Appropriate mitigation measures are included to lower the identified risk as low as reasonably practicable (ALARP). The AECOM EIA Lead shall coordinate activities and meetings with AECOM subcontractors in order to ensure that tasks associated with the Projects are completed smoothly. The procedures and emergency contacts for the Projects are documented in the HASP.

5.2.2 Biodiversity

The biodiversity impact assessment aims to establish baseline biodiversity information of the Study Area and evaluate the impacts of the proposed construction works and operational phase of the proposed Project on existing flora and fauna. Baseline information was first gathered through reviews of past and present biodiversity records,

published literature, and in consultation with taxonomic experts. Thereafter, actual field surveys were carried out to verify and supplement the data. Through desktop and field assessments, important habitats, species of flora and fauna of conservation significance were identified. The information was then used to evaluate the extent of the impacts during construction and operational phases. Mitigation measures are also recommended to reduce and/or minimise the impacts.

5.2.2.1 Desktop Assessment

5.2.2.1.1 Land Use History

Historical and present-day land use of the Study Area were reviewed. Information on land use history was primarily gathered from old maps in the online collection of the National Archives of Singapore (NAS) [M-2] and the National University of Singapore (NUS) Libraries portals, 2023 [M-3]. A list of faunal species that are likely to occur at the site (termed thereafter as 'species of probable occurrence') were also generated using information on past faunal records and existing habitat types and past fauna records up to 2 km from the Study Area.

5.2.2.1.2 Taxonomy and Nomenclature

Past and present floristic as well as faunistic species composition were examined using relevant key references that include books, scientific publications, unpublished literature, and online databases. Sources of databases include The Biodiversity of Singapore by the Lee Kong Chian Natural History Museum [W-2], Flora and Fauna Web by the National Parks Board [W-3] and iNaturalist [W-4]. Other key references include the Singapore Red Data Book [P-2], Singapore Biodiversity Records, encyclopaedia on Singapore's biodiversity [P-3] and the database of flora and fauna records compiled by Camphora Pte Ltd.

Key local and/or regional references for the various taxonomic groups are listed in the table below.

Table 5-4 Key references for the nomenclature and taxonomy for each taxonomic group

Taxon	Key References
Plants	Chong et al., 2009 [P-4]; Lindsay et al., 2022 [P-1]
Odonates	Soh & Ngiam, 2019 [P-5]; NParks, 2022 [W-1]
Butterflies	Jain et al., 2018 [P-6]; Khew, 2015 [P-7]; NParks, 2022 [W-1]
Herpetofauna (amphibians and reptiles)	NParks, 2023 [W-1]
Birds	Gill et al., 2022 [P-14]
Mammals	NParks, 2023 [W-1]

5.2.2.1.3 Species of Conservation Significance

The assessment of whether certain species are of conservation significance is important for highlighting the need and priorities for conservation.

Threatened species of flora—i.e., listed in Chong et al., 2009 [P-4] and/or Lindsay et al. 2022 [P-1] as nationally Vulnerable, Endangered, Critically Endangered, or Presumed Extinct (which indicates a rediscovery)—were assessed to determine whether they are of conservation significance. While the national conservation status of threatened species is true of wild populations that originate in an area without direct or indirect human intervention, some populations may be relics that persist from past cultivation or escapees from present-day cultivation that do not belong to native genetic stock. The assessment of whether a threatened species is of conservation significance was based on, but not limited to, information on the following: (1) land use history, (2) presence of large parent tree(s), (3) commercial availability, (4) data from previous environmental impact assessments, (5) reforestation efforts, (6) natural range, and (7) importance for associated fauna. If the origin of a threatened species population is disputable or difficult to determine, findings were corroborated from field surveys of fauna and/or adopt the more conservative approach by considering them of conservation significance. In carrying out such assessments, we were then able to prioritise conservation needs and focus resources in conserving them.

Faunal species of conservation significance include both threatened species as well as non-threatened species that are regarded as notable records. Threatened species are species listed as globally or nationally Vulnerable, Endangered and Critically Endangered. Notable non-threatened species are species that do not fall within the above categories but are deemed to be of conservation interest within the Study Area based on recent local trends observed by specialists including the following: (1) increased rarity of the species locally; (2) reduced habitat

suitability for the species locally; or (3) presence of breeding sites that are uncommon or rare locally. The national conservation statuses reference the Singapore Red Data Book (SRDB) [P-2] and other more updated local checklists, where available, such as the updated Singapore Red Data List [W-1] for odonates, butterflies, freshwater fishes, amphibians, reptiles, and mammals. The global conservation status references the Red List of Threatened Species by the International Union for Conservation of Nature (IUCN) [R-25].

5.2.2.2 Field Assessment

All floristic field assessment and faunistic field assessment were carried out within the Biodiversity Study Area (red) (refer to Figure 5.2.1).

5.2.2.2.1 Site Reconnaissance

Site reconnaissance surveys were conducted to obtain an initial understanding of the existing habitats and biodiversity. Field observations were used for planning and execution of the actual surveys. The objectives of the reconnaissance survey are as follows:

- Determine site accessibility and terrain
- Conduct a preliminary assessment to determine the dominant vegetation types
- Identify locations of existing natural permanent waterbodies, such as streams, ponds, and swampy areas (if any)
- Mark out survey sampling routes and points, and potential locations for camera traps

5.2.2.2.2 Floristic Field Assessment

The field assessment for flora consisted of: (1) habitat and vegetation mapping; (2) general walking floristic surveys; (3) tree mapping.

5.2.2.2.2.1 Habitat and Vegetation Mapping

A preliminary vegetation map was first prepared based on visual interpretations of satellite images from Google Earth Pro 9.168.0.1 (Google Inc. 2023 [O-1]). Preliminary classification of the vegetation types was determined using visual features, such as textures and colours, observed in the satellite images. Adjustments were then made to the preliminary maps according to actual observations during ground truthing. Ground truthing were conducted throughout the survey area with the aid of a Global Positioning System (GPS) receiver (Garmin GPSMap® 64s). Photographs of the vegetated areas were also taken. The boundaries of each vegetation type were tracked on the GPS receiver and mapped out on Google Earth 9.168.0.1. The classification of vegetation type references to NParks [R-1].

5.2.2.2.2.2 General Walking Surveys

All plants observed in the Study Area during floristic surveys were identified to species whenever possible. A checklist of all the plant species recorded from the present floristic surveys were compiled. The nomenclature and national conservation status follow that of Chong et al. (2009) [P-4], Lindsay et al. (2022) [P-1] and/or other published papers with information on the updated assessment of the species nomenclature and/or conservation status. The latter is usually for one or a few individual species. Other information on the plant species were also crosschecked with online databases, namely, the National Parks Board Flora and Fauna Web and Singapore Biodiversity Online.

For plants that could not be immediately identified with certainty in the field, photographs and/or voucher specimens were taken. They were then identified using identification keys, taxonomic descriptions, online plant photo databases, with the help of taxonomic experts, and/or by matching the pressed and dried collected specimens with existing specimens in the Singapore Botanic Gardens' Herbarium (SING).

For very tall unidentifiable trees with leaves that are too high in the canopy to photograph, dried leaves matching these trees were collected from the forest floor and used to aid in species identification.

5.2.2.2.2.3 Species of Conservation Significance

The geographic coordinates of plants of conservation significance were marked using a GPS receiver (Garmin GPSMap® 64s), which records locations with accuracy of ± 4 m, during floristic surveys. Where there are clusters

of plants of conservation significance—i.e., more than one individual occurring within 5 m or less of another individual—the geographic coordinates of the approximate centre of the area were to be marked using the GPS receiver.

5.2.2.2.2.4 Large Plant Specimens

Similarly, the GPS receiver was used to record locations of all trees of ≥ 3 m girth, as well as bamboo clusters, palm clusters, and strangling *Ficus* species of ≥ 3 m spread. Individuals were identified to species and whenever possible. The girth (for trees) and spread (for bamboo clusters, palm clusters, and strangling *Ficus* species), was measured and estimated, respectively. The height of all specimens was also estimated.

5.2.2.2.2.5 Other Plant Species of Value

Locations of other plants that are of value but do not meet the minimum size requirement, as detailed above, were also recorded using the GPS receiver. Examples of such include bamboo clusters of < 3 -m spread that may be important refugia for rare bamboo bats, exotic albizia trees (*Falcataria falcata*) with raptor nests, amongst others. Given the forest canopy and other conditions, the aim is to achieve at least 5m accuracy 90% of the time.

5.2.2.2.2.6 Tree Mapping Assessment

Mapped specimens were verified with the previous baseline data. Any additional specimens were tagged with a unique serial number on site. All trees, including single-stemmed palm (defined in this study as having one obvious and erect stem), strangling *Ficus* species of ≥ 1.0 m girth or spread, and those of species of conservation significance of ≥ 0.3 m girth or spread were mapped and tagged with a unique serial number on site.

Differential Global Positioning System (DGPS) that can achieve up to sub-meter accuracy was used to record geographic locations of the specimens using the SVY21 plane coordinate system. This local datum gives a more accurate representation of the areas of coverage in Singapore compared to a global datum and is used by the Singapore Land Authority (SLA).

Where there are specimens that are inaccessible due to any obstructions, (e.g., stream, nearby tree fall), specimens were not given a physical tag on site. However, the location of these specimens were still marked using the DGPS and they were still assessed by certified arborists.

Arboriculture assessment of the trees was conducted by certified arborists. Plant health and structural stability was assessed by observing for damages, decays, and/or canopy asymmetry, of which, if present, may compromise plant longevity and stability.

5.2.2.2.3 Faunistic Field Assessment

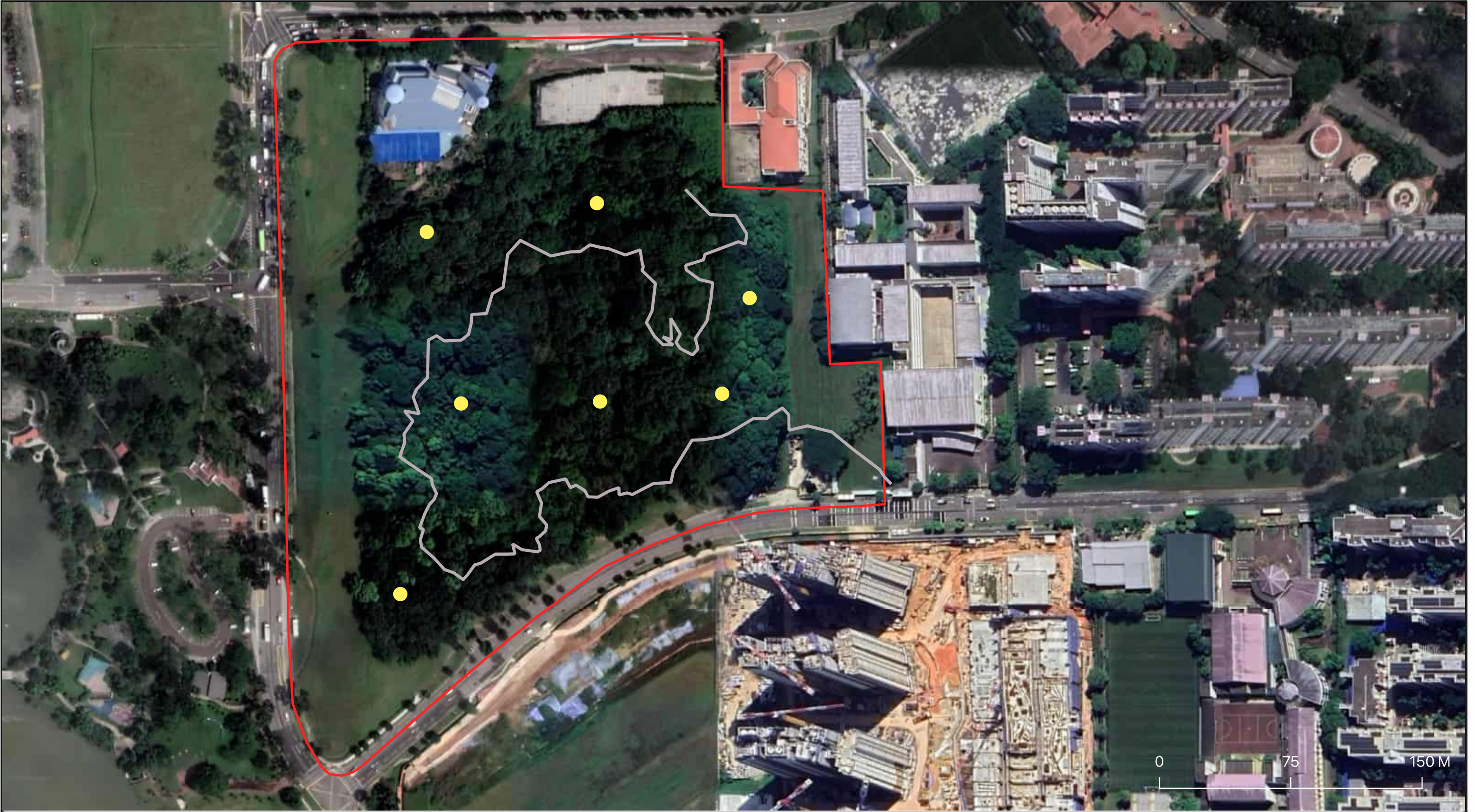
Faunal field surveys were carried out for the following taxa: (1) butterflies, (2) odonates (damselflies and dragonflies), (3) herpetofauna (amphibians and reptiles), (4) birds, (5) mammals (including bats). Each survey was conducted twice with an interval of at least one month between the survey cycles, unless otherwise stated. All observations of notable species from the aforementioned taxa were also recorded if seen outside the stated survey times.

Table 5-5 summarises all the surveys that were carried out for fauna. Each survey was performed by at least two (maximum three) surveyors. All fauna encountered were identified to species, or to the next lowest taxonomic level possible, and the location of each individual were recorded using a handheld GPS (Garmin GPSMAP 64s). The number of individuals observed were also documented. Figure 5.2.1 shows the tentative sampling routes and camera trap location.

Table 5-5 Summary of fauna survey

Survey Type	Taxon	Timing (h)	Duration	Sampling Unit *	Technique	Data Collected
Diurnal transect surveys	Butterflies	0900–1600	20–30 minutes per transect	200-m continuous transects along a sampling route	Visual only; up to 25 m left, right, and front of surveyor	Location, species, quantity, date, time

Survey Type	Taxon	Timing (h)	Duration	Sampling Unit *	Technique	Data Collected
	Odonates (damselflies and dragonflies)	0900–1600	20–30 minutes per transect	200-m continuous transects along a sampling route	Visual only; up to 25 m left, right, and front of surveyor	Location, species, quantity, date, time
Diurnal and nocturnal transect surveys	Herpetofauna (amphibians and reptiles)	0700–1000; 2000–2300	20–30 minutes per transect	200-m continuous transects along a sampling route	Visual and auditory; up to 50 m left, right, and front of surveyor	Location, species, quantity, date, time
	Birds	0700–1000; 2000–2300	20–30 minutes per transect	200-m continuous transects along a sampling route	Visual and auditory; up to 50 m left, right, and front of surveyor	Location, species, quantity, date, time
	Mammals (non-volant)	0700–1000; 2000–2300	20–30 minutes per transect	200-m continuous transects along a sampling route	Visual and auditory; up to 50 m left, right, and front of surveyor	Location, species, quantity, date, time
Camera trapping	Mammals (non-volant)	24 hours a day	60 days	One trap per 1ha. Additional traps will be deployed at strategic locations.	Infrared motion sensing	Location, species, quantity, date, time
Bioacoustics surveys	Mammals (bats)	2000–2300	20–30 minutes per transect	200-m continuous transects along a sampling route	Auditory only	Location, species, date, time
Roost emergence surveys	Mammals (bamboo bats only)	1830–2100	Once per bamboo	Bamboo clusters (if any)	Visual and auditory	Presence/absence of bamboo bats, number of active roosts, number of bats, location, date, time
* Sampling unit is the building block of the dataset that will be used for statistical analyses. For transect surveys, one sampling unit is defined as a 200-m long transect. Hence, a sampling route may consist of several 200 m transects.						



Legend Study boundary Proposed terrestrial sampling route Proposed camera traps N						Qualified Person Endorsement : NA	Consultant : AECOM	Client: HOUSING & DEVELOPMENT BOARD					
										Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT WOODLANDS N1	Figure Title : LOCATION OF TERRESTRIAL SAMPLING ROUTES AND CAMERA TRAP LOCATION		
	1	JUL 2024	TYT	Final Report	NHT	JAG	HDB Endorsement : NA	Designed SAG	Checked NHT	Approved JAG	Figure No. : 5.2.1	Rev. 1	Sheet 1 of 1
	Rev.	Date	By	Description	Chk'd	App'd			Drawn TYT	Date JUL 2024	CAD File Name : NA		A3

5.2.2.2.3.1 Butterflies

Diurnal transect surveys were carried out for adult butterflies along 200-m continuous transects on a sampling route between 0900h and 1600h. Butterfly caterpillars, pupae, eggs, and host plants were also recorded when observed. Adult butterflies were identified visually (with binoculars where necessary), photographed, or caught using insect nets, if required. Captured individuals were released immediately after identification.

5.2.2.2.3.2 Odonates (Dragonflies and Damselflies)

Diurnal transect surveys were carried out for adult damselflies and dragonflies along 200-m continuous transects on a sampling route between 0900h and 1600h. If water bodies are present on site, 20-minutes point counts at aquatic sampling points were also conducted between 0900h and 1600h. Owing to difficulties in sampling and identification, aquatic larvae and exuviae were not surveyed. Adult odonates were identified visually (with binoculars where necessary), photographed, or caught using insect nets, if required. Captured individuals were released immediately after identification.

5.2.2.2.3.3 Herpetofauna (Amphibians and Reptiles)

Diurnal (0700h–1000h) and nocturnal (2000h–2300h) surveys were carried out for amphibians and reptiles along 200-m continuous transects on a sampling route. If water bodies are present on site, 20-minutes diurnal and nocturnal point counts at aquatic sampling points were also conducted. As herpetofauna occupy a wide range of habitat types, both the diurnal and nocturnal surveys were also involved active searches for individuals on the ground, below rocks, logs, leaf litter and debris, in the water, and/or on vegetation. Torches and/or headlamps were used to elicit eyeshine during nocturnal surveys. Vocalising fauna were also located or identified by call recognition, whenever possible. For species that are capable of quick retreats and escapes, the individuals were captured by hand, or using hooks, tongs, or dip nets for identification. Captured individuals were released immediately after identification.

5.2.2.2.3.4 Birds

Diurnal (0700h–1000h) and nocturnal (2000h–2300h) surveys were carried out for birds along 200-m continuous transects on a sampling route. Birds were identified visually (with binoculars where necessary) and photographed. Torches and/or headlamps were used to elicit eyeshine during nocturnal surveys. Vocalising birds were also located or identified by call recognition, whenever possible. Migratory bird surveys may be conducted later during the migratory season (Sep–Mar) as the project timeline is likely to miss the key migratory period.

Additional diurnal (0700h–1000h) surveys were carried out for migratory birds since the allocated field survey period occurs before migratory season. Migratory bird surveys were conducted during the peak bird migratory season in Singapore, which is between September and February [P-14].

5.2.2.2.3.5 Mammals (Non-Volant)

Diurnal (0700h–1000h) and nocturnal (2000h–2300h) surveys were carried out for non-volant mammals along 200-m continuous transects on a sampling route. Both the diurnal and nocturnal surveys also involved searches in burrows and tree holes. Tracks, scats, and holts were also be recorded. Mammals were identified visually (with binoculars where necessary) and photographed. Torches and/or headlamps were used to elicit eyeshine during nocturnal surveys. Vocalising mammals, such as the squirrels, were also located or identified by call recognition, whenever possible.

Approximately one terrestrial camera trap was deployed per 1.0 ha of forest, which amounts to 7 camera traps. The camera traps were kept at least 20 m away from the transects, whenever possible. Locations of the tentative camera traps within the Study Area are reflected in Figure 5.2.1.

Each camera trap was set up at approximately 20–30 cm above ground (Figure 5.2.2). They operated 24 hours a day and were programmed to record 10-second footage per motion trigger with a 10-second quiet period following each trigger. Each camera trap was deployed for 60 days.



Figure 5.2.2 Example of a camera trap setup

5.2.2.2.3.6 Mammals (Bats Only)

Acoustics surveys were carried out for bats along 200-m continuous transects on a sampling route between 2000h and 2300h. The Echo Meter Touch 2 Pro (Wildlife Acoustics, Inc.) was used to record, stream, and attenuate ultrasonic calls between 18 and 192 kHz at a sampling frequency of 384 kHz to low frequency signals below 20 kHz, a range that is audible to the human ear.

Roost emergence surveys (Figure 5.2.3) were also carried out between 1830h and 2100h for bamboo bats, specifically, at bamboo clusters (if any). Bamboo bats were identified visually and photographed, and calls were recorded using the Echo Meter Touch 2 Pro detector. Bamboo slits that are actively used for entry and exit, as well as the number of bats residing within each internode were recorded.

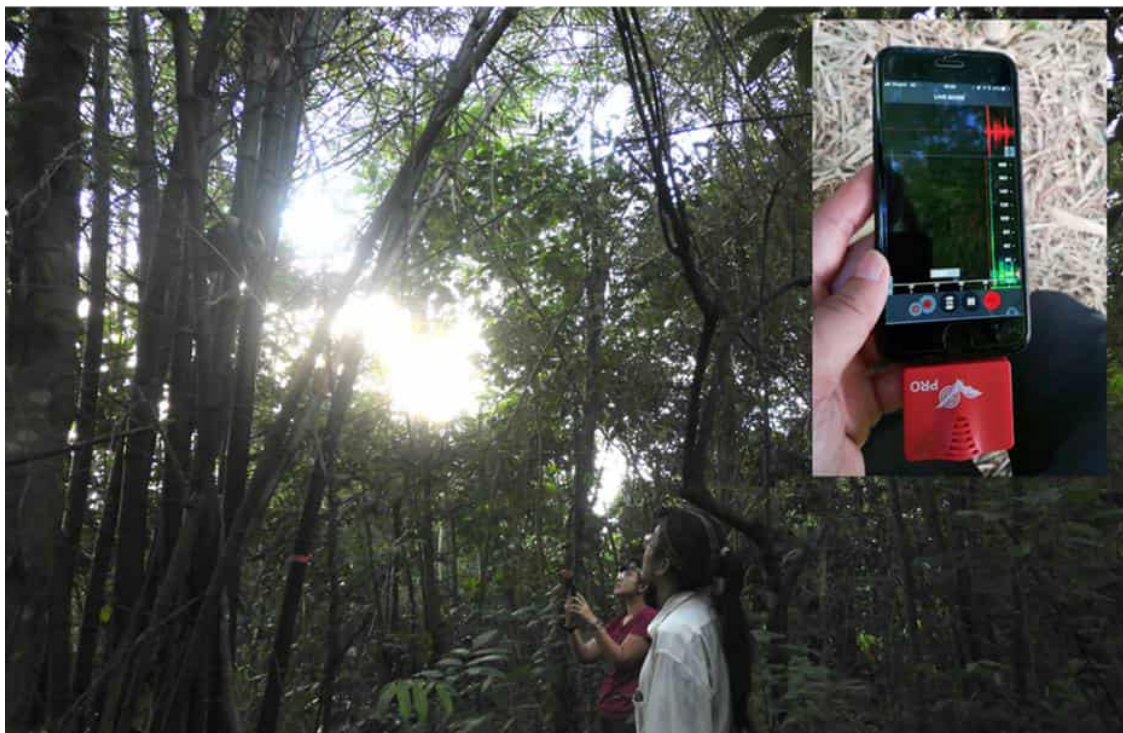


Figure 5.2.3 Roost emergence surveys with the use of acoustic detector

5.2.3 Water Resources

Baseline conditions of water resources (i.e., surface water quality, groundwater quality and level) were established through a combination of primary and secondary data. Secondary data, such as regional catchment data, historical maps, weather and rainfall data, other publicly available data and data provided by the Client, were gathered and reviewed. These collected data were then verified and/ or supplemented through the field surveys, where applicable. The proposed methodology for the water resources baseline study is detailed in the following sub-sections.

5.2.3.1 Desktop Assessment

Desktop research consists of a review of secondary data (including topographic survey data, vegetation cover, historical land use maps, existing land use and activities, satellite images, etc.) which aids in determining the location of existing watercourses within the Project site and its vicinity. The information retrieved during the desktop research, comprises publicly available data from the government and technical agencies, existing available data (e.g., rainfall data, online satellite images), as well as published books, journals, relevant articles and other online sources.

5.2.3.1.1 Historical, Current and Future Land Uses

The information pertaining historical, current and future land uses of the Project site were collected and reviewed. Information regarding the historical land use were primarily collected from various online collections such as the ones from National Archives of Singapore (NAS) [M-2], OneMap [M-3] and the National University of Singapore (NUS) [M-4] as well as historical satellite imagery from Google maps. This information was used to identify the potential watercourses present within the Study Area, watercourses characteristics (e.g., natural or man-made) and also to understand the hydrological changes within the Project site, if any.

Information regarding current land uses was collected primarily through satellite imagery and online maps, and verified through site visits and supplemented by topographic survey data. Future land uses within the Project site were provided by the Client. Current and future land uses aided in identification of the impacted watercourses during both construction and operational phases. It is to note that although hydrology impact assessment is not required for the purposes of this EIA (as communicated by PUB during the scoping meeting held on 22nd March 2023), analysis of current and future hydrological characteristics of the site is still deemed necessary in order to assess the impacts on surface water quality.

5.2.3.1.2 Land Cover and Geology

Land cover and geology of the Study Area was assessed from various available secondary sources, such as current land uses, Google satellite imagery and geological map of Singapore by Building and Construction Authority (BCA) [M-5]. Similar to the understanding provided by the elevation data, land cover information allowed for better understanding of the local hydrology within the site. Underlying the site geology aided in assessing the interdependency of surface water and groundwater, and also help in the understanding of the hydrogeology of the area.

5.2.3.1.3 Catchment Area

As Singapore does not have extensive natural aquifers or lakes, maximisation of stormwater harvesting is key. Stormwater is collected through a network of rivers, canals and drains and channelled into seventeen (17) reservoirs. Likewise, most of Singapore's land can be divided into 17 regional catchments as well. The regional catchment of the Project site was determined based on the Public Utility Board's water catchment map [M-6]. This information helped to identify the potential receiving watercourses and waterbodies and allow for the assessment of potential surface water quality impacts to them due to the proposed developments.

5.2.3.2 Field Surveys and Sampling Events

The activities performed as part of the field assessment included the following:

- Surface Water Quality Sampling:
 - Evaluation of the accessibility of the watercourses through existing tracks during site reconnaissance
 - Verification of the information collected from the available secondary data (e.g., topographic surveys and satellite images)

- Identification of the existing watercourses within and in the vicinity of the Project site
- Observation of surface water quality indicators in existing identified watercourses (e.g., physical parameters such as colour, turbidity, odour, etc.)
- Sampling of representative surface water samples for the purposes of in-situ and ex-situ water quality analysis
- Groundwater Quality and Level Investigation
 - Evaluation of accessibility of the site during site reconnaissance and underground utilities detection
 - Drilling of boreholes and conversion of boreholes into monitoring wells
 - Monitoring wells' development and collection of groundwater samples
 - Observation of groundwater quality indicators during sampling events (e.g., colour, turbidity, odour, etc.)
 - In-situ measurements and laboratory analysis of collected groundwater samples

5.2.3.2.1 Hydrological Survey

Hydrological survey aimed to identify the watercourses currently present within and in the vicinity of the Project site and to understand their conditions such as bank characteristics and flow conditions. Data collected as part of hydrological survey was subsequently used to establish hydrological baseline conditions and to carry out surface water quality impact assessment due to proposed activities during the construction and operational phases of the Project. It is to be noted that hydrological impact assessment will not form part of this EIA (as suggested by PUB during the Scoping Meeting held 22 March 2023) and the hydrological baseline study and analysis was used for the purposes of assessing potential surface water quality impacts.

Prior to site visit, available topographic survey data and Google satellite images were analysed and used for preliminary identification of the watercourses currently present within the site (refer to the Section 5.2.3.1). As the preliminary analysis of available data showed that there are no watercourses within the site, hydrological site survey was conducted by casual exploration methods to verify this. The survey confirmed that there are no permanent watercourses within the site. Hydrological survey also includes on-site verification of local topography and land uses of the site in order to estimate the likely routes of surface runoff. These data gathered from the hydrological survey shall aid catchment delineation.

5.2.3.2.2 Surface Water Quality Sampling

Baseline water quality conditions were examined in the identified watercourses in the potentially impacted area. The surface water quality sampling locations were selected based on the information gathered during the site reconnaissance (carried out on 3rd March 2023) and available secondary data.

One (1) surface water quality sampling location is proposed as shown in Figure 5.2.4, while the rationale behind the selected location with site photos is detailed in Table 5-6.

In order to obtain comprehensive surface water quality baseline data that captures the potential changes in physio-chemical composition of surface water over time and different events, samples were planned to be collected during both dry weather and wet weather conditions. Dry weather conditions are defined as flow conditions and water quality in watercourses after continuous 48-hour period of no-rain, while wet weather conditions are defined as flow conditions and water quality within watercourses after the rainfall event having more than 10 mm of rainfall, with samples to be collected up to three (3) hours after the rain stops. However, as the identified watercourse showed ephemeral flow conditions, the water samples was collected only during wet weather condition.

For this study, in-situ water quality parameters were measured using a calibrated multi-parameter digital sensor (YSI ProDSS) with United States Environmental Protection Agency (USEPA) approved testing methods for water quality parameters and will include:

- Temperature
- pH value

- Oxidation-Reduction Potential (ORP)
- Salinity/ Conductivity
- Turbidity
- Total Dissolved Solids (TDS)
- Dissolved Oxygen (DO)

The ex-situ parameters to be analysed by Marchwood Laboratory Services Pte. Ltd. (MLS) are listed below:

- Total Nitrogen (TN)
- Total Phosphorus (TP)
- Nitrates ($\text{NO}_3\text{-N}$)
- Orthophosphates ($\text{PO}_4\text{-P}$)
- Total Suspended Solids (TSS)
- Total Dissolved Solids (TDS)

During the scoping meeting with the agencies, and as suggested by PUB, the following parameters were also tested in collected surface water samples:

- Total Alkalinity
- Ammonia-Nitrogen as $\text{NH}_4\text{-N}$
- Total Organic Carbon as TOC
- Manganese
- Arsenic
- Chloride as Cl-
- Sulphate as SO_4
- Aluminium as Al
- Iron as Fe
- Enterococci
- Oil and Grease
- List of metals/ heavy metals from NEA's Allowable Limits for Trade Effluent Discharge (i.e., Barium, Tin, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Silver, Zinc)

Table 5-6 Rationale for the selection of proposed water quality sampling location with photos

S/N	Monitoring Location	Justification	Photo of Monitoring Location
WQ1	Junction of the watercourses in the vicinity of the Project site	To capture surface water quality of the water within concrete drains outside of the Project site, where it has a potential to be discharged from the Project Site during construction and operational phases.	



Legend Proposed Surface Water Quality Sampling Location Watercourse Underground Above Project Site N 							Qualified Person Endorsement : NA	Consultant : AECOM	Client:  HOUSING & DEVELOPMENT BOARD						
									HDB Endorsement : NA	Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT AS- SESSMENT (EIA) AT WOODLANDS N1			Figure Title : Surface water quality sampling location		
								Designed KRT		Checked SAG	Approved JAG	Figure No. : 5.2.4		Rev. 1	Sheet 1 of 1
										Drawn KRT	Date JUL 2024	CAD File Name : NA			A3
	1	JUL 2024	KRT	Final Report	SAG	JAG									
	Rev.	Date	By	Description	Chk'd	App'd									

5.2.3.2.3 Groundwater Level and Quality Investigation

A total of three (3) monitoring wells, designated as MW01 through MW03 were established within the Project site. The established groundwater monitoring well location map is presented in Figure 5.2.5 while Table 5-8 presents the justification for the proposed sampling locations.

Table 5-7 Rationale for the selection of proposed borehole, monitoring well locations

S/N	Monitoring Location	Justification	Photo of Installed Monitoring Well
MW01	Located at the northwest in the vicinity of man-made structures	- To determine the hydrogeological conditions of the Study Area (i.e., Project site) - To ascertain the presence of possible pollutants in the underlying groundwater that may impact the local vegetation and downstream waterbodies	
MW02	Located within eastern portion of Project site, which was urbanised historically and is in the vicinity of currently urbanised areas.		
MW03	Located at the southwestern portion of the Project site, towards Marsiling Road.		

All the boreholes were advanced down to 8 meters below ground surface (bgs) by using the hand auger. All boreholes were converted into temporary groundwater monitoring wells to enable groundwater sampling. One (1) groundwater sample was collected from each monitoring well for laboratory analysis.

The collected groundwater samples were analysed by MLS, a Singapore Accreditation Council (SAC) certified laboratory under Singapore Laboratory Accreditation Scheme (SINGLAS). Parameters listed in the Dutch Remediation Circular 2013 were analysed. In addition, ex-situ parameters planned to be tested in surface water (refer to Section 5.2.3.2.2), were also tested. A summary of groundwater analyses parameters and their corresponding test methods are presented in the following table.

Table 5-8 Groundwater parameters to be analysed and the corresponding test methods

Test Parameter	Test Method
Metals³	APHA 3125B
Total Cyanide	APHA 4500-CN
Volatile Organic Compounds (VOCs)	USEPA 5021A / 8260C
Semi-Volatile Organic Compounds (SVOCs), including pesticides⁴	USEPA 3510C / 8270D
Total Petroleum Hydrocarbon (TPH)	USEPA 8015C
Miscellaneous Parameters^{5 6}	APHA 22nd Edition 2012

In-situ measurements of groundwater parameters, including temperature, pH value, conductivity, TDS, ORP and DO were also recorded during groundwater sampling.

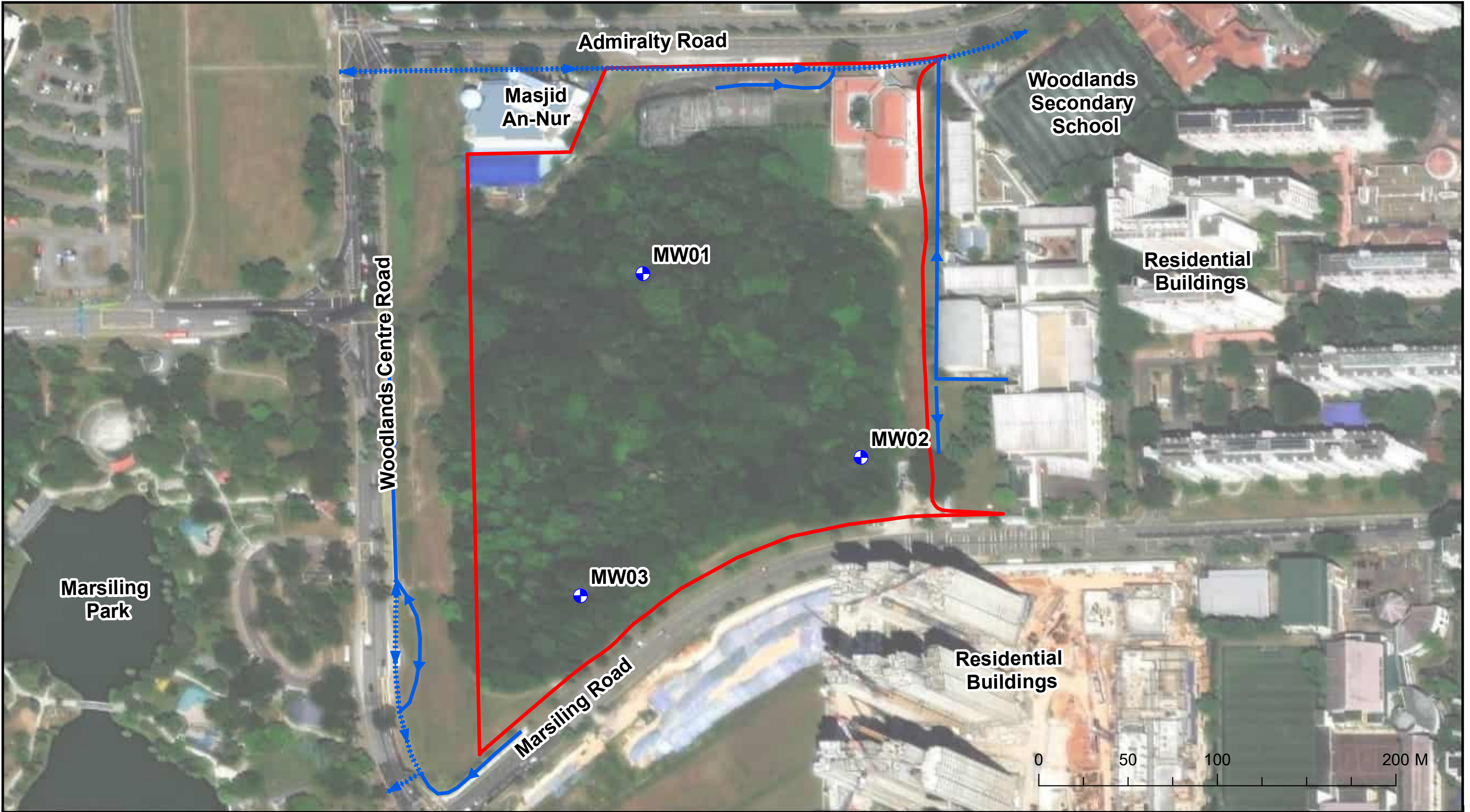
An elevation survey of all the installed wells was also conducted to determine the reduced level of the groundwater elevation. Data from the well gauging and elevation survey was used to generate elevation counter and help derive the inferred groundwater flow direction.

³ Heavy metals analysis to include arsenic, antimony, barium, cadmium, chromium, cobalt, copper, mercury, lead, molybdenum, nickel, and zinc

⁴ Pesticides analysis to include DDT, DDE, DDD, Aldrin, Dieldrin, Endrin, a-HCH, b-HCH, g-HCH, d-HCH, Atrazine, Carbaryl, Carbofuran, Chlordane, Endosulfan, Heptachlor and Heptachlor Epoxide

⁵ The miscellaneous parameters to include Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), total organic compound (TOC), bromide, phosphate and total ammoniacal nitrogen

⁶ Groundwater samples will be tested for nitrates and phosphorus



Legend Project Site Borehole Monitoring Location Watercourse Underground Above N						Qualified Person Endorsement : NA	Consultant : AECOM	Client: HOUSING & DEVELOPMENT BOARD								
									Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT WOODLANDS N1	Figure Title : Established Groundwater Monitoring Well Locations						
							HDB Endorsement : NA	Designed SAG	Checked LL	Approved JAG	Figure No. : 5.2.5	Rev. 1	Sheet 1 of 1			
	1	JUL2024	SAG	Final Report	LL	JAG										
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5.2.3.3 Baseline Assessment Methodology

The activities performed as part of the analysis and assessment of baseline data included the following:

- Analysis of collected data using various specialized software programmes (e.g. ArcGIS)
- Evaluation of the accuracy of collected primary data and comparison and coupling with relevant available secondary data
- Development of maps and figures for better visualisation and comparison of data
- Comparison of data to selected criteria

5.2.3.3.1 Hydrology and Groundwater Baseline Assessment

Hydrological baseline study aims to establish current hydrological conditions of the site and present watercourses based on the collected primary and secondary data. This includes the overview of site's topography, land use/cover, understanding the hydrological features present on the site (e.g. slopes), existing drainage network and flow conditions. Groundwater level conditions will be determined by review and analysis of available secondary and collected primary data.

The elevation and slope maps of the Project site were developed based on surveyed topographic survey data using GIS technique. In order to determine the exact locations of each of the identified watercourses, GPS data from surveys was synchronised with the photos taken on site. Catchment analysis was conducted based on surveyed topographic data and publicly available catchment map of Singapore developed by PUB [W-15]. Catchment delineation is a key step in the identification of the main sources of water that feed each of the watercourses within the Study Area and also aids in the understanding of how stormwater runoff flows within the site.

5.2.3.3.2 Surface Water Quality Baseline Assessment and Adopted Criteria

The baseline water quality of the watercourses located within the Project site was determined by comparing the selected parameters against the NEA Trade Effluent Discharge limits for controlled watercourses [R-15]. This comparison could be used to determine whether the existing baseline water quality of the watercourses within the site complies with NEA limits or already exceeds these limits. However, the NEA Trade Effluent Discharge limits do not provide criteria for the preservation and growth of aquatic life locally. To assess whether the surface water quality within the Project site is suitable for aquatic life, the baseline water quality was compared to the water quality criteria for aquatic life from other countries (i.e., USEPA [R-27], Australian & New Zealand [R-28], Canada [R-29], Philippines [R-32], and Malaysia [R-33]), as well as criteria set up by international organisations (i.e., United Nations Economic Commission for Europe [R-31], World Health Organization [R-30], ASEAN guidelines) which provide guidelines for the protection of aquatic life. The relevant limits and guidelines for water quality parameters were summarised in Table 5-9 however, where no guidelines exist, the monitored results would be considered as the baseline.

Table 5-9 Surface water quality guidelines and criteria

Parameter	NEA Trade Effluent Discharge Limits ¹	International Water Quality Criteria for Aquatic Life ²
DO (mg/L)	-	> 4.0
pH	6 - 9	6 - 9
Conductivity (µS/cm)	-	-
Temperature (°C)	45	-
Turbidity (NTU)	-	200
Salinity (psu)	-	-
Total Suspended Solids, TSS (mg/L)	30	150
Total Dissolved Solids, TDS (mg/L)	1000	1000
Total Phosphorous, TP (mg/L)	-	0.1
Phosphate as PO ₄ -P (mg/L)	2 as PO ₄ (equivalent to 0.652 PO ₄ -P)	<0.033 (equivalent to <0.1 as PO ₄)
Total Nitrogen, TN (mg/L)	-	8
Nitrate as NO ₃ -N (mg/L)	20 as NO ₃ (equivalent to 4.52 NO ₃ -N)	7 (equivalent to 30.99 as NO ₃)
Total Alkalinity (mg/L)	-	20

Parameter	NEA Trade Effluent Discharge Limits ¹	International Water Quality Criteria for Aquatic Life ²
Ammonia as NH ₄ -N (mg/L)	-	<1
TOC (mg/L)	-	25
Manganese as Mn (mg/L)	0.5	0.1
Arsenic as As (mg/L)	0.01	Acute: 0.34 mg/L Chronic: 0.15 mg/L
Chloride as Cl (mg/L)	250	2000
Sulphate as SO ₄ ²⁻ (mg/L)	200	250
Aluminium as Al (mg/L)	-	0.06
Iron as Fe (mg/L)	1	1
Enterococcus (CFU/100 mL)	-	-
Oil & Grease (Total) (mg/L)	1	7
Barium as Ba (mg/L)	1	Acute: 1.1 mg/L Chronic: 0.62 mg/L
Tin as Sn (mg/L)	5	0.004
Beryllium as Be (mg/L)	0.5	Acute: 0.13 mg/L Chronic: 0.0053 mg/L
Boron as B (mg/L)	0.5	0.94
Cadmium as Cd (mg/L)	0.003	0.1
Chromium as Cr (III&VI)	0.05	Acute: 0.016 mg/L Chronic: 0.011 mg/L
Copper as Cu (mg/L)	0.1	Acute: 0.018 mg/L Chronic: 0.012 mg/L
Lead as Pb (mg/L)	0.1	Acute: 0.065 mg/L Chronic: 0.0025 mg/L
Mercury as Hg (mg/L)	0.001	Acute: 0.00014 mg/L Chronic: 0.052 mg/L
Nickel as Ni (mg/L)	0.1	Acute: 0.47 mg/L Chronic: 0.052 mg/L
Selenium as Se (mg/L)	0.01	0.25
Note: - NEA Trade Effluent Discharge Limits for discharge into a controlled watercourse. - The sources of international water quality criteria for aquatic life includes ASEAN Guidelines [R-42], United Nations Economic Commission for Europe [R-31], World Health Organization [R-30], United States Environmental Protection Agency [R-27], Australian & New Zealand [R-28], Canada [R-29], Philippines [R-32], and Malaysia [R-33] - Singapore's Water Quality Guidelines for Recreational Beaches and Fresh Water Bodies requires that the Enterococcus count should be less than or equal to 200 counts per 100 millilitres of water at 95% of the time [W-16]		

5.2.3.3.3 Groundwater Level and Quality

The purpose of groundwater baseline study is to determine the hydrogeological conditions of the aquifer and groundwater chemistry which may potentially have adverse impacts on surrounding watercourses, eventually impacting habitats, biodiversity and humans, especially direct receptors such as groundwater dependent flora and fauna species. More importantly, groundwater baseline study serves to ascertain the presence of possible pollutants in the aquifers that may destructively impact local biodiversity and humans.

5.2.3.3.3.1 Groundwater Investigations

Groundwater investigations include the following tasks:

- Site reconnaissance
- Drilling of three (3) boreholes at the Project site
- Conversion of all the boreholes into monitoring wells and elevation surveys of wells

- Monitoring well development and subsequent collection of three (3) groundwater samples
- Groundwater gauging at all monitoring wells and laboratory analysis of collected groundwater samples

Site reconnaissance was carried out firstly to do a visual investigation of the site and obtain preliminary information regarding Study Area's topography, geology, soil conditions, watercourses as well as flora and fauna presence. This information gathered were used to justify the borehole/ monitoring well locations as shown in table 5-8 above.

5.2.3.3.3.2 Soil Boring

A total of three (3) boreholes, designated as MW1 through MW3 were advanced within the Project site. To avoid destruction of the forested paths and to avoid disturbing the animals within the forest with loud machinery, all boreholes were elected to be advanced by hand auger. All boreholes were advanced to at least 6.0 m below ground surface level, which is sufficient in depth for subsequent installation of groundwater monitoring wells to capture possible fluctuations of groundwater.

5.2.3.3.3.3 Monitoring Well Installation and Elevation Survey

All boreholes were converted into temporary groundwater monitoring wells (MW1 through MW3) to facilitate groundwater sampling and gauging. Well casings of 50-millimeter (mm) internal diameter unplasticized polyvinyl chloride (uPVC) pipes were elected to be installed, in a way that the screens intersect the water table to the base of the borehole/monitoring well. A filter pack (consisting of uniformly graded fine gravel) was placed in the annular space between the uPVC screen and borehole wall up to ground level.

Elevation survey was performed upon completion of installation of the monitoring wells, to obtain relative elevation of the monitoring wells, based on the Singapore Height Datum (SHD) of 0.000m). Northing and Easting of coordinates of the groundwater monitoring wells were collected via the SVY21 system.

5.2.3.3.3.4 Groundwater Gauging and Laboratory Analysis of Collected Groundwater Samples

All groundwater monitoring wells were developed for at least 24 hours after installation to remove fine particles that may have accumulated in the well during installation, as well as enhance the hydraulic connection between the well screen and target water-bearing zone. Disposable 1-litre (L) polyvinyl chloride (PVC) bailers were used to purge a minimum of five (5) well volumes of groundwater or until dry, as part of the well development procedures. The monitoring wells were then subsequently gauged for groundwater levels and presence of light non-aqueous phase liquids (LNAPL) using an oil-water interface meter. Following that, well purging and sample collection were conducted. Upon receiving consistent readings of in-situ physiochemical parameters (e.g. pH, electrical conductivity [EC], oxidation and redox potential [ORP], dissolved oxygen [DO], TDS and temperature), one (1) groundwater sample was collected from each groundwater monitoring well for laboratory analysis.

5.2.4 Airborne Noise

Baseline noise monitoring is used to establish the existing noise levels in the Project Site. Sensitive ecological receptors within the vicinity of the Project were hence considered before proposing the baseline monitoring locations. Human receptors are excluded in this assessment as agreed with NEA.

5.2.4.1 Desktop Research

Desktop research consists of a review of secondary data (including existing land use and development activities, satellite images, rainfall data etc.) which aids in determining the baseline noise monitoring location. The information retrieved during the desktop research comprised of publicly available data from government and technical agencies, existing available data, relevant articles, and other online sources.

5.2.4.2 Field Survey and Assessment

A total of one (1) noise monitoring location was proposed at the Inception stage, based on the following considerations:

- Identification of Noise Sensitive Receptors (NSRs) (fauna and habitats of high ecological value) nearest to the Study Area
- Other NSRs away from the Study Area were eliminated
- NSRs with areas having ongoing construction were avoided
- The closest NSR to the Study Area was selected

Noise monitoring was conducted for one (1) week from 7am to 7pm, 7 pm to 10 pm and 10pm to 7am for weekdays and weekends to capture baseline noise levels over time periods of 12 hours (long term), 1 hour, 15 minutes, and 5 minutes (short term) at each of these locations. The NEA-approved Norsonic 131 Type 1 Sound Level Meter (SLM) was used to record the noise levels during the time periods. The baseline airborne noise monitoring location is detailed in Table 5-10 and presented in Figure 5.2.6 with the methods and results detailed in a separate Baseline Noise Monitoring Report (Appendix U).

As observed in Table 5-10, baseline noise monitoring was conducted to capture the ambient noise conditions experienced by ecological receptors in its vicinity. In determining the impact of the construction noise to sensitive receptors, the baseline noise level in the Study Area was included in the calculation to derive a background noise correction factor to establish the maximum permitted noise level from the construction activities in accordance with the noise legislation stated in *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008* [R-23]. In determining the impact of the operational noise to sensitive receptors, the baseline noise level in the study area was included to derive corrected boundary noise limits in accordance with NEA Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings, 2018 [R-37].

Table 5-10 Airborne noise baseline monitoring locations

S/N	Monitoring Location	Justification	Photo of Monitoring Location
NM01	Marsiling Park	Marsiling Park is an ecologically sensitive site within the western side of Study Area. The selected location represents the environment of the ecologically sensitive site. The baseline noise level was dominated by the traffic noise from Woodland Centre Road.	



Legend Noise Monitoring Location Noise Study Area (150m) Project Site N						Qualified Person Endorsement : NA	Consultant : AECOM	Client: HOUSING & DEVELOPMENT BOARD				
										Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT WOODLANDS N1	Figure Title : Airborne Noise Monitoring Locations	
	1	JUL 2024	SHA	Final Report	SAG				JAG			
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						HDB Endorsement : NA						
							Designed SHA	Checked SAG	Approved JAG	Figure No. : 5.2.6	Rev. 1	Sheet 1 of 1
								Drawn PNZ	Date JUL 2024	CAD File Name : NA		A3

5.3 Impact Assessment

5.3.1 Definition of Minimum Controls

Minimum control measures are the standard practices that should be implemented on-site during construction and operational phases of the Project, based on legislation (where applicable), guidelines and best management practices. Examples include on-site water storage and treatment to comply with NEA Trade Effluent Criteria prior to discharging into receiving watercourses, hoarding of construction worksite on all sides, restricted working hours of noisy equipment, etc.

5.3.2 Prediction of Impacts

Key potential environmental impacts arising from the Project's pre-construction, construction and operational activities were assessed within the Project scope. The methodology for the prediction of impacts is as given in Table 5-11 and Table 5-12.

Table 5-11 Methodology for prediction of construction impacts

Environmental Parameter	Predictive Methods	Assessment Criteria	EIA
Biodiversity	A mix of quantitative and qualitative assessment to evaluate the impacts of construction activities on key biodiversity sensitive receptors of floral communities, faunal species and habitats within the Study Area and its immediate surrounding.	Assessment criteria broadly takes guidance from Hong Kong Environmental Impact Assessment Ordinance - Technical Memorandum Annex 8, with considerations from literature review and local biodiversity standards [R-26].	Section 7
Water Resources (Surface Water Quality, Groundwater Quality and Level)	Qualitative , analytical assessment of direct impacts on surface water and groundwater resources and their catchments and groundwater baseflow during construction phase of the Project. Qualitative assessment of impacts on identified ecological receptors (based on pre-determined tolerance, where applicable).	• Singapore Environmental Protection and Management (Trade Effluent) regulations [R-3] • Singapore NParks Biodiversity Impact Assessment (BIA) Guidelines [R-1] • Water Quality Criteria for Aquatic Life from other countries and organisations including United Nations Economic Commission for Europe [R-31], ASEAN [R-38], World Health Organization [R-16], United States Environmental Protection Agency [R-27], Philippines [R-31], Australian and New Zealand Environment and Conservation Council (ANZECC) [R-28], Canadian Council of Ministers of the Environment [R-29], and Department of Environment in Malaysia (DOE) [R-33]	
Airborne Noise	Qualitative assessment was adopted to assess construction noise impacts to noise sensitive ecological receptors.	Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008 [R-24]	

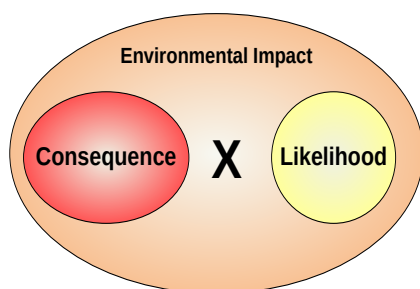
Table 5-12 Methodology for prediction of operational impacts

Environmental Parameter	Predictive Methods	Assessment Criteria	EIA
Biodiversity	Qualitative assessment to evaluate the impacts of operational activities on key biodiversity sensitive receptors of floral communities, faunal species and habitats within the Study Area and its immediate surrounding.	Assessment criteria broadly takes guidance from Hong Kong Environmental Impact Assessment Ordinance - Technical Memorandum Annex 8, with considerations from literature review and local biodiversity standards. [R-26]	Section 7
Water Resources (Surface Water Quality, Groundwater Quality and Level)	Qualitative , analytical assessment of direct impacts on surface water and groundwater resources and their catchments and groundwater baseflow due to operational activities within the Study Area. Qualitative assessment of impacts on identified ecological receptors (based on pre-determined tolerance, where applicable).	• Singapore Environmental Protection and Management (Trade Effluent) regulations [R-3] • Singapore NParks Biodiversity Impact Assessment (BIA) Guidelines [R-1] • Water Quality Criteria for Aquatic Life from other countries including ASEAN [R-38], United Nations Economic Commission for Europe [R-31], World Health Organization [R-16], United States Environmental Protection Agency [R-27], Philippines [R-31], Australian and New Zealand Environment and Conservation Council (ANZECC) [R-28], Canadian Council of Ministers of the Environment [R-29], and Department of Environment in Malaysia (DOE) [R-33]	
Airborne Noise	Qualitative assessment was adopted to assess operational noise impacts to noise sensitive ecological and human receptors.	• NEA Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings, 2018 [R-37] • NEA Technical Guideline for Land Traffic Noise Impact Assessment, 2016 [R-39]	

5.3.3 Evaluation of Impacts

Key potential environmental impacts arising from the proposed Project and significance of impacts will be assessed using the methodology described in the following sections.

In evaluating the Significance of impacts, the following factors will be taken into consideration:



- **Impact Consequence:** The consequence of an impact is a function of a range of considerations including impact spread, impact duration, impact intensity and nature, legal and guideline compliance
- **Likelihood of Occurrence:** The likelihood of the impact occurring in life of the Project

5.3.3.1 Impact Consequence

In evaluating the consequence of environmental impacts, the following aspects will be taken into consideration:

- **Receptor Sensitivity:** categorises receptors according to their susceptibility to adverse impacts from the Project's construction and operational phases (refer to Table 5-2)
- **Impact Intensity:** defines the magnitude of the impact and the status of the impact in relation to regulations (e.g. discharge limits), standards (e.g. environmental quality criteria) and guidelines. The criteria presented in Table 5-13 will be used to categorise the impact intensity.

Table 5-13 Evaluation of impact intensity for construction and operational phases

Environmental Parameters	Impact Intensity			
	Negligible	Low	Medium	High
Biodiversity	No expected changes to species population	Short duration and small-scale localised spatial changes that could cause minimal changes to species population; changes are reversible	Moderate duration and medium-scale spatial changes that could cause moderate reduction in size of species population but would not threaten species long-term viability; changes are reversible with compensatory measures.	Extended duration and large-scale spatial changes that could cause substantial reduction in size of species population and threaten species long-term viability; changes are irreversible
Water Resources (Surface Water and Groundwater Quality)	No contamination; or likely to be well within regulatory limits	Small scale localised contamination within regulatory limits	Medium scale contamination or just exceeding regulatory limits	Large scale contamination exceeding regulatory limits by hazardous levels for the habitat/conservation species
Water Resources (Groundwater Level)	No reduction in groundwater level	Small scale localised groundwater level decrease which is	Medium scale groundwater level decrease that is possibly going to	Large scale groundwater level decrease that is likely going to

Environmental Parameters	Impact Intensity			
	Negligible	Low	Medium	High
		not likely going to extend beyond the Study Area	extend beyond the Study Area	extend far beyond the Study Area
Airborne Noise (Construction and Operational Phase)	No detectable change to fauna and habitats.	Potential impacts last a short duration, are reversible and/or of a small magnitude for species with low auditory sensitivity level	Potential impacts last for a moderate duration, are reversible with significant input and compensatory measures, and/or of a moderate magnitude for species with medium auditory sensitivity level	Potential impacts last for a long time, are non-reversible, and/or of a significant magnitude for species with high auditory sensitivity level
Notes: The Flora & Fauna Specialist will be consulted to identify the species sensitivity to the potential change to their habitat, conservation status and foraging regime.				

A consequence category is then derived based on receptor sensitivity and impact intensity, as shown in Table 5-14.

Table 5-14 Impact consequence matrix

Sensitivity Impact Intensity	Priority 3	Priority 2	Priority 1
Negligible	Imperceptible	Imperceptible	Very Low
Low	Very Low	Very Low	Low
Medium	Very Low	Low	Medium
High	Low	Medium	High

5.3.3.2 Likelihood

Likelihood is estimated on the basis of experience and/or evidence that such an outcome has previously occurred. Impacts resulting from routine/planned events (normal operations) are classified under High Likelihood.

Table 5-15 Likelihood Criteria

Likelihood Criteria	Definition for All Environmental Parameters	Definition for Airborne Noise (Construction)
Unlikely/ Remote	Would be unlikely or not expected to occur during construction and operational activities.	Frequency of exposure of less than 5% to active duration of equipment over daily working period.
Less Likely/ Rare	Would less likely/ rarely occur during construction and operational activities.	Frequency of exposure of 5% and up to 15% to active duration of equipment over daily working period.
Possible/ Occasional	Would possibly/ occasionally occur during construction and operational activities.	Frequency of exposure of 15% and up to 25% to active duration of equipment over daily working period.

Likelihood Criteria	Definition for All Environmental Parameters	Definition for Airborne Noise (Construction)
Likely/ Regular	Would likely to occur or would occur on a regular basis during construction and operational activities.	Frequency of exposure of 25% and up to 50% to active duration of equipment over daily working period.
Certain/ Continuous	Would be certain to occur or would occur continuously during construction and operational activities.	Frequency of exposure of more than 50% to active duration of equipment over daily working period.
References: 1. Ecological Impact Assessment (EclA). EIANZ Guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd Edition. May 2018. [R-40] 2. CIEEM (2018). Guidelines for ecological impact assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal. September 2018. [R-41]		

5.3.3.3 Impact Significance

The significance of each impact will be determined by assessing the impact consequence against the likelihood of the impact occurring using the Impact Significance Assessment Matrix. A simple risk-based matrix will be used for summation of consequence and likelihood, a sample of which is shown below in Table 5-16.

Table 5-16 Impact significance matrix

Consequence Likelihood	Imperceptible	Very Low	Low	Medium	High
Unlikely/ Remote	Negligible	Negligible	Negligible	Negligible	Negligible
Less Likely/ Rare	Negligible	Negligible	Minor	Minor	Minor
Possible/ Occasional	Negligible	Minor	Minor	Moderate	Moderate
Likely/ Regular	Negligible	Minor	Moderate	Moderate	Major
Certain/ Continuous	Negligible	Minor	Moderate	Major	Major

Positive impacts are classified under a single category. Impacts assessed as negligible or minor will require no additional management or mitigation measures (on the basis that the magnitude of the impact is sufficiently small, or that the receptor was of low sensitivity and/or that adequate controls were already included in the Project design). Negligible and minor impacts are therefore deemed to be “Insignificant”. Impacts evaluated as moderate or major require the adoption of management or mitigation measures. Major impacts are therefore deemed to be “Significant” and moderate impact as “Relatively Significant”. Major impacts always require further management or mitigation measures to minimise or reduce the impact to an acceptable level.

Where the implementation of minimum controls is insufficient to alleviate any significant environmental construction and operational impacts (moderate to major impacts), Project-specific final mitigation measures, in consultation with the HDB and relevant Authorities, will be proposed.

5.3.3.4 Mitigation of Significant Impacts and Residual Impact Assessment

Where applicable and practical, engineering control measures are accompanied by specifications (product brochures), estimated cost and source of supply. In addition, mitigation measures at receptors’ end are also recommended on a case-by-case basis. For example, if the unmitigated construction noise levels are found exceeding the relevant criteria, practical direct mitigation measures such as the use of noise barriers, enclosures, quieter powered mechanical equipment (PME) and construction methods, etc. are recommended. Effective dust control measures are recommended to minimise dust emission from the site, where necessary. Mitigation measures

are proposed in accordance with the following hierarchy in line with Biodiversity Impact Assessment (BIA) Guidelines published by NParks [R-1]:

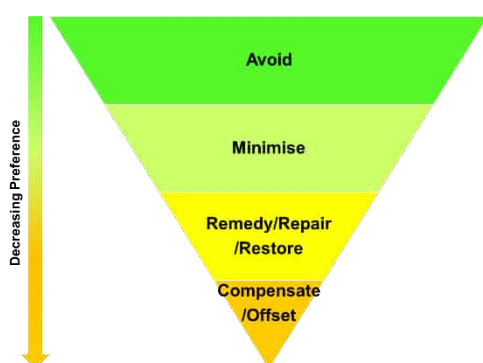


Figure 5.3.1 Mitigation hierarchy

- **Avoid** – Where changes to the Project design and construction/ operational methodology can be made to eliminate or avoid an identified impact (e.g. optimisation or reduction of construction footprint, shift or elimination of construction site in critical areas, etc.). If a full elimination is not possible, the next level of mitigation is to minimise the identified impact.

- **Minimise** – Where changes to the Project design and construction/ operational methodology cannot affect impact elimination or avoidance, use of alternative construction methodology or any enhancement measures can be adopted to minimise for identified impacts. For e.g. a wildlife shepherding plan is put in place to allow any animals trapped on the site to escape into the surrounding vegetation.

- **Remedy/ Repair/ Restore** – Where changes to the Project design and construction/ operation cannot affect impact avoidance and impact minimization, restoration methodology can be applied after construction is completed to remedy/ repair/ restore the ecological habitat as much as possible. For e.g. after construction, appropriate trees and shrubs are replanted in appropriate locations on the impacted site to restore part of the habitat.

- **Compensation/ Offset** – Where measures taken to compensate or offset the residual impacts after implementing the first three steps of the mitigation hierarchy, wherever technically and financially feasible, e.g. transplanting of rare shrubs or trees to elsewhere in consultation with government authorities, etc.

An “acceptable level” is the reduction of a major impact to a moderate one after mitigation. In seeking to mitigate moderate impacts, the emphasis is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable. It will not always be practical to reduce moderate impacts to minor ones in consideration of the cost-ineffectiveness of such an approach (due to the diminishing return of a reduction of impact versus cost). Residual impact assessment will be conducted for those parameters where impact from the activity is identified to be significant and additional mitigation measures are recommended. Positive impacts were not assessed for significance. Assessment of residual impact will follow similar risk approach as outlined above.

5.4 Preliminary Environmental Management and Monitoring Plan (EMMP)

Preliminary Construction Phase EMMP and Operational Phase EMMP are formulated to specify mitigation measures, monitoring scope, methodology and locations, and triggers to report and escalate irregularities in the environmental conditions during construction and operational stages. Additional vector mitigation measures and waste management measures will be included as part of the EMMP as well, since construction activities and poor waste management onsite tend to contribute to the occurrence and breeding of vectors (e.g., mosquitoes, rats, etc), leading to the spread of vector-borne disease.

5.5 Stakeholder and Public Engagement

It is known that effective communication and cooperation between various expert groups, the Client and other stakeholders can minimise risks throughout the project delivery process. Stakeholder and public engagements are necessary to better understand their requirements and concerns for this Project. The scoping meeting with technical agencies and other stakeholders (viz. NEA, NParks and PUB) was held on 7 March 2023. An engagement session with Nature Groups was held on 4th April 2024. Feedback from the Nature Groups were taken into consideration and included in the final report where appropriate.

6 Environmental Conditions

Baseline

6.1 Historical Land Use

A chronological account of the changes in land use of the site is provided in the following paragraphs, with inferences drawn from historical resources (maps, sea charts, and aerial photographs) contained within the NUS Libraries Historical Maps of Singapore (NUSLHMSG) [M-3] and old Master Plan of Singapore (1958), unless otherwise mentioned.

The earliest available maps of Singapore dated 1852 and 1873 indicate that the site was a hilly terrain located along the eastern banks of Sungei Mandai. The site was likely undeveloped at that time until the early 1940s. Site development appears to have started in the 1940s when a road running from the north to the west of the site was constructed, as shown in the 1943 map (Figure 6.1.1 A). From the 1940s to early 1950s, most of the area has been used as a rubber plantation; the Sungei Mandai area to the west remained a mangrove swamp.

Residential development around the area started in the 1950s. The settlement expanded rapidly between 1950s and 1960s. The 1953 map shows building footprints forming the Marsiling Village to the north and Bukit Sembawang Estate to the south of the site. By 1958, the site and its surroundings were zoned as a “new town” (1958 Master Plan). Soon, residential buildings were built within the site boundaries (1963 historical map). Small roads were also built to accommodate the increasing population in the area (Figure 6.1.1 B).

In the early 1970s, rapid development occurred in Woodlands. In 1974, the surrounding areas started to get developed with additional roads and buildings, including the newly built HDB estates along Marsiling Drive and south of Marsiling Road (Figure 6.1.1 C). Old residential buildings were also vacated from the site. Based on the map dating 1978, a community centre (unknown name) and a police station can be found on the site and a school was established in the southeast (Figure 6.1.1 D).

Whilst the site remained vacant, there were developments in the surrounding lands in the 1980s. The Masjid An-Nur was later built on the original community centre site in 1980 [W-5] and a new community centre (Marsiling Community Club) was established in 1982 [W-6]. The Sungei Mandai area which originally was a mangrove swamp was developed into a park, which opened in 1983 as Woodlands Town Garden (now called Marsiling Park). It was the first park to provide a recreational space in the Woodlands HDB estate [W-7]. In 1984, the Woodlands Secondary School moved to its current premises on the east of the site [W-7]. More HDB estates were built on the south along Woodlands Street 13 in 1985 [W-9]. Based on the 1987 map, the police station was vacated.

From the 1990s to the present, the site has barely changed, except for the overgrowth of the vegetation into a secondary forest as the site remained unused. The only remaining structure within the site boundary is the Marsiling Community Club in the northeast. The Masjid An-Nur is located right outside of the boundary in the northwest. The Marsiling Secondary School, established in 2000, officially moved to its current premises in late 2001 [W-10].

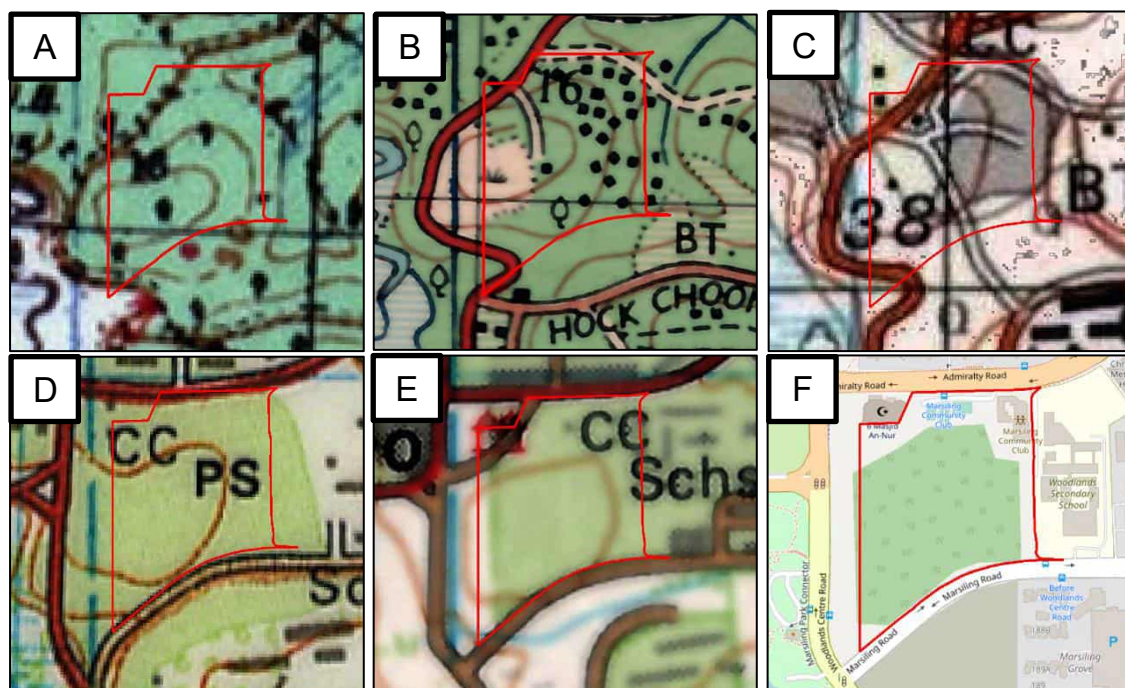


Figure 6.1.1 Historical maps of the area (A) 1943; (B) 1966; (C) 1974; (D) 1978; (E) 1987; and (F) 2023

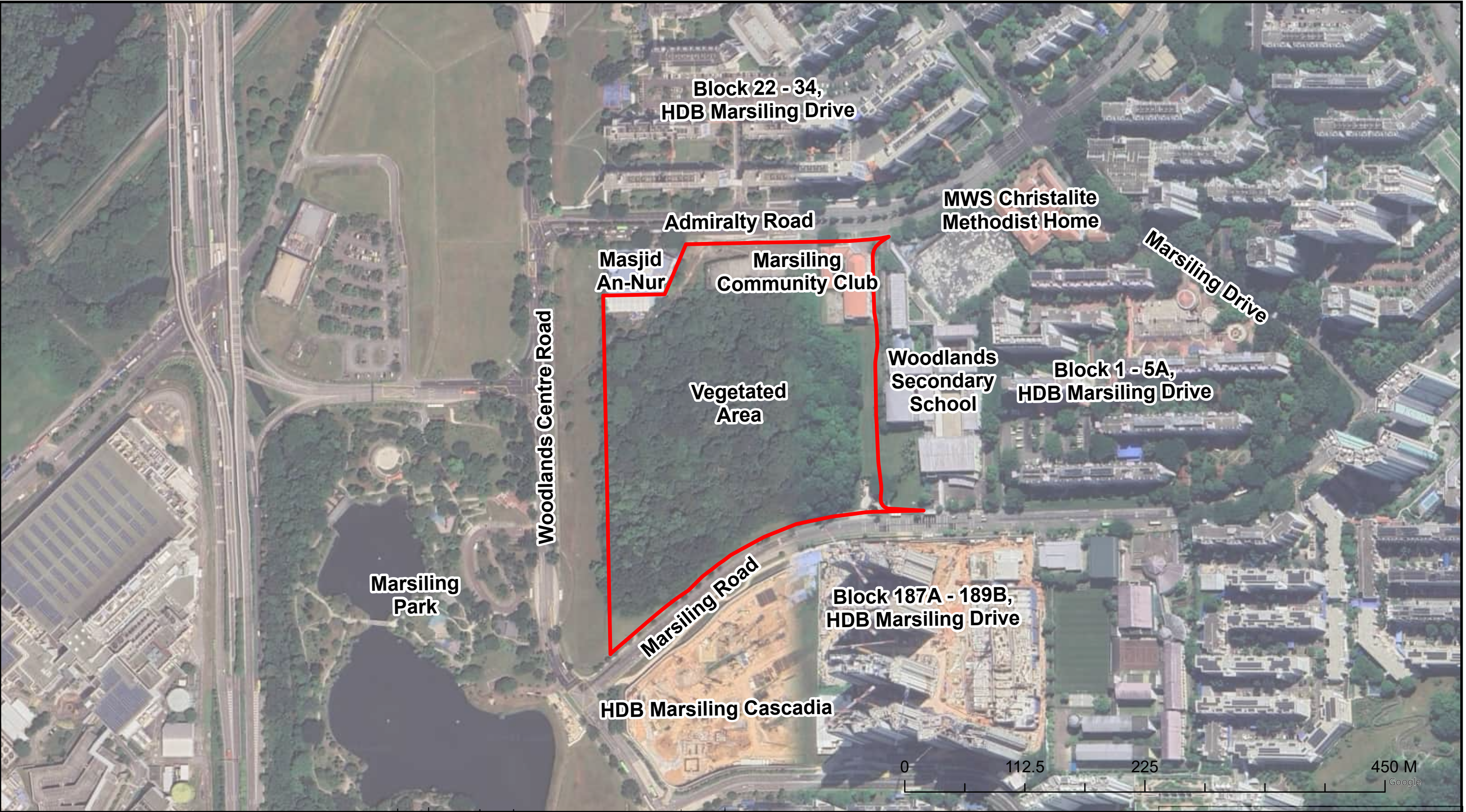
6.2 Current Land Use

Currently, the Project site is mostly vegetated, dominated by the secondary forest in the central portions. Low-lying vegetation can be found in the southeast corners of the site. Parts of An-Nur Mosque, Marsiling CC and its accompanying facilities (i.e., courts) are located in the northern part of the Project site.

More details about the current land uses within the site and its surroundings are summarised in the table below and shown in Figure 6.2.1.

Table 6-1 Current land use uses within and in the vicinity of the Project site

Current Land Features	Current Land Use Type	Planned Removal Timeline	Future Plans (Demolish/Cleared or Retained)	Proposed Future Land Use (URA Master Plan 2019)
Within the Project Site				
Marsiling Community Club	Civic Community Institution &	After Q2 2026	To be demolished	Road
In the Vicinity of the Project Site				
Marsiling Park	Park	-	-	Park
Woodlands Secondary School	Educational Institution	-	-	Educational Institution
Masjid An-Nur	Place of Worship	-	-	Place of Worship
Block 22 – 34. HDB Marsiling Drive	Residential	-	-	Residential
Block 1 – 5A, HDB Marsiling Drive	Residential	-	-	Residential
HDB Construction at Woodlands Street 13	Residential	-	-	Residential
Block 187A – 189B, Marsiling Road	Residential	-	-	Residential
MWS Christalite Methodist Home	Civic Community Institution &	-	-	Civic & Community Institution
Woodlands Centre Road	Road	-	-	Road
Marsiling Road	Road	-	-	Road
Admiralty Road	Road	-	-	Road
Marsiling Drive	Road	-	-	Road
Note:				
1. '-' indicates that the land feature is not within the Project site and will be retained.				



Legend Project Site N						Qualified Person Endorsement : NA HDB Endorsement : NA	Consultant : AECOM			Client: HOUSING & DEVELOPMENT BOARD			
								Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT WOODLANDS N1			Figure Title : Current land uses within Project site		
								Designed KRT	Checked SAG	Approved JAG	Figure No. : 6.2.1	Rev. 1	Sheet 1 of 1
									Drawn KRT	Date JUL 2024	CAD File Name : NA		A3
	1	JUL 2024	KRT	Final Report	SAG		JAG						
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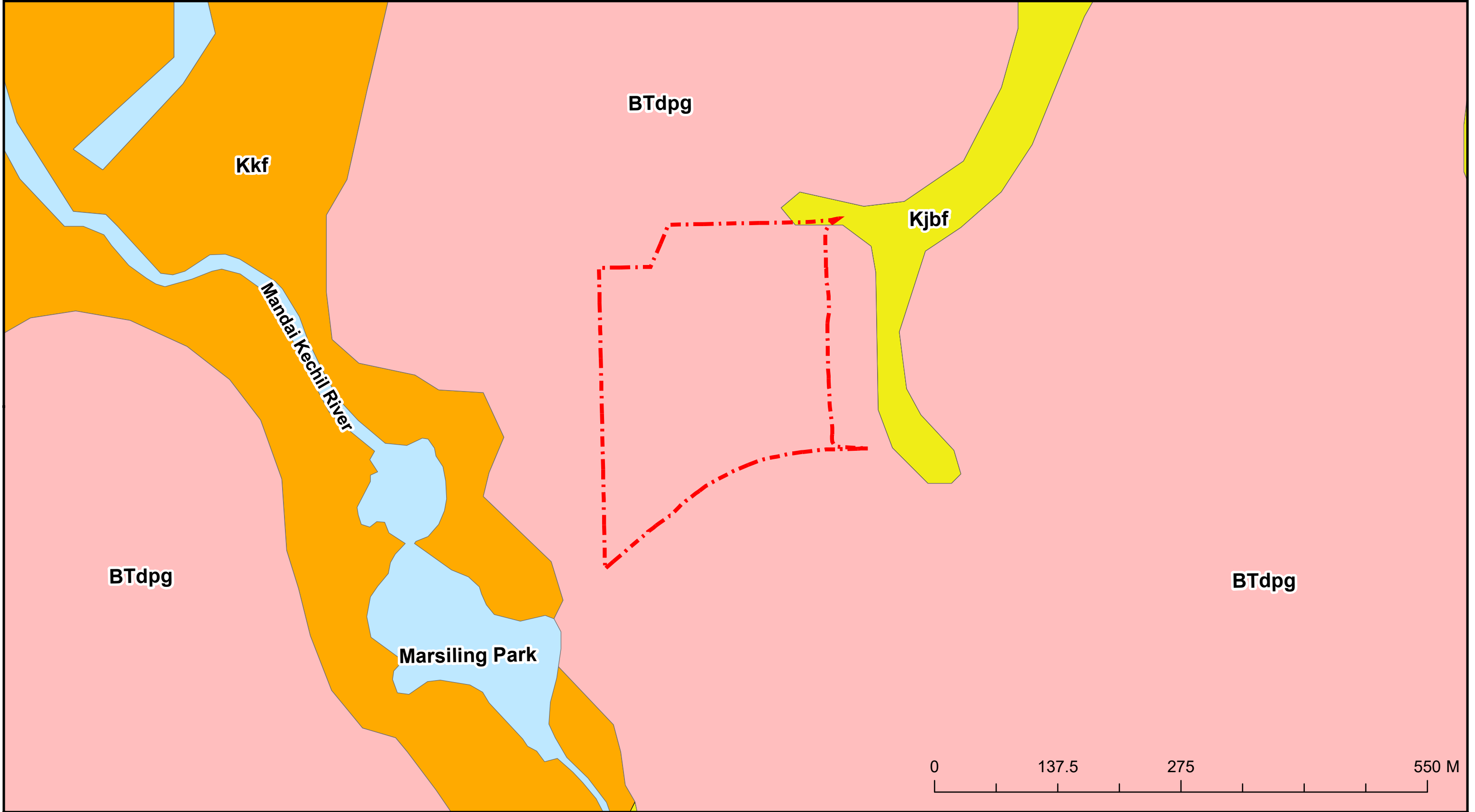
Note: Source of basemap - Google Earth Map

6.3 Physical Environment

6.3.1 Geology

As shown on the Geological Map of Singapore [M-5] (refer to Figure 6.3.1), the Project site is underlain by the Dairy Farm Granite-microgranite Pluton (BTdpg), a part of the Bukit Timah Centre.

The Dairy Farm Granite-microgranite Pluton (BTdpg), is part of the Bukit Timah Centre strata which is located in the central of Singapore Island and one of the oldest formations, dating back to early to middle Triassic [O-1]. This Dairy Farm Granite-microgranite Pluton comprises monzogranite composition with two texturally distinct components where the eastern part is entirely aphyric while western part is dominantly porphyritic [P-17].



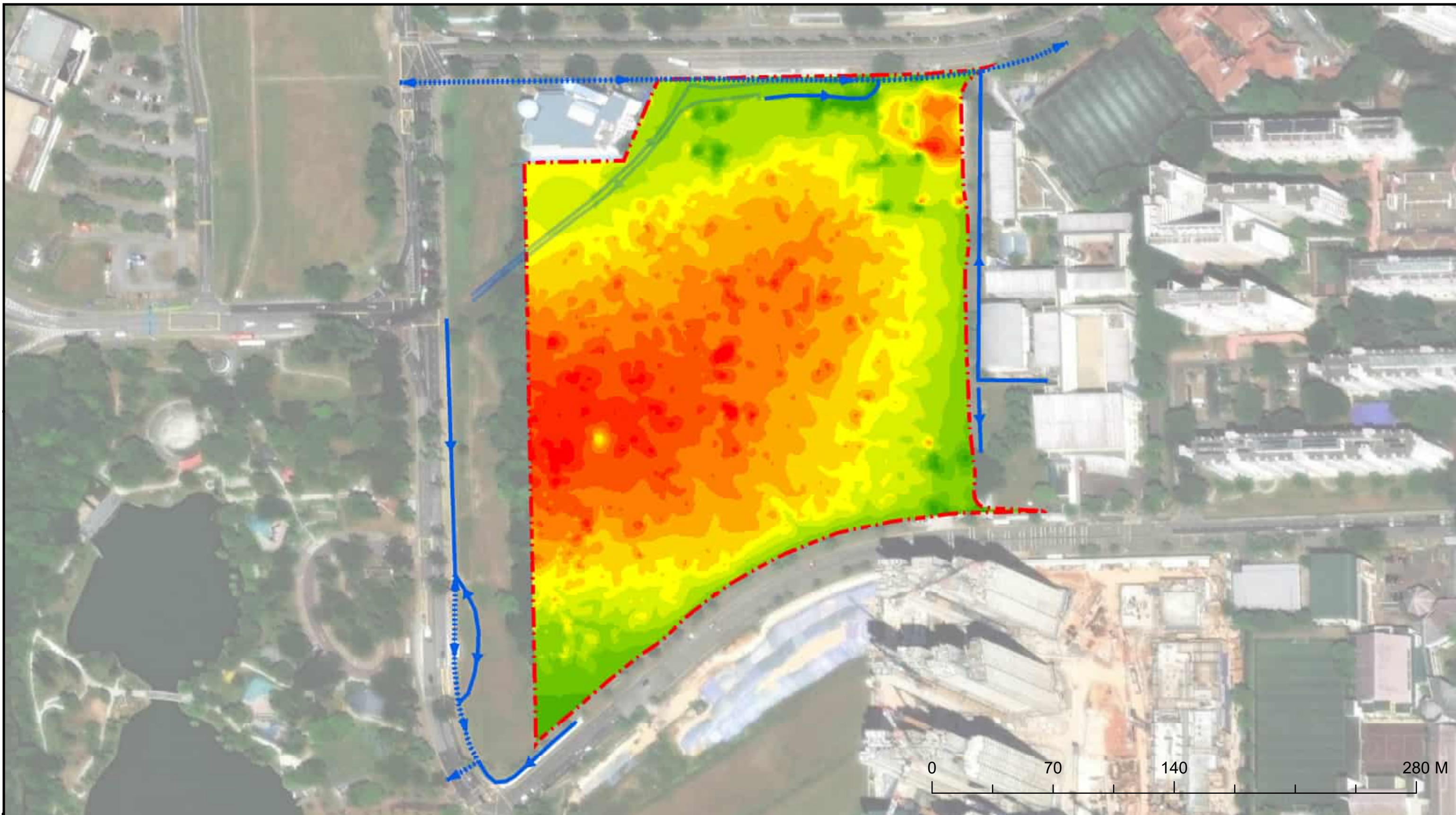
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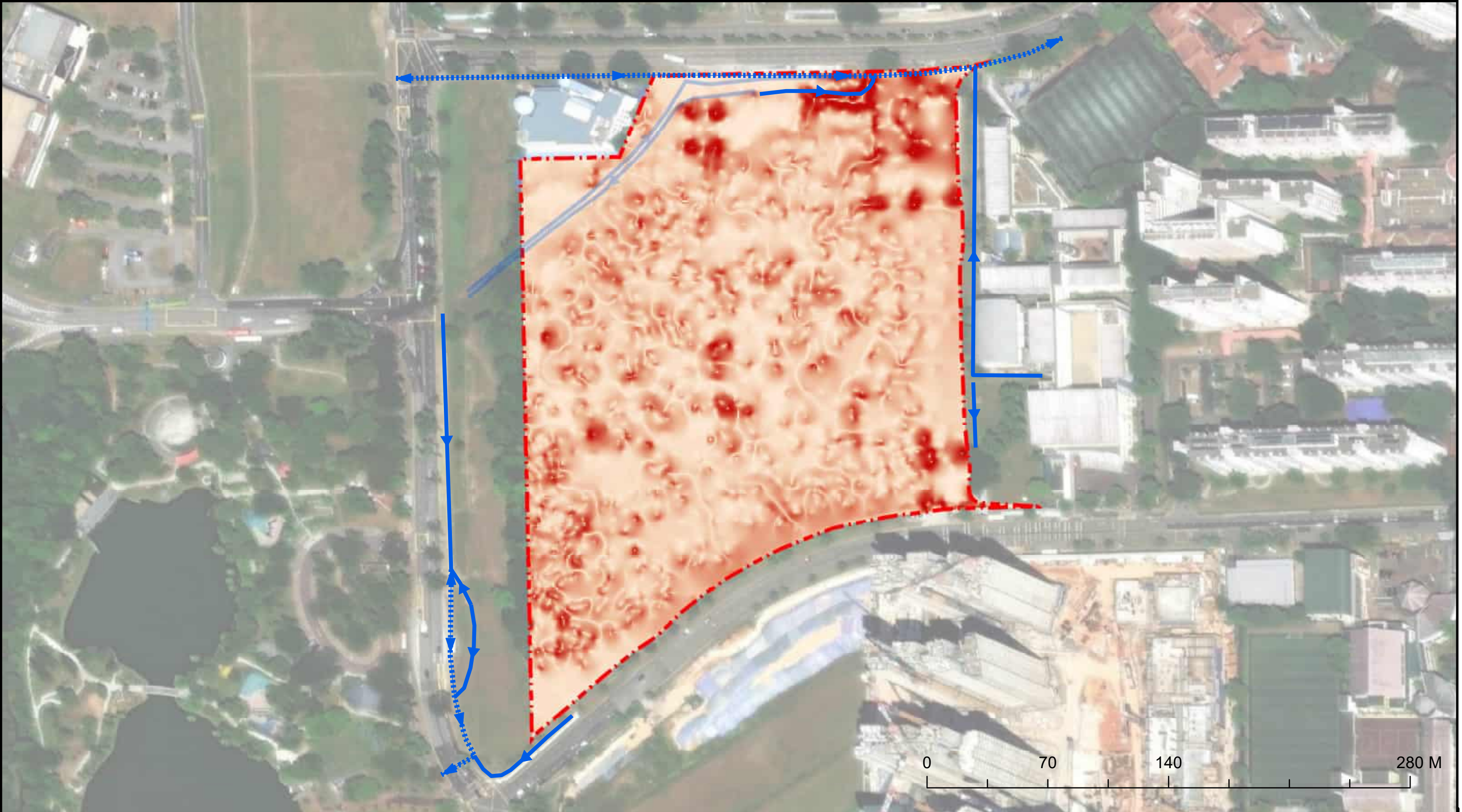
- Project Site
- Waterbody
- Dairy Farm Granite-microgranite Pluton (BTdpg)
- Jalan Besar Formation (Kjbf)
- Kranji Formation (Kkf)

						Qualified Person Endorsement : NA	Consultant : AECOM	Client: 				
								Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT WOODLANDS N1	Figure Title : Geological map of the Woodlands N1 Project site and its surroundings			
						HDB Endorsement : NA						
1	JUL 2024	KRT	Final Report	SAG	JAG		Designed KRT	Checked SAG	Approved JAG	Figure No. : 6.3.1	Rev. 1	Sheet 1 of 1
Rev.	Date	By	Description	Chk'd	App'd			Drawn KRT	Date JUL 2024	CAD File Name : NA		A3

6.3.2 Topography

As shown in the Figure 6.3.2, the site is generally hilly and undulating, with elevations ranging from almost +0.00 mRL to +30.30 mRL. The highest elevation point is located on the top of the hill which dominates the western portion of the site. From there, the elevations gradually decrease towards north, east and south. Lowest elevations can be observed at the northern, eastern and southern outskirts of the site, adjacent to the surrounding roads and existing structures. In addition, significant elevation drop from the hill within the Project site and drain D1 (west of the site) was observed during the site visits. Slope map was derived from the obtained elevation data and it reflects the current topography of the site, with slopes ranging from 0.1% to up to 70% (refer to Figure 6.3.3). The steepest slopes can be observed along the southern border of the site as well as around the existing structures within the site.

[illegible]



Legend

Project Site

Watercourse

Underground

Above

Abandoned drains

slope value

Value

High : 79.5008

Low : 0.0858566

N

						Qualified Person Endorsement : NA	Consultant : AECOM	Client: HOUSING & DEVELOPMENT BOARD						
								Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT WOODLANDS N1	Figure Title : Slope map of the Project site with watercourses					
									Designed KRT	Checked SAG	Approved JAG	Figure No. : 6.3.3	Rev. 1	Sheet 1 of 1
1	JUL 2024	KRT	Final Report	SAG	JAG					Drawn KRT	Date JUL 2024	CAD File Name : NA		A3
Rev.	Date	By	Description	Chk'd	App'd									

Note: Source of basemap - Google Earth Map

THIS DRAWING IS COPYRIGHT

6.3.3 Regional Climate

6.3.3.1 Rainfall

Singapore is situated near the equator and has typically tropical climate. Singapore's year-to-year rainfall is highly variable. Based on the 30-years long-term climate information (1981 – 2010) by the Meteorological Service Singapore (MSS), it rained an average of 167 days of the year [W-11]. The long-term mean annual rainfall total is 2534.3 millimetres (mm) when averaged across island-wide stations with long-term records [W-12]. Based on the findings from MSS, the annual rainfall total has increased at an average rate of 75.2 mm per decade, and hourly rainfall increased at the rate of 0.8 days per decade for heavy rain (>40 mm) and 0.2 days per decade for very heavy rain (>70 mm) from Year 1980 to 2019 (refer to Figure 6.3.4) [W-13].

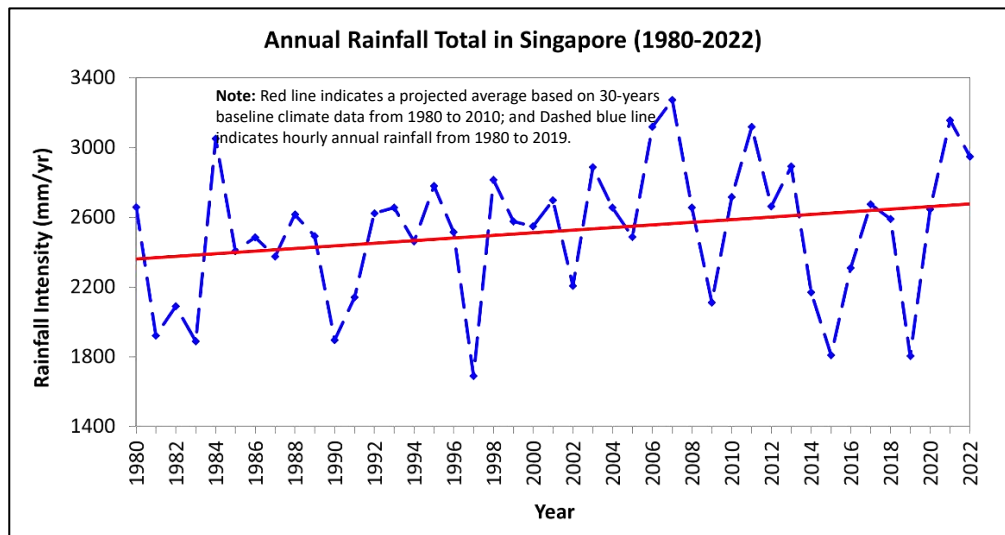


Figure 6.3.4 Annual rainfall total in Singapore from 1980 to 2022 (Source: Meteorological Service Singapore [MSS] [W-13])

In terms of spatial distribution, rainfall is higher over the northern and western parts of Singapore and decreases towards the eastern part of the island (Figure 6.3.5) [W-11]. The figure also shows that the Central Catchment possibly receives the maximum rainfall in Singapore. The annual average rainfall in the Project site is anticipated to be approximately 2,800 mm to 3,000 mm. Furthermore, the recent findings from MSS had shown an overall upward trend in total annual rainfall at increased average rates ranging from 0.3 mm/ year to 15.3 mm/year, during the period from 1980 to 2022 (refer to Figure 6.3.6) if compared to the 30-years long-term basis, except for the areas near Queenstown climate station at the south of Singapore [W-13].

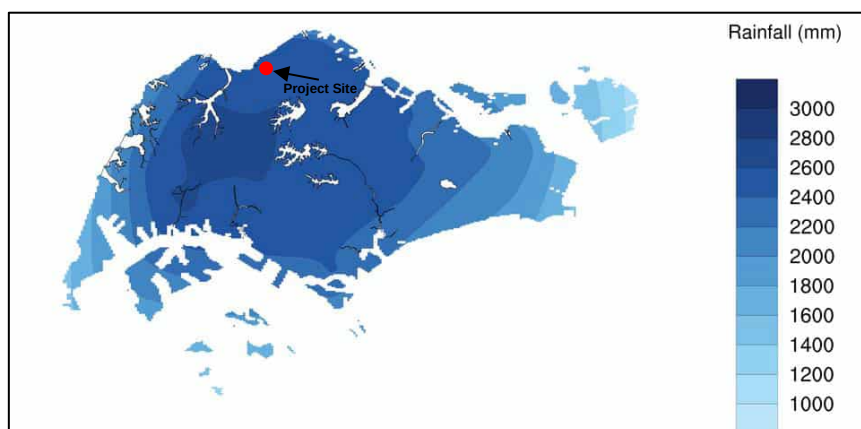


Figure 6.3.5 Annual average rainfall spatial distribution (1981 - 2010) (Source: MSS [W-11])

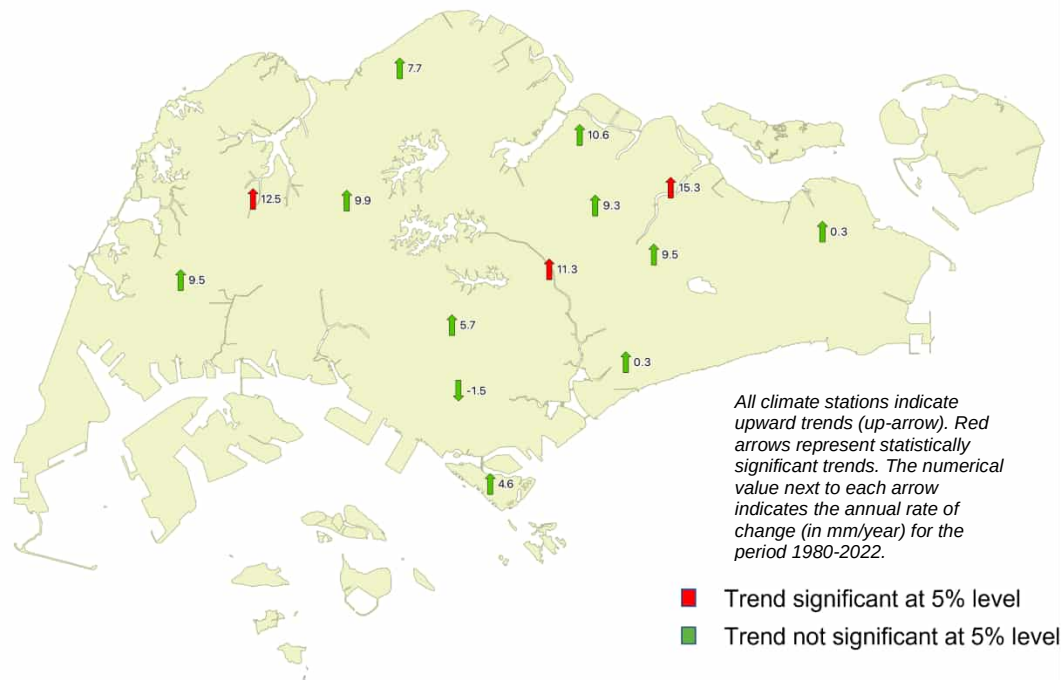


Figure 6.3.6 Past trends of annual rainfall total at indicative stations (1981-2022) [W-13]

Singapore has two monsoon seasons separated by inter-monsoonal periods, where the Northeast Monsoon occurs from December to early March and the Southwest Monsoon from June to September. In 2022, Singapore has abundant rainfall all year round with 210 rainy days and mean rainfall amount of 251 mm (refer to Figure 6.3.7). The average rainfall in Singapore is approximately 234 mm and 209 mm during Northeast and Southwest Monsoon, respectively. Most months in 2022 had rainfall that were below average (refer to Figure 6.3.7).

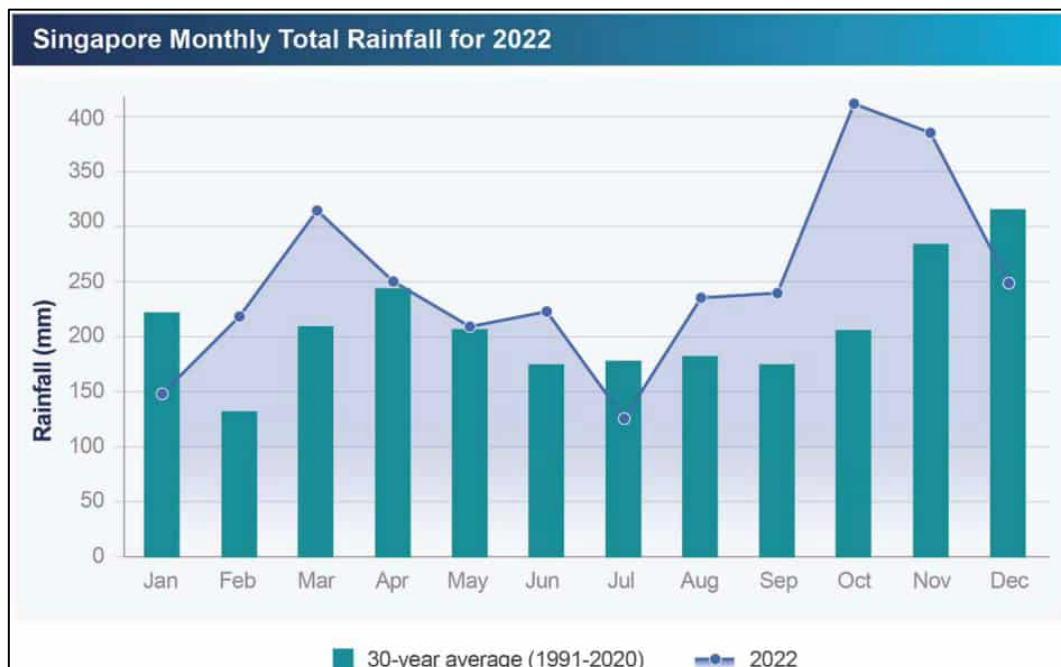


Figure 6.3.7 Monthly total rainfall in Singapore for 30-year average over island-wide stations with long-term records (bars, 1991 – 2020) compared to 2022 (solid line) (Source: MSS [W-12])

6.3.3.2 Temperature

Singapore's continuous temperature records since 1948 show that the island has warmed by an average of 0.25°C per decade, with a visible and sudden rapid increase after the mid-1970s (see Figure 6.3.8). This may have been due to the rapid economic development and urbanization that took place after Singapore's political reformation, as well as due to the influence of anthropogenic global warming effects. Eight (8) out of the ten (10) warmest years recorded in Singapore have occurred in the 21st century and all ten (10) occurred after 1997. This increasing trend has led to an increase in warm days and warm nights, and a decrease in cool days and cool nights.

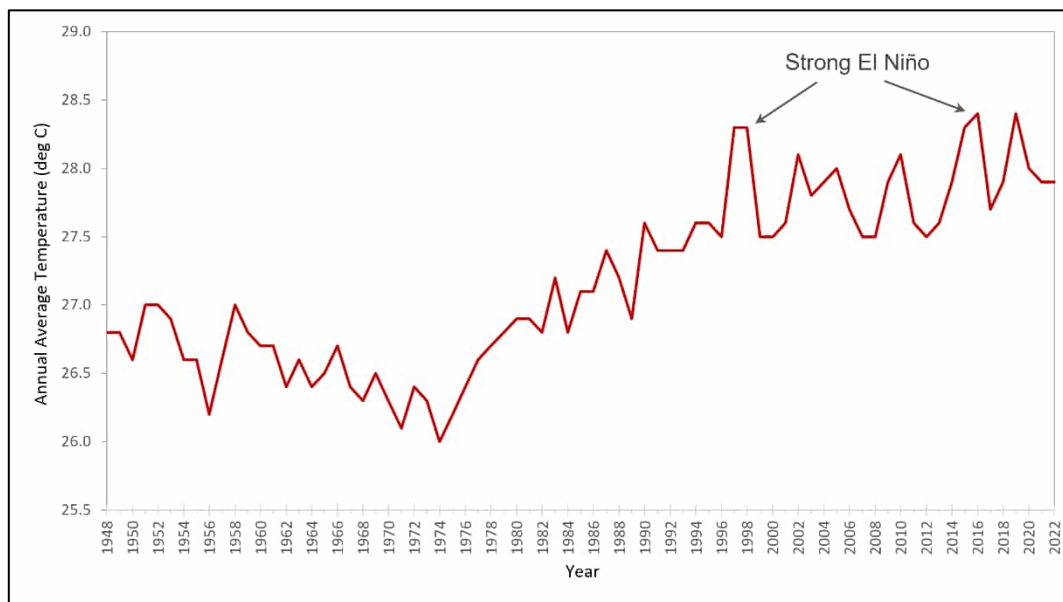


Figure 6.3.8 Annual mean temperature in Singapore from 1948 to 2022 (Source: MSS [W-13])

Generally, the temperature variation throughout the year is relatively small as compared to the mid-latitude regions [W-14]. The mean temperature from 2013 to 2022 was 28.01°C, which is 0.04°C higher than the previous record of 27.97°C for the decade from 2012 to 2021. In Year 2022, the annual mean temperature in 2022 was 27.9°C, with May 2022 being the warmest month at 29.2°C and December 2022 being the coolest month at 26.7°C. Overall, though the annual mean temperature of Year 2022 is 0.1°C above the long-term average of 27.8°C, however it has not exceeded the long-term monthly temperature records [W-12] as shown in figure below.

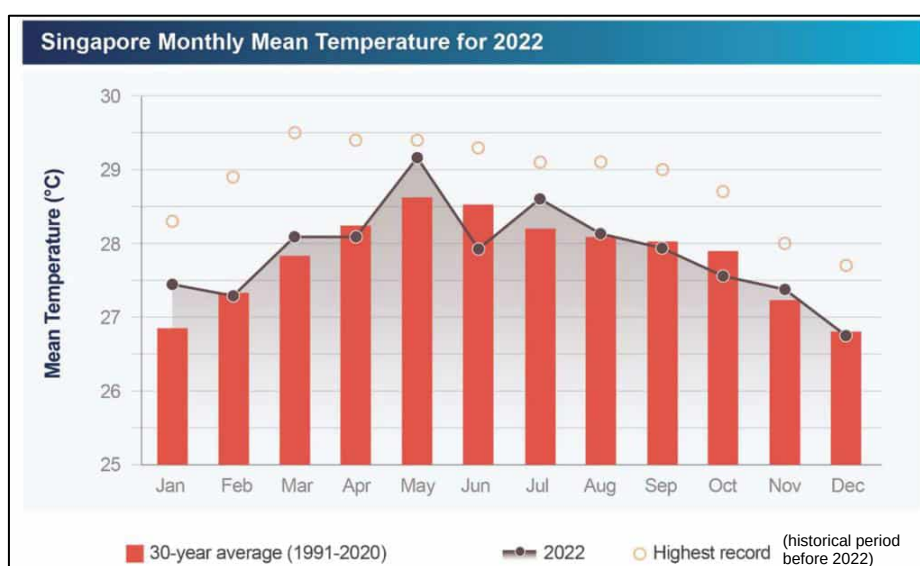


Figure 6.3.9 Singapore monthly mean temperature for 30-years average from Changi Climate Station with comparison to Year 2022 monthly mean temperature [W-12]

Although there is no distinct borderline between “urban” and “rural” areas in Singapore, maximum temperature difference of 4.01°C was observed between well-planted area, such as Lim Chu Kang area, and the Central Business District (CBD) area [P-18]. This shows the presence of an Urban Heat Island (UHI) effect in Singapore. Green areas in cities have been considered as potential measure in mitigating the UHI effect. This finding is also supported by a study conducted by Jusuf et al (2007), which shows different daytime temperature at different type of land use areas in Singapore. As observed in Figure 6.3.10, the daytime temperature in park areas is considerably lower compared to other type of land use areas [P-19].

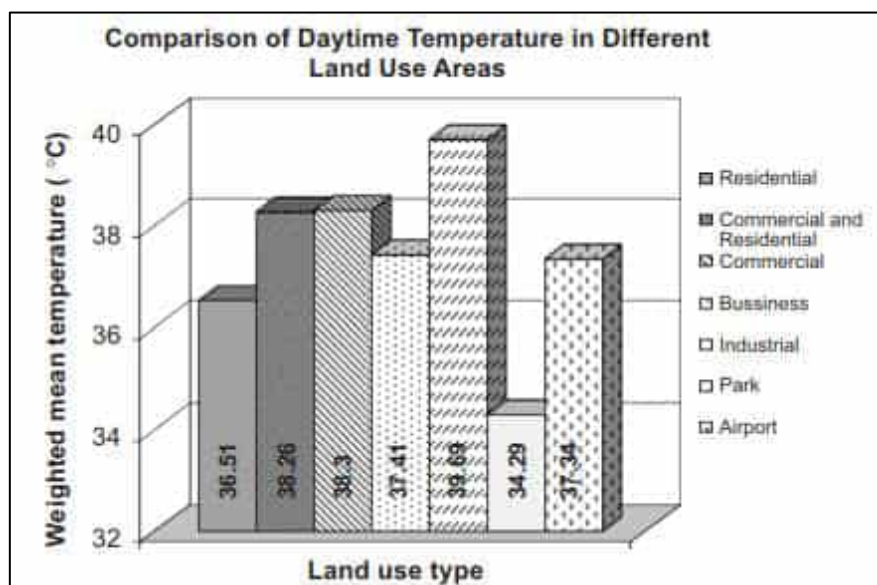


Figure 6.3.10 Comparison of daytime and night time temperature in different land use areas [P-18]

6.3.3.3 Relative Humidity

Relative humidity shows a fairly uniform pattern throughout the year and does not vary much from month to month (refer to Figure 6.3.11). Its daily variation is more marked, varying from more than 90% before sunrise to around 60% in the mid-afternoon on days when there is no rain. While the mean annual relative humidity is 83.9%, the relative humidity frequency reaches 100% during prolonged periods of rain.

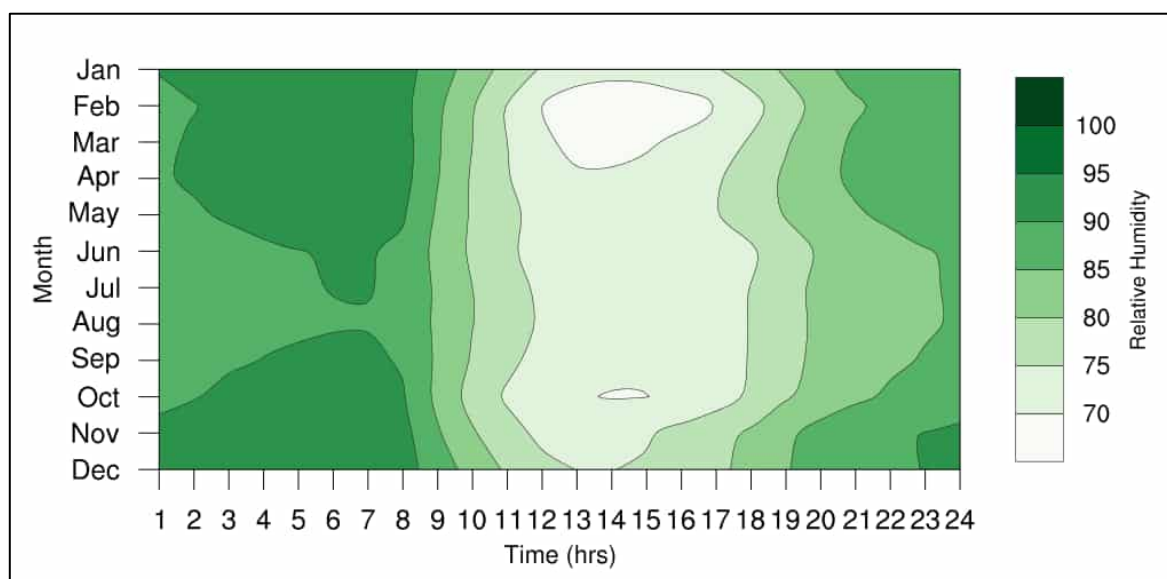


Figure 6.3.11 Hourly variation of relative humidity for each month from 1981 to 2010 (Source: MSS [W-11])

6.3.3.4 Surface Wind

Winds in Singapore are generally light, with the mean surface wind speed normally less than 2.5 m/s. An exception to this is during the presence of a Northeast Monsoon surge, where mean speeds of 10 m/s or more have been observed. Strong winds also occur during thunderstorms. Surface wind gusts are produced from thunderstorm downdrafts and from the passage of Sumatra Squall Lines. As shown in Figure 6.3.12, the most prominent winds in Singapore are from northeast and the south, occurring during the Northeast and Southwest Monsoon, respectively. The mean monthly wind speeds ranges from 1.4 m/s to 2.8 m/s [W-11].

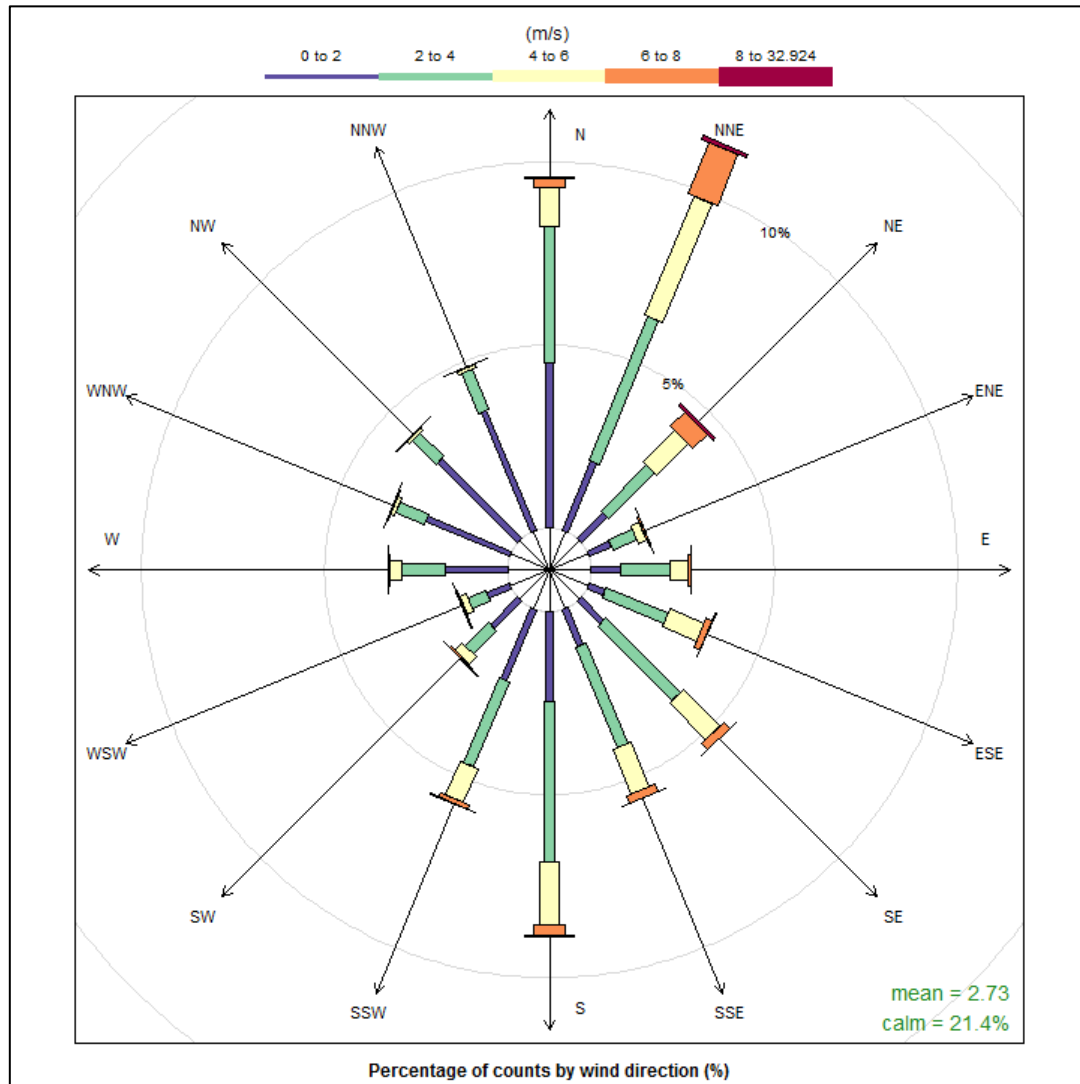


Figure 6.3.12 Annual wind rose of Singapore (Source: MSS [W-11])

6.4 Biodiversity

6.4.1 Floristic Baseline Conditions

6.4.1.1 Habitat Description

There are seven habitat and vegetation types (Table 6-2; Figure 6.4.1) identified in the Study Area. Majority of the vegetation type within the Study Area is abandoned-land forest (3.9 ha, 38.1%). The second largest habitat type is urban vegetation (2.5 ha, 24.2%) and are mainly found along periphery of the Study Area. A patch of native-dominated secondary forest (1.5 ha, 15%) occupies the western part of the Study Area, while scrubland (0.6 ha, 5.5%) borders the perimeter of the forest. The remaining habitat consist of farmland (0.3 ha, 3.1%) and infrastructure (1.3 ha, 13.2%). These are located within the northern portion of the Study Area, while construction (0.1 ha, 1.0%) occupies a small portion on the south-eastern corner.

Table 6-2 Absolute (ha) and relative (%) sizes of each habitat and vegetation type in the Study Area

Habitat type	Absolute size (ha)	Relative size (%)
Native dominated forest	1.5	15.0
Abandoned-land forest	3.9	38.1
Scrubland	0.6	5.5
Urban vegetation	2.5	24.2
Others (Farm)	0.3	3.1
Others (Infrastructure)	1.3	13.2
Others (Construction)	0.1	1.0
Total	10.2	100



Legend

Study Area

Native dominated secondary forest

Abandoned-land forest

Scrubland

Urban vegetation

Others (Farm)

Others (Infrastructure)

Others (Construction)

N

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Figure Title :

Habitats and vegetation distribution within the
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1 of 1

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6.4.1.1.1 Native-dominated Secondary Forest

The native-dominated secondary forest (1.5 ha, 22.8%) occupies the western part of the Study Area (Figure 6.4.1). The terrain within this patch was undulating, with a hill towards the middle of the Study Area. Threatened species observed in this habitat type include the nationally Critically Endangered *Aporosa falcifera*, *Dioscorea hispida* and *Psychotria polycarpa* (see Section 6.4.1.3 more details). This late-successional forest was largely dominated by slow-growing species, tembusu (*Cyrtophyllum fragrans*) (Figure 6.4.2A) and *Syzygium grande* (Figure 6.4.2B). Among the tembusu trees measured within the Study Area, about one-third had a girth of more than 2-m. Given the slow-growing nature of this species, tembusu with such girth size are estimated to be at least 50 years old, where some might even be over a 100 years old. This suggested that the tembusu in this Study Area were likely to have established naturally before the species was commercially available in Singapore or planted locally.

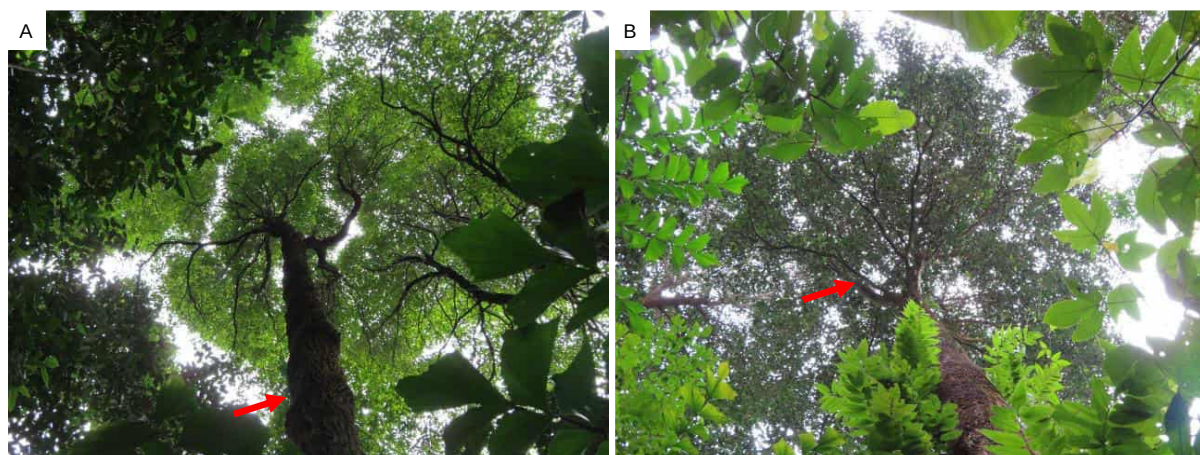


Figure 6.4.2 Native-dominated Secondary Forest in the Study Area. (A) *Cyrtophyllum fragrans*; and (B) *Syzygium grande*



Figure 6.4.3 (A) *Timonius wallichianus*; (B) *Gironniera nervosa*; and (C) *Camptosperma auriculatum*

Within the understorey, saplings of native common species that were not typically found in disturbed forest were observed here. Especially in this area where the forest is in proximity to the road and litters was found, suggesting possible human disturbance. This includes common species such as *Timonius wallichianus* (Figure 6.4.3A), *Gironniera nervosa* (Figure 6.4.3B) and *Camptosperma auriculatum* (Figure 6.4.3C). Towards the edge of the native forest patch, tree falls were commonly observed, with rubber trees (*Hevea brasiliensis*) and rambutan (*Nephelium lappaceum*) trees commonly recorded in the understorey. The colonisation of non-native species from the adjacent abandoned-land forest may poses a threat to the native-dominated secondary forest, with possible exotic species invading into the forest interior overtime.

6.4.1.1.2 Abandoned-land Forest

Abandoned-land forest the largest habitat type in Study Area (3.9 ha, 38.1%; Figure 6.4.1)—was located in the eastern portion of the Study Area, adjacent to the native-dominated secondary forest. Numerous threatened species were recorded in this habitat type, such as nationally Critically Endangered *Bouea oppositifolia*; nationally Endangered *Gymnacrancher farquhariana* var. *farquhariana*; nationally Vulnerable *Curculigo latifolia* and *Microlepidia speluncae* (See Section 6.4.1.3 for more details).

The most frequently encountered species in both canopy and understorey layers were rubber (*Hevea brasiliensis*; Figure 6.4.4A) and rambutan (*Nephelium lappaceum*). African tulip trees (*Spathodea campanulata*), durian (*Durio zibethinus*; Figure 6.4.4B), and *Ficus variegata* were also interspersed across this habitat type. Towards the

western half of this patch, a mixture of species, such as wild cinnamon (*Cinnamomum iners*), *Baccaurea motleyana*, *Piper sarmentosum* (Figure 6.4.4C), and durian dominates the understorey. Whereas the other half, was dominated by *Dracaena fragrans*, fishtail palm, dumb cane (*Dieffenbachia seguine* var. *seguine*; Figure 6.4.4D) and *Andira inermis*.



Figure 6.4.4 Abandoned-land Forest in the Study Area. (A) Dominated by *Hevea brasiliensis* trees; (B) Fruiting *Durio zibethinus*; (C) *Piper sarmentosum*; and (D) *Dieffenbachia seguine* var. *seguine*

Additionally, the Dutchman's pipe (*Aristolochia acuminata*; Figure 6.4.5A) was also recorded here. Despite being an exotic species, *A. acuminata* is the host plant for the nationally Vulnerable common birdwing (*Troides helena* *Cerberus*; Figure 6.4.5B). Butterflies are host specific; this means that the butterflies need to lay their eggs on specific host plants that their caterpillars can eat, making host plant important in the life cycle of a butterfly. This will help to ensure continuity of the common birdwing's population when species disperse out from neighbouring source populations such as Marsiling Park (See Section 6.4.2.3 for more details).

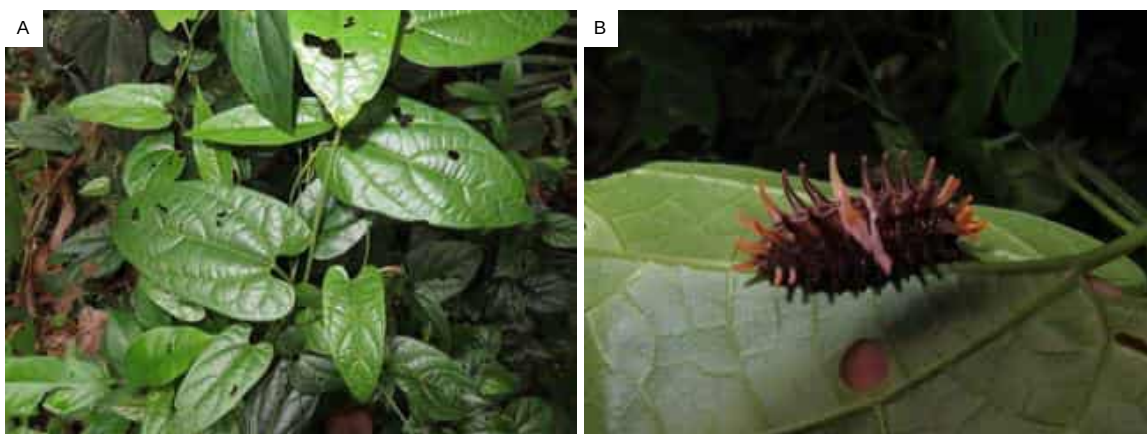


Figure 6.4.5 (A) *Aristolochia acuminata*; and (B) Common birdwing caterpillar found on *A. acuminata*

6.4.1.1.3 Scrubland and Herbaceous Vegetation

The scrubland is located along the perimeter of the forest (0.6 ha, 5.5%; Figure 6.4.6A–B). This vegetation type is partially shaded by the tree canopy that abuts the forest edge, especially along the south. Areas that had more shades will provide a more optimal environment for plants to grow in, resulting in a higher species diversity of shrub and herbaceous species. Some of these species includes *Ficus grossularioides* var. *grossularioides*, *Mallotus paniculatus*, *Dillenia suffruticosa*, *Asystasia gangetica* ssp. *micrantha*, *Xanthosoma sagittifolium* and *Scleria ciliaris*. Open-canopy areas with a paucity of shade predominantly comprised of broad sword fern (*Nephrolepis biserrata*), *Ottochloa nodosa* and *Colocasia esculenta*. These species have been adapted to areas of direct sunlight, allowing them to thrive in fairly open areas with high light levels.



Figure 6.4.6 (A–B) Scrubland in the Study Area

6.4.1.1.4 Urban Vegetation

Urban vegetation in the Study Area (2.5 ha, 24.2%) is mainly found along the borders. It was predominantly covered by cow grass (*Axonopus compressus*; Figure 6.4.7A) and planted trees (Figure 6.4.7B) beside Woodlands Secondary School and Marsiling mega sports park.

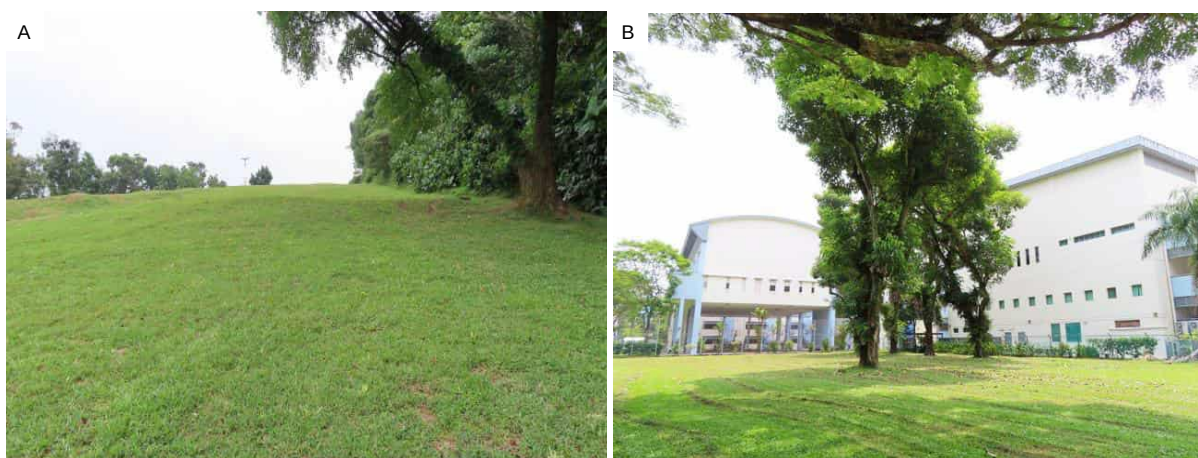


Figure 6.4.7 Urban vegetation in the Study Area. (A) Managed *Axonopus compressus* turf; and (B) Planted trees

6.4.1.1.5 Others (Farm)

A small portion of farmland (0.3 ha, 3.1%; Figure 6.4.8A–B) is found at the north portion of the Study Area. It was situated between the abandoned-land forest and Masjid An-Nur Mosque. Numerous edible and ornamental species were grown in this area and is currently still managed by people. This includes species such as papaya (*Carica papaya*), pineapple (*Ananas comosus*), chili (*Capsicum annuum*), *Tagetes erecta*, and *Hibiscus rosa-sinensis*.



Figure 6.4.8 (A–B) Managed Farm in the Study Area

6.4.1.1.6 Others (Infrastructure)

Infrastructure makes up 13.2% (13.2 ha) of the total Study Area. This includes roads such as Admiralty Road, Woodlands Centre Road and Marsiling Road, Masjid An-Nur Mosque (Figure 6.4.9A) and Marsiling mega sports park (Figure 6.4.9B).



Figure 6.4.9 (A) Masjid An-Nur Mosque; and (B) Marsiling mega sports park

6.4.1.1.7 Others (Construction)

A small area of construction site along Marsiling Road and next to Woodlands Secondary School, occupies about 1% (0.1 ha) of the total Study Area—this construction works was for the proposed sewers at North Woodlands area (Figure 6.4.10A–B).



Figure 6.4.10 (A–B) Others (Construction) in the Study Area

6.4.1.2 Overall

A total of 195 species, belonging to 77 families were recorded in the Study Area. The number and percentage of the plant species belonging to each status category at each site are summarised in Table 6-3. Of these, 89 are native (45.6%), 99 (50.8%) are exotic and seven are cryptogenic (3.6%). The list of flora species recorded within the Study Area is provided in Appendix D.F

Native threatened species comprise of species that have been accorded the following statuses: Vulnerable, Endangered, Critically Endangered, Presumed Extinct. For overall findings, however, a distinction was not made as to whether threatened species are from native wild populations or are cultivated locally and/or relics from past cultivation. Species belonging to the latter category are not of conservation significance even though they have been accorded with a threatened status. This is discussed in greater detail in Sections 5.2.2.1.3 and 5.2.2.2.3.

Table 6-3 Number and percentage (%) of species belonging to each status category in the Study Area

Origin	Status	Number of Species	Percentage (%)
Native		89	45.6
	Common	71	36.4
	Vulnerable	5	2.6
	Endangered	2	1.0
	Critically Endangered	10	5.1
	Data deficient	1	0.5
Exotic		99	50.8
	Cultivated Only	32	16.4
	Casual	38	19.5
	Naturalised	26	13.4
	Not assessed	3	1.5
Cryptogenic		7	3.6
Total		195	100

6.4.1.3 Species of Conservation Significance

Out of the 17 threatened native species, ten are considered to be of conservation significance (Table 6-4; Figure 6.4.11; Appendix E). Altogether, 51 specimens and/or clusters of specimens belonging to these species of conservation of significance were recorded (Figure 6.4.13). Some species, although listed as nationally threatened, were not considered of conservation significance in this study because they were most likely escapees from present-day cultivation or relics that had persisted from past cultivation. The assessment of whether a threatened plant species is of conservation significance was carried out based on the criteria detailed in Section 5.2.2.1.3.

Table 6-4 Breakdown of threatened plant species and those regarded as species of conservation significance

Species Conservation Status*	VU	EN	CR	Total
Non-cultivated Threatened Species	5	1	4	10
Cultivated Threatened Species	0	1	6	7

Note: VU – Vulnerable; EN – Endangered; CR– Critically Endangered.

Table 6-5 Number of plant specimens and species of conservation significance in the overall Study Area.

Habitat	Number of Individuals and Clusters					Number of Species				
	VU	EN	CR	EX	Total	VU	EN	CR	EX	Total
Native-Dominated Secondary Forest	13	0	13	0	26	2	0	3	0	5
Abandoned-Land Forest	18	5	2	0	25	5	1	2	0	7

Note: Total species richness of the Study Area is not the sum of species richness per vegetation type as some species occur in more than one vegetation type. VU – Vulnerable; EN – Endangered; CR – Critically Endangered.

There were several species of conservation significance scattered within Study Area, mostly restricted to either native-dominated secondary forest or abandoned-land forest. Only one sapling specimens of nationally Critically Endangered *Aporosa falcifera* (Figure 6.4.11A) was recorded within the native-dominated secondary forest. This species was previously mis-identified as *Aporosa nervosa* in the past EIA study conducted in 2021 (AECOM, 2022). According to Lam et al. 2022 [P-19], one of the distinguishable features between the two species is the disc-like glands in the stipule, which is likely to be overlooked. The population of this species seems to be restricted within nature reserves, such as Bukit Timah Nature Reserve (BTNR), Central Catchment Nature Reserve (CCNR) or Nee Soon Swamp Forest (NSSF). This information is solely based on vouchered specimens in the Singapore Botanic Gardens Herbarium (SING) and Lam et al. 2022 [P-19]. It is important to note that only three vouchered specimens from Singapore have been deposited into SING thus far, with the latest dated back to 2010. This represents the extant of the low-density population it has in Singapore. Thus, findings of this species in the Study Area is extremely rare, making it important to preserve the forest to ensure continuity in the population. On the other hand, a well-established population of another nationally Critically Endangered species—*Psychotria polycarpa*—was also found in the native-dominated secondary forest (Figure 6.4.11B).

A total of four clusters of nationally Endangered *Gymnacranthera farquhariana* var. *farquhariana* (Figure 6.4.11C) were recorded within the abandoned-land forest. Similar to *A. falcifera*, *G. farquhariana* var. *farquhariana* was previously incorrectly identified as *Gymnacranthera forbesii*. However, the identification has been now confirmed by SING upon checking on the specimen. Likewise, this species seems to be mostly confined within the nature reserves, making it exceedingly rare.

Another noteworthy threatened species is *Baccaurea polyneura* (Figure 6.4.11D). A single tree of *B. polyneura*, with girth size of about 1.1 m was recorded in the Study Area. Numerous seedlings of *B. polyneura* were also growing below the tree. Most of the voucher specimens' collection catalogued in the SING date back to more than 10 years ago, with the latest one collected in 2010 at NSSF. Other localities of this species were recorded at BTNR, CCNR, Singapore Botanic Garden Rain Forest and Windsor Forest (Neo et al. 2014 [P-20]; Lam et al. 2022 [P-19]). Given the girth size, it is plausible that this mature individual is likely a remnant of the original native population before human disturbance and survived despite the forest fragmentation and surrounding developments. Other species unique to the abandoned-land forest in this Study includes the nationally Critically Endangered *Bouea oppositifolia* (Figure 6.4.11F), the nationally Vulnerable *Curculigo latifolia* (Figure 6.4.12A) and *Microlepia speluncae* (Figure 6.4.12B).

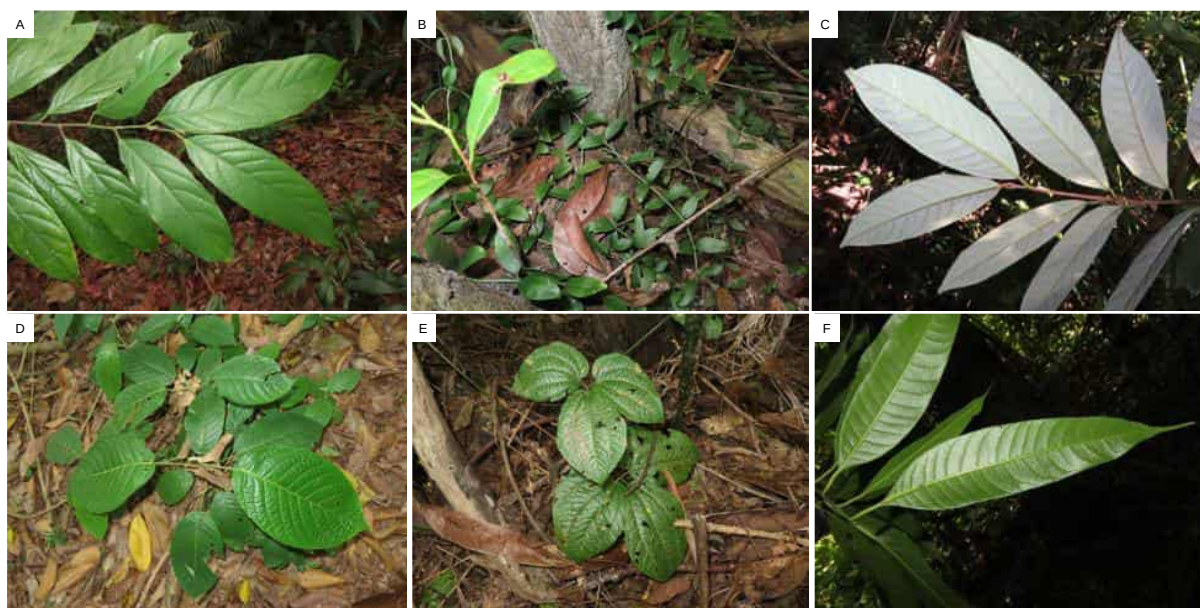


Figure 6.4.11 Plants of conservation significance in the Study Area. (A) *Aporosa falcifera*; (B) *Psychotria polycarpa*; (C) *Gymnacranthera farquhariana* var. *farquhariana*; (D) *Baccaurea polyneura*; (E) *Dioscorea hispida*; and (F) *Bouea oppositifolia*

Aside from the non-widespread rare native species, there were also a three large population of the nationally Critically Endangered climber *Dioscorea hispida* (Figure 6.4.11E) found within both habitat types. Apart from SING's information, there is very little information to-date on the distribution and habitats of *D. hispida* in Singapore. Majority of the population seems to be limited at Pulau Tekong, based on the latest voucher specimens deposited in 2016. More studies will be needed to assess if there are undetected population elsewhere in Singapore. Meanwhile, protection of the habitat will be crucial in allowing the current population to continue thriving. Other widespread species that can be found throughout the forested area includes *Lindera lucida* (Figure 6.4.12C) and *Litsea umbellata* (Figure 6.4.12D).

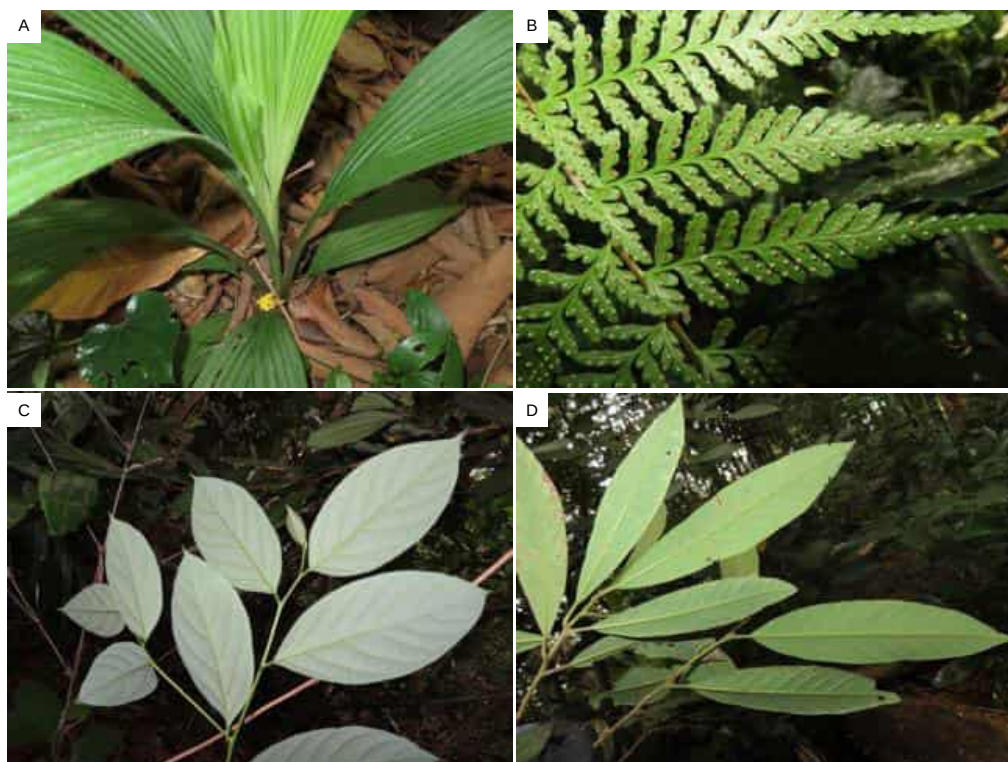


Figure 6.4.12 Other threatened species found in the Study Area. (A) Flowering specimen of *Curculigo latifolia*; (B) *Microlepia speluncae*; (C) *Lindera lucida*; and (D) *Litsea umbellata*



Legend

Study Area

Native dominated secondary forest

Abandoned-land forest

Scrubland

Urban vegetation

Others (Farm)

Others (Infrastructure)

Others (Construction)

Species of Conservation Significance

Critically Endangered

Endangered

Vulnerable

N

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Distribution of species of conservation significance
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6.4.1.4 Large specimens

A total of 28 large plant specimens were recorded in the Study Area (Figure 6.4.15; Table 6-6; Appendix F). Of these specimens (Figure 6.4.14A–C), nine (32.1%) are native, 18 (64.3%) are exotic and one (3.6%) cryptogenic. These specimens consist of 24 (85.7%) large tree specimens (3.0–4.0-m girth), and four (14.3%) stranglers (3.0–15.0-m spread).

Table 6-6 Number of large specimens recorded in the Study Area

Habit	Species	No. of Specimens
Tree	<i>Adenanthera pavonina</i>	4
	<i>Cyrtophyllum fragrans</i>	5
	<i>Falcataria falcata</i>	1
	<i>Ficus variegata</i>	1
	<i>Hevea brasiliensis</i>	4
	<i>Mangifera indica</i>	1
	<i>Samanea saman</i>	1
	<i>Spathodea campanulata</i>	6
	<i>Tabebuia rosea</i>	1
Strangler	<i>Ficus benjamina</i>	1
	<i>Ficus microcarpa</i>	3
Total		28



Figure 6.4.14 Large specimens in the Study Area. (A) *Ficus macrocarpa*; (B) *Hevea brasiliensis*; and (C) *Cyrtophyllum fragrans*



Legend

Study Area

Native dominated secondary forest

Abandoned-land forest

Scrubland

Urban vegetation

Others (Farm)

Others (Infrastructure)

Others (Construction)

Large specimens

Keystone species

Tree

Storm vulnerable species

N

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Distribution of large specimens in the Study Area

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6.4.1.5 Other Specimens of Value

There are only two clusters of bamboos recorded near the farmland (Figure 6.4.17; Appendix G), namely *Thyrsostachys siamensis* (Figure 6.4.16A) and *Bambusa vulgaris* (Figure 6.4.16B). These two bamboo species are most likely planted along with the other cultivated species in the farm. The girth spread of both bamboo is around 0.4 m, which size is currently too small for the nationally threatened bamboo bats (*Tylonycteris sp.*) to roost in. However, these bamboo cluster could still be a potential roosting spot for the bamboo bats in the future.



Figure 6.4.16 Other specimens of value recorded in the Study Area. (A) *Thyrsostachys siamensis*; and (B) *Bambusa vulgaris*



Legend

Study Area

Native dominated secondary forest

Abandoned-land forest

Scrubland

Urban vegetation

Others (Farm)

Others (Infrastructure)

Others (Construction)

Other specimens of value

Bamboo

N

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							HDB Endorsement : NA	Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT WOODLANDS NEIGHBOURHOOD 1	Figure Title : Distribution of other specimen of value in the Study Area				
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6.4.1.6 Tree Mapping Findings

A total of 509 specimens belonging to 37 species were assessed during the arboriculture surveys (Figure 6.4.18; Appendix H). These specimens belong to a total of 18 families.

Nearly half of the tree specimens that were recorded comprise of exotic species (242 specimens; 47.5%). Remaining 193 specimens (37.9%) were native and 74 specimens (14.5%) were cryptogenic. Among all the trees mapped, there were five species that made up more 60% of the overall count. These four species belongs to (1) *Hevea brasiliensis* (153 specimens; 30.1%), (2) *Nephelium lappaceum* var. *lappaceum* (73 specimens; 14.3%), (3) *Syzygium grande* (55 specimens; 10.8%), and (4) *Cyrtophyllum fragrans* (53 specimens; 10.4%). Altogether, ten specimens belonging to three species of conservation significance were tagged and assessed. These species include *Lindera lucida*, *Baccaurea polyneura*, and *Gymnacranthera farquhariana* var. *farquhariana*.



Legend

- Study Area
- Native dominated secondary forest
- Abandoned-land forest
- Scrubland
- Urban vegetation
- Others (Farm)
- Others (Infrastructure)
- Others (Construction)

N

1

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Distribution of mapped trees in the Study Area

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6.4.2 Faunistic Baseline Conditions

6.4.2.1 Overall

The field assessment documented a total of 95 species, dominated by birds (37 species), and butterflies (29 species) (Table 6-7). Of all the species recorded, four were of conservation significance (Table 6-8).

A list of 26 probable species of conservation significance was also generated, based on recent locality records within and around the Study Area, existing habitat types and dispersal abilities of the various species. The list of recorded faunal species and probable species of conservation significance is available in Appendix I and summarised in Table 6-7. The faunal survey and camera trap data are provided in Appendix J and Appendix K respectively.

Generally, the findings indicate that although the Study Area is an isolated forest separated by a road to Marsiling Park, it still provides an ecological connectivity mainly for flying fauna like birds and bats. It is an important connecting node for these animals traversing between green spaces from Mandai Mangrove and Mudflat to Marsiling Park and further afield to Central Catchment Nature Reserve (CCNR).



Legend

Study Area

Native dominated secondary forest

Abandoned-land forest

Scrubland

Urban vegetation

Others (Farm)

Others (Infrastructure)

Others (Construction)

— Terrestrial sampling route

Conservation Status

● Critically Endangered

● Vulnerable

Two taxa

□ Mammals

☆ Butterfly

1

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Location of faunal species of conservation
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Table 6-7 Summary of recorded faunal species and species of conservation significance

Faunal Group	No. of Recorded Species		Total No. of Probable Species
	All Species	CS Species	CS Species
Odonates	6	0	0
• Dragonflies	6	0	0
• Damselflies	0	0	0
Butterflies	29	2	8
Herpetofauna	10	0	2
• Amphibians	4	0	0
• Reptiles	6	0	2
Birds	37	1	12
Mammals	13	1	4
• Non-volant mammals	7	0	2
• Bats	6	1	2
Total	95	4	26

Table 6-8 List of faunal species of conservation significance recorded

Fauna Group	Scientific Name	Common Name	National Status	Global Status
Bird	<i>Zosterops simplex</i>	Swinhoe's white-eye	Vulnerable	Least Concern
Butterfly	<i>Jamides caeruleus caeruleus</i>	Sky blue	Critically Endangered	Not Listed
	<i>Troides helena cerberus</i>	Common birdwing	Vulnerable	Not Listed
Mammal	<i>Eonycteris spelaea</i>	Cave nectar bat	Vulnerable	Least Concern

6.4.2.2 Taxon Sampling Curve

For transect surveys, sample coverage was generated for the following target taxa: 1) Amphibians 2) Bats, 3) Butterflies, 4) Birds, 5) other Mammals (excluding bats), and 6) Reptiles. Taxon with less than 3 species, i.e., Odonates, were excluded from the analysis. Sample coverages for all taxon were above 75% except for the Reptiles (Table 6-9; Figure 6.4.20). Since the standard error is high and the 95% confidence interval is wide, the estimate for Reptiles would be poor and may not closely represent the population in the survey area. For camera trapping, sample coverage was generated for mammals only and was 97.8% (Table 6-9; Figure 6.4.21). It is worthy to note that the low Reptile diversity is consistent with past studies conducted within the Study Area (AECOM, 2022). More importantly, data from these past studies will also be considered whilst accounting for the assessment on all the taxon.

Table 6-9 Result summary of taxon sampling analysis

Fauna Group	Sample Coverage (%)	Observed Richness	Estimated Richness ($\pm$ S.E)	95% Confidence Interval
Transect Surveys				
Amphibian	86.7	4	5 $\pm$ 1.8	4.1 - 14.9
Bats	76.6	6	10 $\pm$ 5.8	6.4 - 39.2
Bird	89.2	31	39 $\pm$ 6.8	32.9 - 65
Butterfly	77.3	27	37 $\pm$ 7	29.8 - 61.6
Other mammals	90.5	3	3 $\pm$ 1.1	3 - 10

Fauna Group	Sample Coverage (%)	Observed Richness	Estimated Richness ($\pm$ S.E)	95% Confidence Interval
Reptile	40.7	5	11 $\pm$ 9.4	5.8 - 57.3
Camera trapping				
Mammals	97.8	7	7 $\pm$ 0.6	7 – 11.2

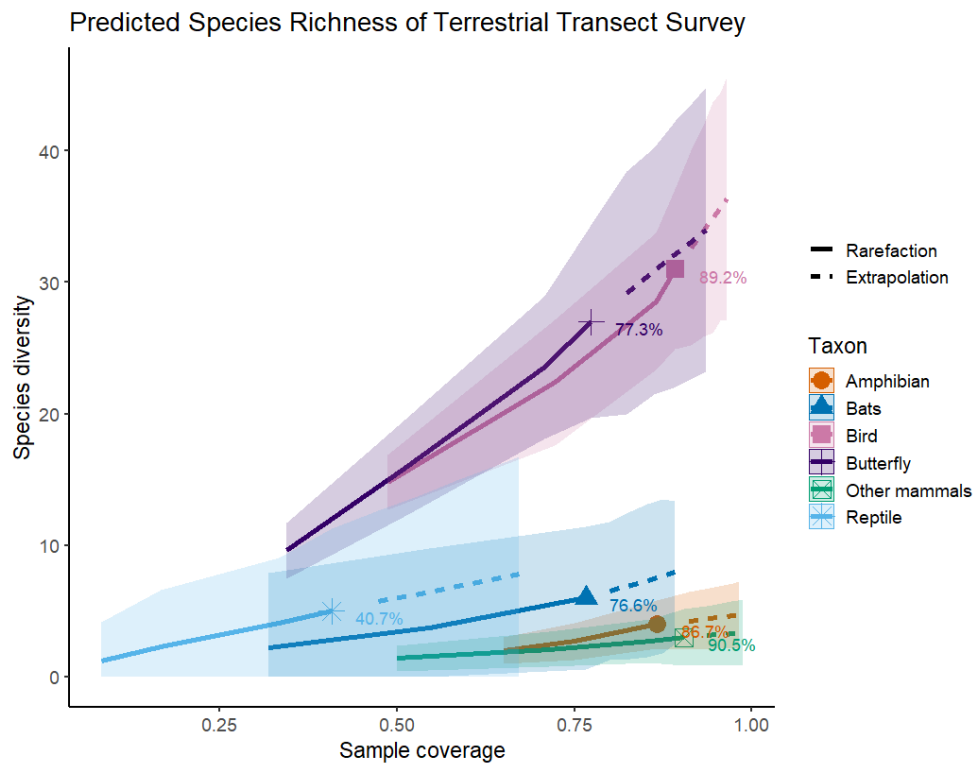


Figure 6.4.20 Taxon sampling curve for terrestrial sampling route

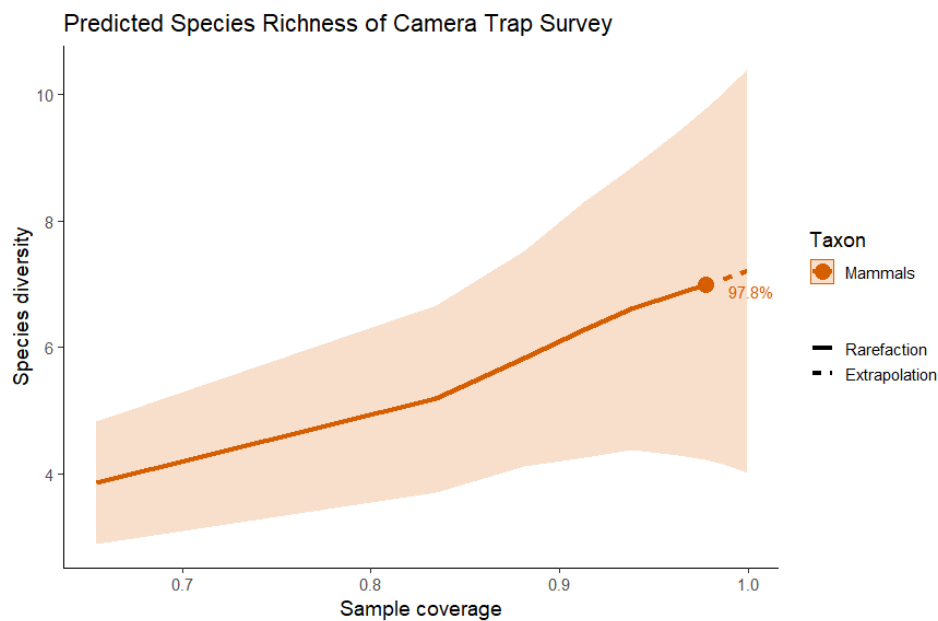


Figure 6.4.21 Taxon sampling curve for camera trap survey

6.4.2.3 Butterflies

In this study, a total of 29 species of butterflies were recorded (Figure 6.4.23; Appendix J), with two considered conservation significance—the nationally Critically Endangered sky blue (*Jamides caeruleus caeruleus*) and nationally Vulnerable common birdwing (*Troides helena cerberus*).

Sky blue (*Jamides caeruleus caeruleus*; Figure 6.4.22A) is a moderately rare species that inhabits shaded forests, and its host plant is yellow saraca (*Saraca cauliflora*) (Khew, 2015) [P-7]. The common birdwing is considered uncommon locally even though it can be found in both forests and urban parks (Khew, 2015) [P-7]. This species was widely distributed within the Study Area.

The common birdwing (*Troides helena cerberus*; Figure 6.4.22B) is a strong flier often associated with forested habitats. However, within Singapore, the extirpation of its native host plant, *Aristolochia jackii*, has prompted this species to rely solely on the non-native Dutchman's pipe (*Aristolochia acuminata*) as their larval host plant instead [P-7], and hence the species is more often encountered within the urban parks and gardens of Singapore including the Study Area, where the Dutchman's pipe is cultivated. The host plant *Aristolochia acuminata* is also utilised by another recorded species, the moderately common rose (*Pachliopta aristolochiae asteris*). Indeed, caterpillars of both species are sighted in the Study Area (Figure 6.4.22C).

Based on previous studies, the common birdwing and common rose were also observed at Marsiling Park which is opposite the Study Area, and these species are likely moving between both sites. Within Marsiling Park, the planted vegetation provides both species with additional food sources. The two sites are hence valuable for the common birdwing and common rose. Sky blue (*Jamides caeruleus caeruleus*) and its host plant were also recorded at Marsiling Park (AECOM, 2022). Since its host plant was not recorded in the Study Area, it is likely that the sighting here is a transient individual. Eight species of conservation significance were deemed probable.



Figure 6.4.22 Butterfly species of conservation significance recorded during field assessment. (A) Sky blue (*Jamides caeruleus caeruleus*); (B) Common birdwing (*Troides helena cerberus*); (C) Common birdwing (*Troides helena cerberus*) caterpillars on Dutchman's pipe (*Aristolochia acuminata*)



Legend

Study Area

Native dominated secondary forest

Abandoned-land forest

Scrubland

Urban vegetation

Others (Farm)

Others (Infrastructure)

Others (Construction)

—

Terrestrial sampling route

★

Critically Endangered

★

Vulnerable

N

1	JUL 2024	TYT	Final Report	SAG	JAG
Rev.	Date	By	Description	Chk'd	App'd

Qualified Person Endorsement :
NA

HDB Endorsement : NA

Consultant :
AECOM

Project Title :
**SPECIALIST CONSULTANCY SERVICES
FOR ENVIRONMENTAL IMPACT
ASSESSMENT (EIA) AT
WOODLANDS NEIGHBOURHOOD 1**

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Figure Title :

Location of butterfly species of conservation
significance in the Study Area

Figure No. :
6.4.23

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6.4.2.4 Odonates

In this study, a total of six odonate species were recorded (Appendix J), comprising of only dragonflies (Figure 6.4.24A–B). None of the odonate species recorded during the field assessment were of conservation significance. One of them, a duskhawker dragonfly, can only be identified to genus level as it is typically elusive, flying into thick undergrowth when disturbed. All six recorded species are locally widespread. The poor species richness can be attributed to the lack of waterbodies in the Study Area. No species of conservation significance were expected.

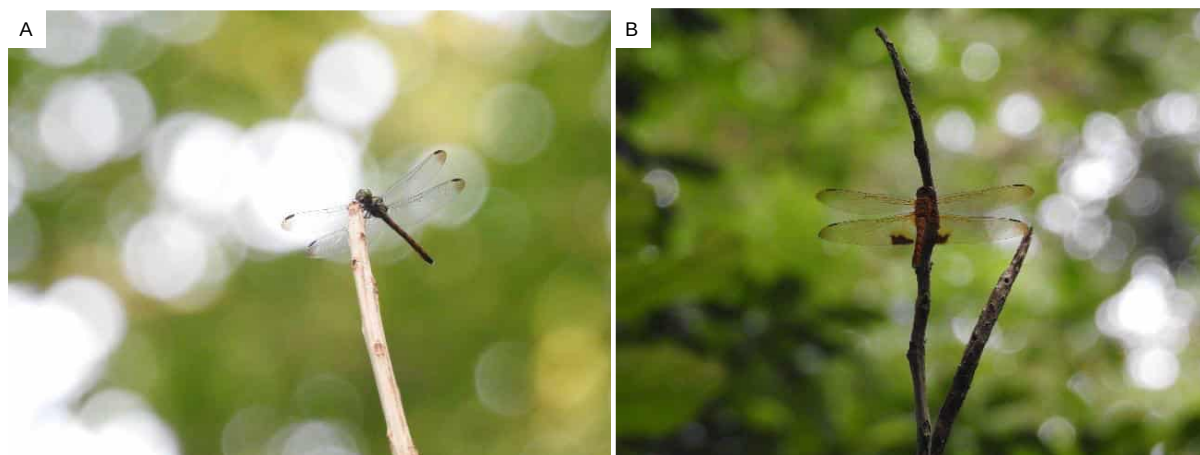


Figure 6.4.24 Scarlet grenadier (*Lathrecista asiatica*) and Water monarch (*Hydrobasileus croceus*) recorded within the Study Area

6.4.2.5 Amphibians

Due to the absence of waterbodies in the Study Area, only four species of amphibians were recorded (Appendix J), none of which is of conservation significance. The most abundant species is the greenhouse frog (*Eleutherodactylus planirostris*). It is a widespread, non-native species introduced locally via the horticulture trade (Figuerola et al., 2023) [P-37].

6.4.2.6 Reptiles

Six species of reptiles are recorded in the Study Area (Appendix J). None of them are of conservation significance. The most encountered reptiles were the non-native changeable lizard (*Calotes versicolor*) and painted bronzeback (*Dendrelaphis pictus*)—species which typically occurs in abandoned-land forest, the most extensive habitat in the Study Area. Two species of conservation significance were deemed probable.

6.4.2.7 Birds

37 species of birds were recorded in the Study Area, one of which was of conservation significance — the Swinhoe's white-eye (*Zosterops simplex*) (Figure 6.4.25; Appendix J). The national status of the Swinhoe's white-eye (*Zosterops simplex*) was recently raised to vulnerable (NParks, 2023) because the local population of the naturally occurring native *erwini* subspecies appears to be confined to Pulau Ubin (Wu et al., 2023) [P-39]. On the main island of Singapore, the white-eye population is mostly composed of the non-native *simplex* or hybrid *simplex-erwini* gene pools believed to be established from escaped individuals from the pet trade. Although the individuals recorded in this assessment are most likely of introduced origin and unlikely to be of true conservation significance, there is still a possibility that they are of the native gene pool established from natural range expansion. Hence, it is still conservatively regarded as a species of conservation significance in this study.

Notable sightings are the nationally near threatened red-legged crane (*Rallina fasciata*) and common hill myna (*Gracula religiosa*). One species (*Aerodramus* sp.) was only identifiable to genus level and thus not classified by its native status.

Of the recorded species, all are considered resident breeders except the Arctic warbler (*Phylloscopus borealis*) which is a winter visitor.

12 species of conservation significance were deemed probable.



Legend

Study Area

Native dominated secondary forest

Abandoned-land forest

Scrubland

Urban vegetation

Others (Farm)

Others (Infrastructure)

Others (Construction)

Terrestrial sampling route

Species of Conservation Significance N

Vulnerable

1

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Qualified Person Endorsement :
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AECOM

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**HOUSING &
DEVELOPMENT
BOARD**

Figure Title :
Location of bird species of conservation
significance in the Study Area

Figure No. :
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6.4.2.8 Mammals (Non-Volant)

A total of seven species of non-volant mammals, none of which are of conservation significance, were recorded via transect surveys, incidental sightings, and camera trapping (Appendix K). Scats of the Sumatran palm civet (*Paradoxurus musangus*; Figure 6.4.26B) was observed during transects surveys while sightings were recorded in the camera traps (Figure 6.4.26A), indicating that the Study Area contains food resources for the species.

Seven camera traps yielded 222 independent detections of seven non-volant mammal species over a total of 453 trap nights (Table 6-10). Most of the recorded species were small ground-dwelling mammals, with the common treeshrew (*Tupaia glis*) being the most commonly detected mammal (Table 6-11). This species along with Asian house rat (*Rattus tanezumi*), feral dog (*Canis lupus familiaris*), house shrew (*Suncus murinus*) and Malaysian wood rat (*Rattus tiomanicus*) were only recorded via camera trapping. Two species of conservation significance were deemed probable.

Table 6-10 Summary of trap-nights and number of mammal species at each camera tap

Station	No. of trap nights	No. of species
CT1	66	2
CT2	66	6
CT3	67	3
CT4	66	4
CT5	66	5
CT6	62	3
CT7	60	5

Table 6-11 Location of and number of independent detections of mammal species across all camera traps

Scientific Name	Common Name	Stations	No. of independent detections
<i>Callosciurus notatus</i>	Plantain squirrel	CT2, CT3, CT4, CT5, CT6	58
<i>Canis lupus familiaris</i>	Feral dog	CT2, CT3, CT5, CT7	10
<i>Paradoxurus musangus</i>	Sumatran palm civet	CT4, CT5	4
<i>Rattus tanezumi</i>	Asian house rat	CT2, CT3, CT4, CT5, CT6, CT7	22
<i>Rattus tiomanicus</i>	Malaysian wood rat	CT2, CT7	8
<i>Suncus murinus</i>	House shrew	CT2	1
<i>Tupaia glis</i>	Common treeshrew	CT1, CT2, CT4, CT5, CT6, CT7	119
		Total	222



Figure 6.4.26 Sumatran palm civet (*Paradoxurus musangus*) recorded during camera traps and transects (scat)

6.4.2.9 Mammals (Bats)

A total of six species of bats were detected via visual surveys and acoustic sampling (Appendix J). The nationally Vulnerable cave nectar bat (*Eonycteris spelaea*) and the frugivorous lesser short-nosed fruit bat (*Cynopterus brachyotis*) were detected visually while the remaining insectivorous bats were detected acoustically. They are the Asian whiskered myotis (*Myotis muricola*; Figure 6.4.27A), pouch tomb bat (*Saccolaimus saccolaimus*; Figure 6.4.27D), lesser Asian house bat (*Scotophilus kuhlii*; Figure 6.4.27C), black-bearded tomb bat (*Taphozous melanopogon*; Figure 6.4.27B).

Three species of conservation significance were deemed probable - Cave nectar bat (*Eonycteris spelaea*), Lesser bamboo bat (*Tylonycteris fulvida*) and Greater bamboo bat (*Tylonycteris malayana*).

The cave nectar bat is the largest insectivorous bat in South and Southeast Asia, and a key pollinator for many tree species such as the durian (*Durio zibethinus*) (Thavry et al., 2017) [P-38], which is present in the Study Area. This species is considered a forest-specialist, indicating the ability of the Study Area in supporting forest-specialists species despite the highly urbanised surroundings.

Additionally, the nationally Vulnerable Bamboo bat (*Tylonycteris* sp.) was recorded in the Study Area during a previous EIA study (AECOM, 2022). There are two species of bamboo bats found in Singapore: lesser bamboo bat (*Tylonycteris fulvida*) and greater bamboo bat (*Tylonycteris malayana*). The acoustic signatures of the two species overlap, making it difficult to distinguish the species without a live specimens. As both species are nationally Vulnerable, the bamboo bat was considered a species of conservation significance.

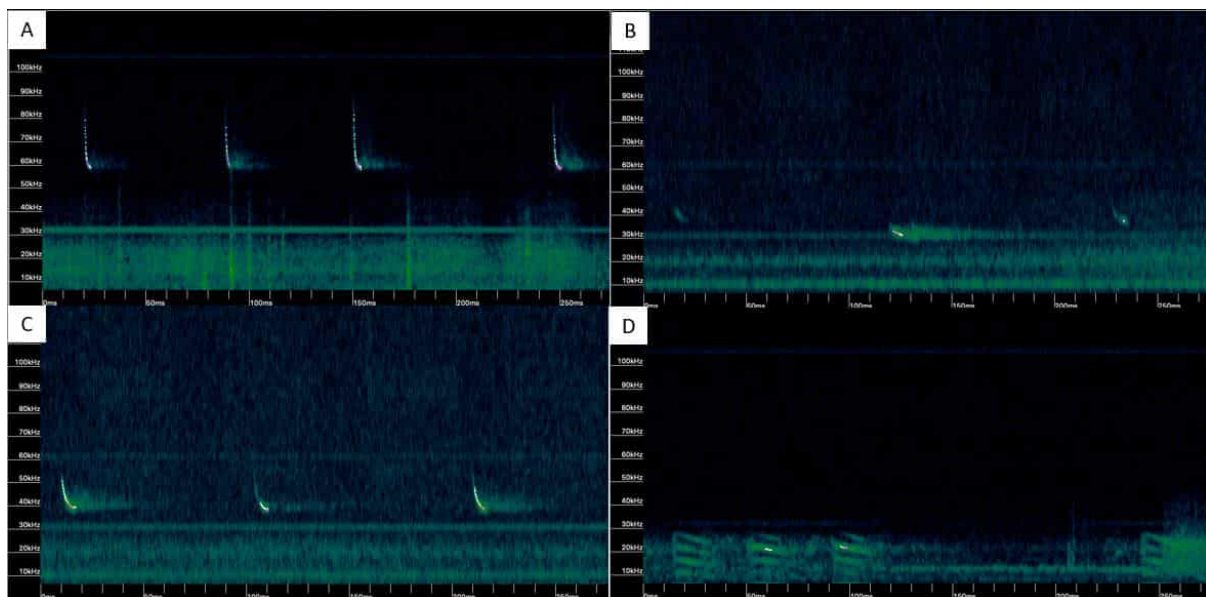


Figure 6.4.27 Bat recordings obtained during field assessment. (A) Asian whiskered myotis (*Myotis muricola*); (B) Black-bearded tomb bat (*Taphozous melanopogon*); (C) Lesser Asian house bat (*Scotophilus kuhlii*); (D) Pouch tomb bat (*Saccolaimus saccolaimus*)

6.4.3 Assessment of Ecological Value

Habitats and species within the Study Area were assessed for their ecological value. Habitats and species accorded with higher ecological value were regarded of greater importance for conservation relative to other habitats and species, respectively, within the Study Area. Those of high ecological value were assigned the Priority 1 sensitivity level, while those of moderate or low ecological value were assigned the Priority 2 or 3 sensitivity levels, respectively. The assessment was carried out using biodiversity baseline findings.

6.4.3.1 Habitats

The ecological value of four terrestrial habitats within the biodiversity Study Area were assessed.

One terrestrial habitat—native-dominated secondary forest—was accorded high ecological value (Priority 1). One terrestrial habitat—abandoned-land forest—was accorded medium ecological value (Priority 2) while the remaining two terrestrial habitats (i.e., scrubland and urban vegetation) were assessed to be of low ecological value (Priority 3). The assessment of ecological value is detailed in the respective paragraphs below and Table 6-12.

Table 6-12 National assessment of habitat ecological value in the biodiversity Study Area

Criterion	Terrestrial habitat			
	Native-dominated Secondary Forest	Abandoned-land Forest	Scrubland	Urban Vegetation
Flora and fauna species richness	3	2	1	1
Irreplaceability	2	1	1	1
National rarity of habitat	3	2	2	1
Unique flora and fauna species	1	1	0	1
Total score	9	6	4	4
Ecological value	High (Priority 1)	Medium (Priority 2)	Low (Priority 3)	Low (Priority 3)

I. Native-dominated Secondary Forest (High Ecological Value; Priority 1)

Native-dominated secondary forests usually have high species richness (Score 3), allowing it to support unique flora and fauna species in the Study Area (Score 1). This is evident from the baseline finding where dominant tree species were made up with tembusu (*Cyrtophyllum fragrans*) and *Syzygium grande*. Common native species were also frequently encountered within the understory of this habitat type. Majority of the native plants of conservation significance also concentrates within this habitat.

Although possible, it is challenging to recreate and replace this habitat type given the complexities of the forest structure and composition. Moreover, time is also needed to allow for natural succession to occur, making it difficult to replace (Score 2 in irreplaceability). This habitat type is also rare in Singapore (Score 3), owing to urbanisation. With two assessment criteria accorded to be Score 3, one Score 2 and another one as Score 1, the overall score for native-dominated secondary forest is nine. Therefore, this habitat type is of high ecological value compared to other terrestrial habitats in Singapore.

II. Abandoned-land Forest (Medium Ecological Value; Priority 2)

Abandoned-land forests generally have moderate species richness (Score 2) with fewer unique flora and fauna species (Score 1). It is possible to recreate and replace this habitat by means of human intervention, natural or accelerated succession, thus assessed as a low score in irreplaceability (Score 1). However, because of rapid land developments, abandoned-land forests are uncommon in Singapore (Score 2). The total score for abandoned-land forest is six, after assessment of two medium (Score 2) and two low (Score 2). Therefore, abandoned-land forests are of medium ecological value compared to other terrestrial habitats in Singapore.

In the baseline findings, this habitat type is characterised from past cultivation of fruit trees and crops, or ornamental plants from abandoned villages, orchards and/or plantations. Cultivated species such as rubber (*Hevea*

brasiliensis), rambutan (*Nephelium lappaceum*), African tulip trees (*Spathodea campanulata*) and durian (*Durio zibethinus*) can be found through the area. Despite being dominated by exotic species, several plant species of conservation significance were found scattered across the biodiversity Study Area.

III. Scrubland (Low Ecological Value; Priority 3)

Scrublands usually have low flora and fauna species richness (Score 1) and rarely supports any unique flora and fauna species (Score 0). In the baseline findings, scrubland occupied the perimeter of the forest edge. The floristic composition are mainly dominated by spontaneous vegetation of shrubs, climbers, and/or ferns. There are no plant species of conservation significance recorded in this habitat type.

Scrublands are easy to recreate or replace as this habitat can rapidly establish and regenerate extensively with minimal human intervention (Score 1). Like other terrestrial habitats in Singapore, in the face of urbanisation, this habitat type is increasingly uncommon (Score 2). The overall score for scrubland is four after one assessment criterion accorded as medium (Score 2) and two as low (Score 1), which translate to low ecological value.

IV. Urban Vegetation (Low Ecological Value; Priority 3)

Urban vegetations has low species richness (Score 1) but can surprisingly, hosts few unique flora and fauna species (Score 1). In the baseline findings, urban vegetation is characterised by managed turf made up of cow grass (*Axonopus compressus*) and streetscape trees, with no plant species of conservation significance observed.

This habitat type is common in Singapore (Score 1) and can be easily reconstructed via human intervention, which renders it a low score for irreplaceability (Score 1). With all four assessment criteria as Score 1, the overall score for urban vegetation is four. Therefore, urban vegetation is of low ecological value compared to other terrestrial habitats in Singapore.

6.4.3.2 Flora

The ecological value of 195 plant species in the biodiversity Study Area was assessed. The list of species is summarised in Appendix D.

Of the 195 species assessed for their ecological value, 21 are of high value, 71 of medium value and 102 of low value. A total of 12 species had their ecological value raised. Four species were raised from low to high ecological value, two being bamboo species—namely *Bambusa vulgaris* and *Thyrsostachys siamensis*—and *Aristolochia acuminata* and *Ficus benjamina*. Eight species were raised from medium to high ecological value.

Although *B. vulgaris* and *T. siamensis* are both of exotic origin, bamboos are known to be a roost for the nationally Threatened bamboo bats (*Tylonycteris* sp.). Conserving such bamboo clusters are essential for ensuring the survival of bamboo bats, hence it was assessed to be of high ecological value.

The other species raised from low to high ecological value is *A. acuminata*. This plant species is the host plant for nationally Vulnerable butterfly, common birdwing (*Troides helena cerberus*). Butterflies are host specific; this means the host plant plays an important role in their life cycle. Presence of this climber would allow common birdwing caterpillar to complete their life cycle's stages. This helps to ensure continuity of the common birdwing population that was recorded in the Study Area (see Section 6.4.2.3). Hence, ecological value has been raised to high.

Among the eight species that were raised from medium to high ecological value, seven *Ficus* species, together with *F. benjamina* are considered keystone species. *Ficus* species, in particular monoecious figs (i.e., species that bear both male and female reproductive organs within the same individual) produce fruits all year round. Thus, they are an important food source for many frugivores, especially during seasons where there are no other fruits available (Lok et al. 2013). Apart from monoecious figs, dioecious figs (i.e., species that only produce either the male or female gametes in an individual) are also an important food source for avian insectivores that feed on fig wasps.

Lastly, *Camposperma auriculatum* was raised from medium to high ecological value despite being listed as nationally Least Concern due to its restricted distribution. This species occurs more frequently in later-stage successional secondary forests and/or forest reserves in the CCNR, BTNR and NSSF. This study site may thus serve as an additional refuge outside of forest reserves.

6.4.3.3 Fauna

The ecological value of 117 faunal species in the Study Area was assessed. All 26 faunal species of conservation significance (recorded and probable) were accorded a Priority 1 sensitivity level and deemed to be of high ecological value.

6.4.4 Area of High Ecological Value (AHEV)

The baseline findings together with the assessment of habitat and plant species of ecological value were used to identify Area of High Ecological Value (AHEV) (Figure 6.4.29). Reasons for identified AHEV:

1. High priority habitat type consisting of the native-dominated secondary forest (Section 6.4.3.1)
2. Majority of trees recorded within the AHEV (> 50 trees) with more than 1m girth are *Cyrtophyllum fragrans* (tembusu). Tembusu trees are slow-growing trees, making these trees within the Study Area estimated to be at least 50 years old and for those with girth size of 2m estimated to be over 100 years old. It is rare to find such an area with such high density of old growth tembusu trees in Singapore.
3. AHEV also consist of some particularly important conservation significant species:
 - a. *Aporosa falcifera* (nationally Critically Endangered): Restricted in range and usually only found in Bukit Timah Nature Reserve, Central Catchment Nature Reserve and Nee Soon Swap Forest. Only one specimen of this species was recorded within the biodiversity Study Area.
 - b. *Dioscorea hispida* (nationally Critically Endangered): Restricted in range and usually only found in Bukit Timah Nature Reserve and restricted military training grounds, where the last collected specimen was 50 years ago. Only three locations where species were recorded within the biodiversity Study Area.

AHEV is of the highest priority for conservation and should be left untouched as far as possible. A 30-m buffer of retained forested area can be integrated as part of the Project development plans where light structures such as footpaths/boardwalks may be constructed for public use. Large/heavy structures should be avoided. It is important to note that while certain areas must be prioritised over others, those accorded with medium of low conservation value are also important and contribute to the ecological integrity of the landscape.



Legend

Study Area

Native dominated secondary forest

Abandoned-land forest

Scrubland

Urban vegetation

Others (Farm)

Others (Infrastructure)

Others (Construction)

Area of high conservation with 30-m buffer

N

							Qualified Person Endorsement : NA
							HDB Endorsement : NA
1	JUL 2024	TYT	Interim Report	SAG	JAG		
Rev.	Date	By	Description	Chk'd	App'd		

Qualified Person Endorsement :
NA

HDB Endorsement : NA

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Project Title :
**SPECIALIST CONSULTANCY SERVICES
FOR ENVIRONMENTAL IMPACT
ASSESSMENT (EIA) AT
WOODLANDS NEIGHBOURHOOD 1**

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Figure Title :

Area of high conservation with 30-m buffer

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6.4.28

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Legend

Study Area

Area of High Ecological Value (AHEV)

Keystone species

Species of conservation significance

Critically Endangered

Endangered

Vulnerable

Cyrtophyllum fragrans trees (girth/m)

≥ 1

≥ 2

≥ 3

Vegetation map

Native dominated secondary forest

Abandoned-land forest

Scrubland

Urban vegetation

Others (Farm)

Others (Infrastructure)

Others (Construction)

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							HDB Endorsement : NA	Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT WOODLANDS N1	Figure Title : Area of High Ecological Value				
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6.5 Water Resources

The following sections describe the baseline conditions of the water resources within the Study Area.

6.5.1 Baseline Monitoring Personnel

The site surveys and assessment were conducted by the following AECOM personnel:

- Dr. Liang Liang (Water Resources Technical Reviewer);
- Mr. Grujica Sarenac (Water Resources Lead Consultant);
- Ms. Yi Leng Tan (Water Resources Consultant – Surface Water)
- Mr. William Ling (Water Resources Specialist – Groundwater);
- Ms. Vanessa Goh (Water Resources Specialist – Groundwater);
- Mr. Boey Zhi Ming (Water Resources Specialist – Groundwater);
- Marchwood Laboratory Services Pte Ltd;
- Specialist Testing and Technical Services (STATS) Asia Pacific Pte Ltd (Drilling Specialists).

6.5.2 Hydrological Baseline Conditions

The main objective of this baseline study is to characterise the existing surface water hydrological conditions and gain understanding of how the surface water will likely flow within the Project site. This baseline information will subsequently be used to assess the potential impacts on identified sensitive receptors due to the likely changes in baseline conditions due to proposed developments.

As detailed in Section 5.2.3 of this Report, the hydrological baseline information has been collected from both primary and secondary sources. Following sub-sections detail the findings.

6.5.2.1 Regional Catchment Analysis

Due to the lack of extensive natural aquifers or lakes from which the water could be used for beneficial purposes, Singapore has developed a robust water supply system aiming to diversify its water sources. As part of these efforts, Singapore aims to maximise stormwater harvesting practices. Namely, stormwater is collected through a network of rivers, canals and drains and subsequently channelled into one of seventeen (17) reservoirs. From there, water is sent to water treatment plants for multiple-stage treatment before it is distributed to final users. As such, stormwater represents one of Singapore's main sources of drinking and industrial water.

Based on the PUB's catchment map (refer to Figure 6.5.1), and data provided by PUB during the scoping stage of this EIA, the Project site is partly located within the catchment of Upper Seletar Reservoir. More specifically, the stormwater from the southern portions of the site gets channelled via drains and culverts into the Pond at Marsiling Park. Part of the water from the Pond flows northwards, towards the Sungei Mandai Kechil also via bund overflow and lined drains. In addition, as per data provided by PUB, part of the water from the Pond eventually reaches the Upper Seletar Reservoir. From there, it is assumed that the water will be used for some of the beneficial purposes such as drinking or industrial purposes. More detailed, site-specific catchment analysis is provided in the Section 6.5.2.2 below.

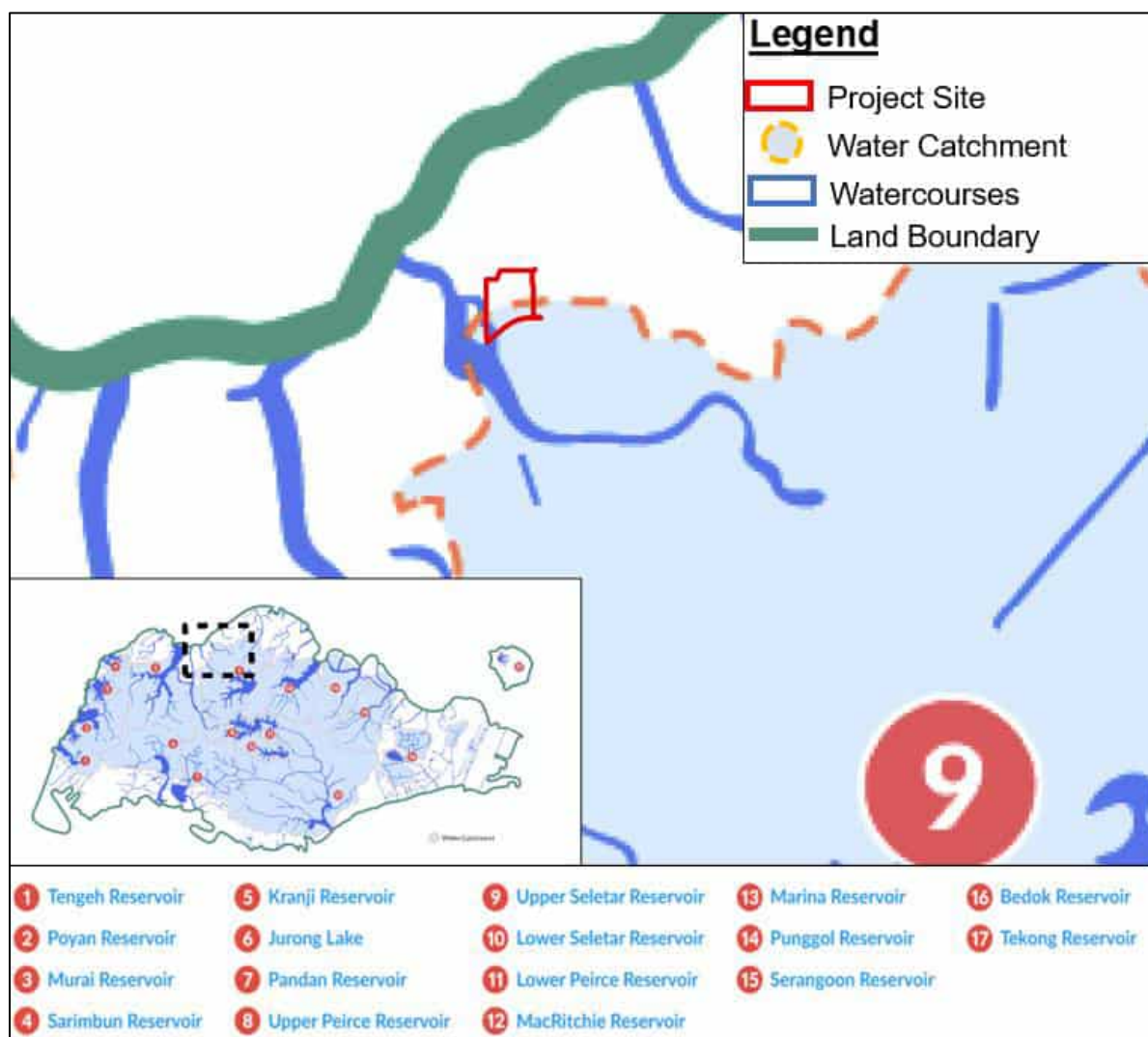


Figure 6.5.1 Singapore water catchment map and Project site (sourced from PUB, 2020 [W-15])

6.5.2.2 Site Catchment Analysis

During the site reconnaissance, no watercourses (natural or man-made) were observed within the forested area of the Project site. Only one small, concretised drain within Marsiling CC can be observed at the far north of the site, which showed ephemeral flow conditions. However, based on the observations during the site visits as well as data provided by PUB, the site is surrounded by opened/ partially opened drains in the north (i.e. along Admiralty Road), east (i.e. between the site and Woodlands Secondary School) and west (i.e. along Woodlands Centre Road). Their locations are shown in Figure 6.5.3 The drain north of the site (i.e. along Admiralty Road) is a concretised below ground drain while the drain west of the site (i.e. along Woodlands Secondary School) is above ground concretised drain flow. Both of these drains are ephemeral. The drain west of the Project site (i.e. Drain D1) starts as a concretised above ground drain which channels the water southwards. It should also be noted that the turf area west of the Project site is on a higher ground compared to the adjacent Woodlands Centre Road with steep slope. Therefore, this slope has multiple drainage pipes which discharge into D1. Southwest of the site, D1 connects with the smaller drains originating from turf area and becomes an underground drain. At the crossroad of Woodlands Centre Road and Marsiling Road, small above ground drain southwest of the site discharges into D1 and collected water is channelled via under road culvert into Marsiling Park Pond. From there, in the north, the water flows over the bund and drain firstly into concrete canal and from there it will eventually reach Sungei Mandai Kechil. It should also be noted that the part of the water from the pond will be transferred into Upper Seletar reservoir.

More detailed catchment delineation and estimation of probable overland flow directions were carried out based on the surveyed topographic data and observations (for detailed methodology for this analysis refer to Section 5.2.3 of this Report). As shown in Figure 6.3.2, the elevation map of the Project site shows that the site topography

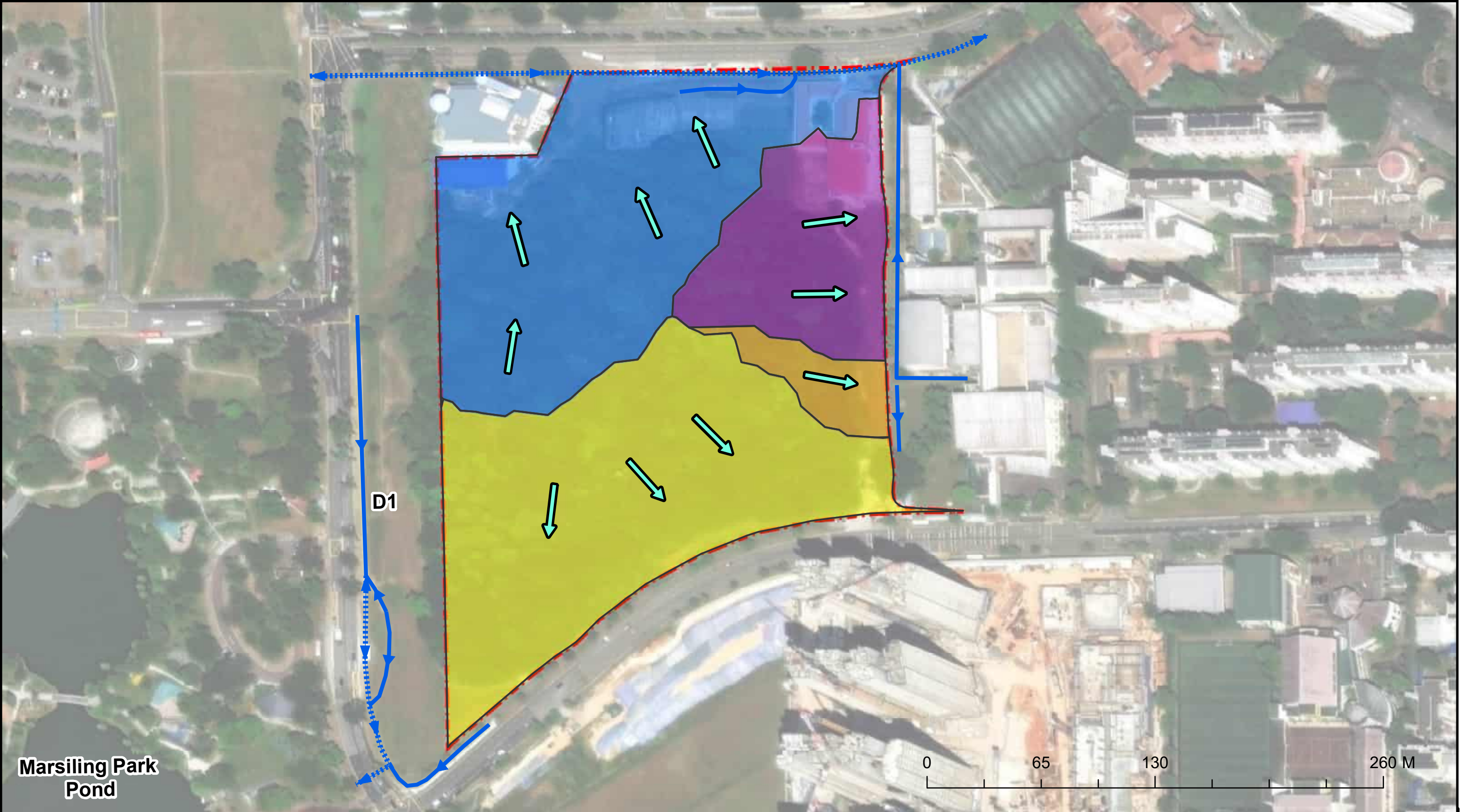
is dominated by the hill located at the western portion of the site. From there the elevations gradually decrease towards the north, east and south. Towards the west significant elevation drop can be observed from the site towards the roadside drain along Woodlands Centre Road. In addition, slope map also shows the likely dominant pathways of surface water runoff, represented as localised linear soil depressions at southern and northern edges of the site.

As shown in Figure 6.5.3, four sub-catchments can be observed within the Project site – northern, northeastern, eastern and southern (denoted as 1, 2, 3 and 4, respectively in Figure 6.5.3). The northern sub-catchment area comprises northern parts of the woodlands as well as urbanised parts of the site such as Marsiling CC and its facilities. The surface water from this sub-catchment gets drained into the drain along Admiralty Road. The northeastern and eastern sub-catchments comprise eastern parts of the woodland within the site that drains the water into the concrete drain east of the site. Subsequently, this water gets discharged into the drain along Admiralty Road. The southern sub-catchment is the biggest catchment which comprises most of the vegetated parts of the site that gets channelled via Drain D1 and culvert into Marsiling Park Pond.

Drain D1 has ephemeral flow, with the water flow during wet weather conditions (i.e. during wet weather sampling) of approximately 0.17 m/s. The fast discharge of water from the drain was observed during the rain event. The measured water depth and width were approximately 10 cm and 12 cm, respectively. Figure below shows photographs of D1, taken during dry and wet weather conditions.



Figure 6.5.2 Photographs of drain D1 during (A) dry weather; (B) wet weather conditions; and (C) discharge point during wet weather conditions (underground)



Legend

Project Site

1

2

3

4

Subcatchments

Underground

Above Ground

Inferred Surface Water Flow

Watercourse

N

1	JUL 2024	SAG	Final Report	LL	JAG	
Rev.	Date	By	Description	Chk'd	App'd	

Qualified Person Endorsement :
NA

HDB Endorsement : NA

AECOM

Project Title :
**SPECIALIST CONSULTANCY SERVICES
FOR ENVIRONMENTAL IMPACT AS-
SESSMENT (EIA) AT
WOODLANDS N1**

Designed
KRT

Checked
LL

Approved
JAG

Date
JUL 2024

Figure No. :
6.5.3

Rev.
1

Sheet
1 of 1

CAD File Name : NA

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Client:

HOUSING &
DEVELOPMENT
BOARD

Figure Title :
Catchment map of the Project site

6.5.3 Surface Water Quality Baseline Conditions

The surface water sample was collected at one (1) water quality station, located at the junction of Drain D1 and southern roadside drain, as shown in Figure 6.5.4. As detailed in Section 5.2.3, this location was selected as it receives water from the largest sub-catchment of the Project site which gets discharged into the Pond at Marsiling Park. Hence, it is regarded as the most representative location for collection of samples, taking into consideration the overall aim of this EIA. The baseline conditions of the surface water quality were established by comparing the water quality parameters detections to national/ international water quality standards/ criteria.

As the drain D1 is ephemeral, surface water sample was collected only during wet weather condition (i.e. on 16th November 2023) and the sample was tested both in-situ and ex-situ for the parameters specified in Section 5.2.3. The baseline results are summarised in Table 6-13.

Table 6-13 Summary of surface water quality baseline results

	Sampling Location –	NEA Trade Discharge Limits	Effluent Note 1	Other Relevant Water Quality Criteria for Aquatic Life Note 2
WQ1				
Dissolved Oxygen (DO) (mg/L)	6.05	N.A.		> 4.00 mg/L
pH	6.7	6 – 9		6 – 9
Conductivity (µS/cm)	200	N.A.		N.A.
Temperature (°C)	29.1	45		N.A.
Salinity (psu)	0.09	N.A.		N.A.
Turbidity (NTU)	16	N.A.		200 NTU
Total Nitrogen as TN (mg/L)	1.93	N.A.		8.00 mg/L
Nitrate as NO ₃ -N (mg/L)	1.88	20 mg/L as NO ₃ (equivalent to 4.52 NO ₃ -N)		7 mg/L (equivalent to 30.99 as NO ₃)
Ammonia as NH ₄ -N (mg/L)	N.D.	N.A.		<1 mg/L
Total Phosphorus as TP (mg/L)	0.043	N.A.		0.1 mg/L
Phosphate as PO ₄ -P (mg/L)	0.030	2 mg/L as PO ₄ (equivalent to 0.652 PO ₄ -P)		<0.033 mg/L (equivalent to <0.1 as PO ₄)
Total Suspended Solids (TSS) (mg/L)	12.2	30 mg/L		150 mg/L
Total Dissolved Solids (TDS) (mg/L)	76	1,000 mg/L		1,000 mg/L
Total Alkalinity (mg/L)	38	N.A.		20 mg/L
Total Organic Carbon (TOC) (mg/L)	3.63	N.A.		25 mg/L
Manganese as Mn (mg/L)	0.0087	0.5 mg/L		0.1 mg/L
Arsenic as As (mg/L)	0.0008	0.01 mg/L		Acute: 0.34 mg/L

Water Parameter	Quality	Sampling Location –	NEA Discharge	Trade Limits	Effluent Note 1	Other Relevant Criteria for Aquatic Life	Water Quality Note 2
WQ1							
						Chronic: 0.15 mg/L	
Chloride as Cl (mg/L)		N.D.		250 mg/L		2,000 mg/L	
Sulphate as SO ₄ ²⁻ (mg/L)		5.88		200 mg/L		250 mg/L	
Aluminium as Al (mg/L)		0.42		N.A.		0.06 mg/L	
Iron as Fe (mg/L)		0.19		1 mg/L		1 mg/L	
Enterococcus (cfu/100mL)		700		N.A.		N.A.	
Oil & Grease (Total) (mg/L)		0.22		1 mg/L		7 mg/L	
Barium as Ba (mg/L)		0.025		1 mg/L		Acute: 1.1 mg/L Chronic: 0.62 mg/L	
Tin as Sn (mg/L)		N.D.		5 mg/L		0.004 mg/L	
Beryllium as Be (mg/L)		N.D.		0.5 mg/L		Acute: 0.13 mg/L Chronic: 0.0053 mg/L	
Boron as B (mg/L)		0.004		0.5 mg/L		0.94 mg/L	
Cadmium as Cd (mg/L)		N.D.		0.003 mg/L		0.1 mg/L	
Chromium as Cr (III&VI) (mg/L)		0.00056		0.05 mg/L		Acute: 0.016 mg/L Chronic: 0.011 mg/L	Note 4
Copper as Cu (mg/L)		0.0056		0.1 mg/L		Acute: 0.018 mg/L Chronic: 0.012 mg/L	
Lead as Pb (mg/L)		0.00084		0.1 mg/L		Acute: 0.065 mg/L Chronic: 0.0025 mg/L	
Mercury as Hg (mg/L)		N.D.		0.001 mg/L		Acute: 0.00014 mg/L Chronic: 0.052 mg/L	
Nickel as Ni (mg/L)		N.D.		0.1 mg/L		Acute: 0.47 mg/L Chronic: 0.052 mg/L	
Selenium as Se (mg/L)		N.D.		0.01 mg/L		0.25 mg/L	
Notes: 1. NEA Trade Effluent Discharge Limits are for controlled watercourses 2. The sources of water quality criteria for aquatic life include ASEAN Marine Water Quality Criteria [R-38], United States Environmental Protection Agency [R-27], Australian & New Zealand [R-28], Philippines [R-32], and Malaysia [R-33] 3. Blue values mean data exceeding Aquatic Life criteria (Freshwater) 4. Values were adopted for Cr (VI) as they are more stringent. In addition, Cr VI is more toxic than Cr III							

Generally, the existing baseline surface water quality meet the adopted criteria, as detailed in Table 6-13, with the exception of the aluminium which exceeded the adopted aquatic life criteria. The detailed explanation for each of the water quality parameters is provided below. All the results were compared to NEA guidelines (where applicable) and to adopted aquatic life criteria for freshwater.

As shown in Figure 6.5.4, water temperature at water quality station during wet weather condition was 29.1 °C, which is below the NEA's limit of 45 °C. The pH was measured to be 6.7 which is within both criteria (i.e. 6 – 9), and indicates slightly acidic conditions.

The conductivity of water is strongly dependent on the number of ions available to participate in the conduction process. This parameter is positively correlated to salinity which measures the amount of salts dissolved in water. The salinity and conductivity of the watercourse were low (i.e. 0.09 PSU and 200 µS/cm), indicating freshwater conditions, (seawater generally has salinity of around 35 PSU [NOAA.n.d.] and conductivity of around 3.31×10^6 µS/cm [Blakely, 2014]), while the TDS was 121 mg/L.

Measured Dissolved Oxygen (DO) was 6.05 which follows the adopted aquatic life criteria (i.e. >4 mg/L).

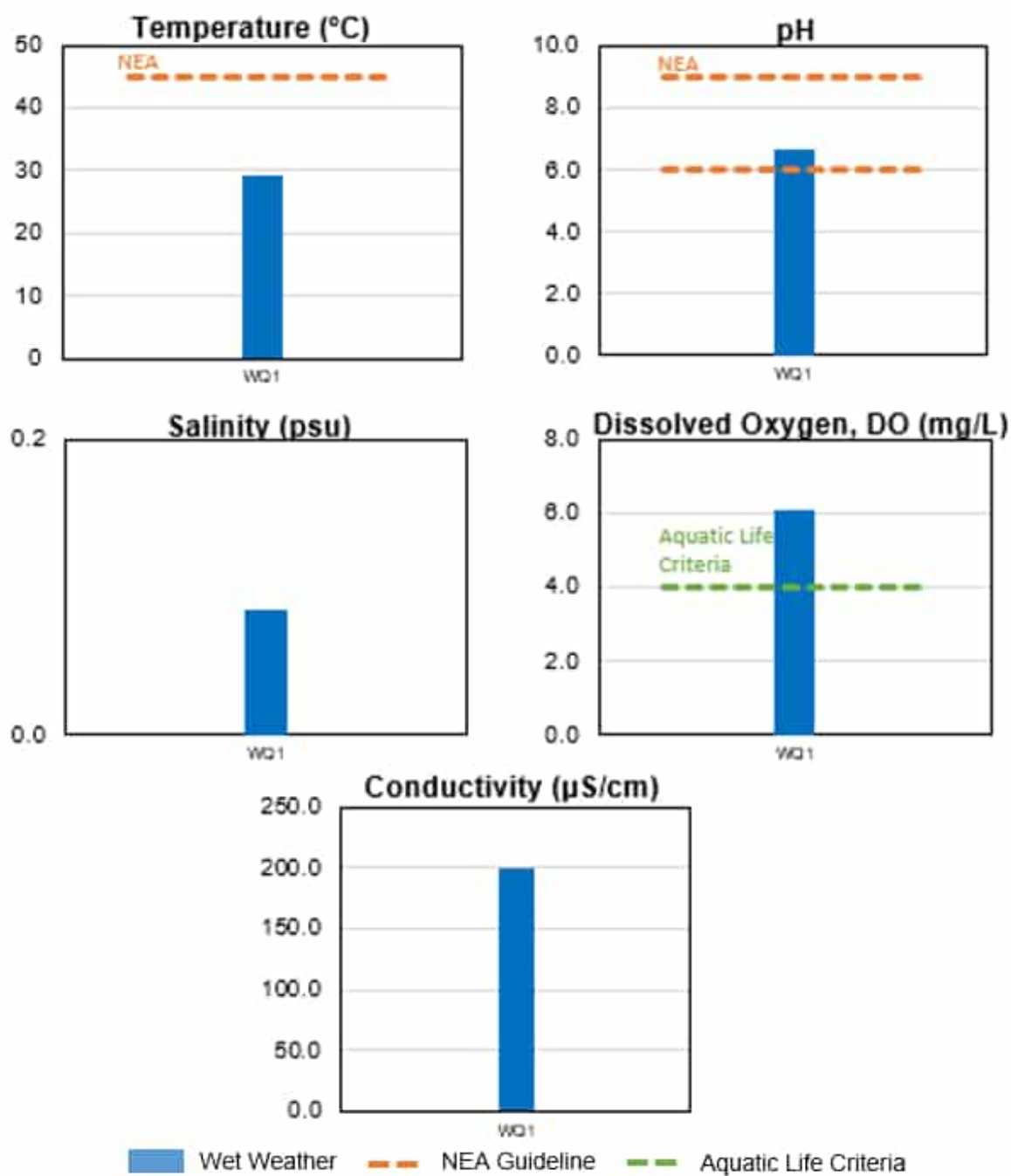


Figure 6.5.4 Monitoring results of in-situ measured parameters for wet weather conditions

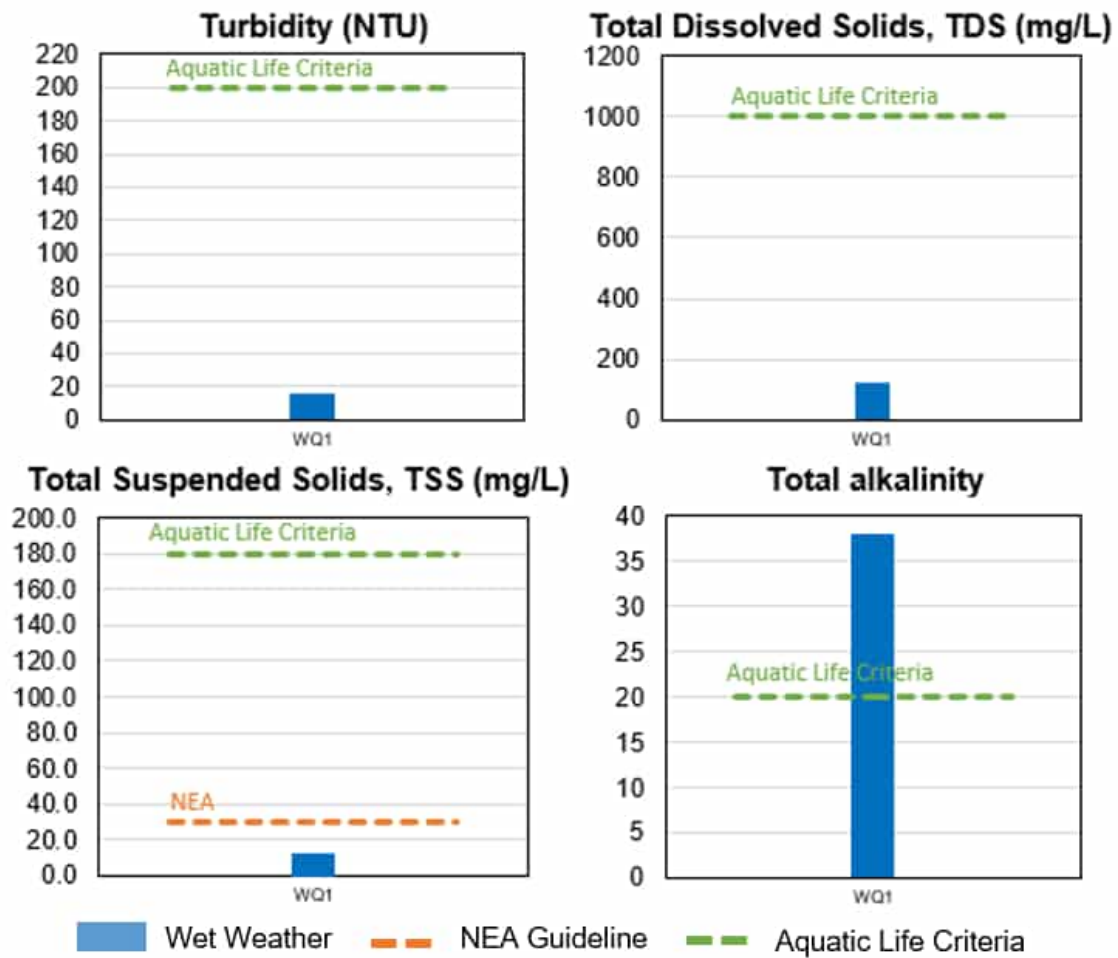


Figure 6.5.5 Monitoring results of ex-situ measured parameters (turbidity, TDS, TSS, total alkalinity) for wet weather conditions

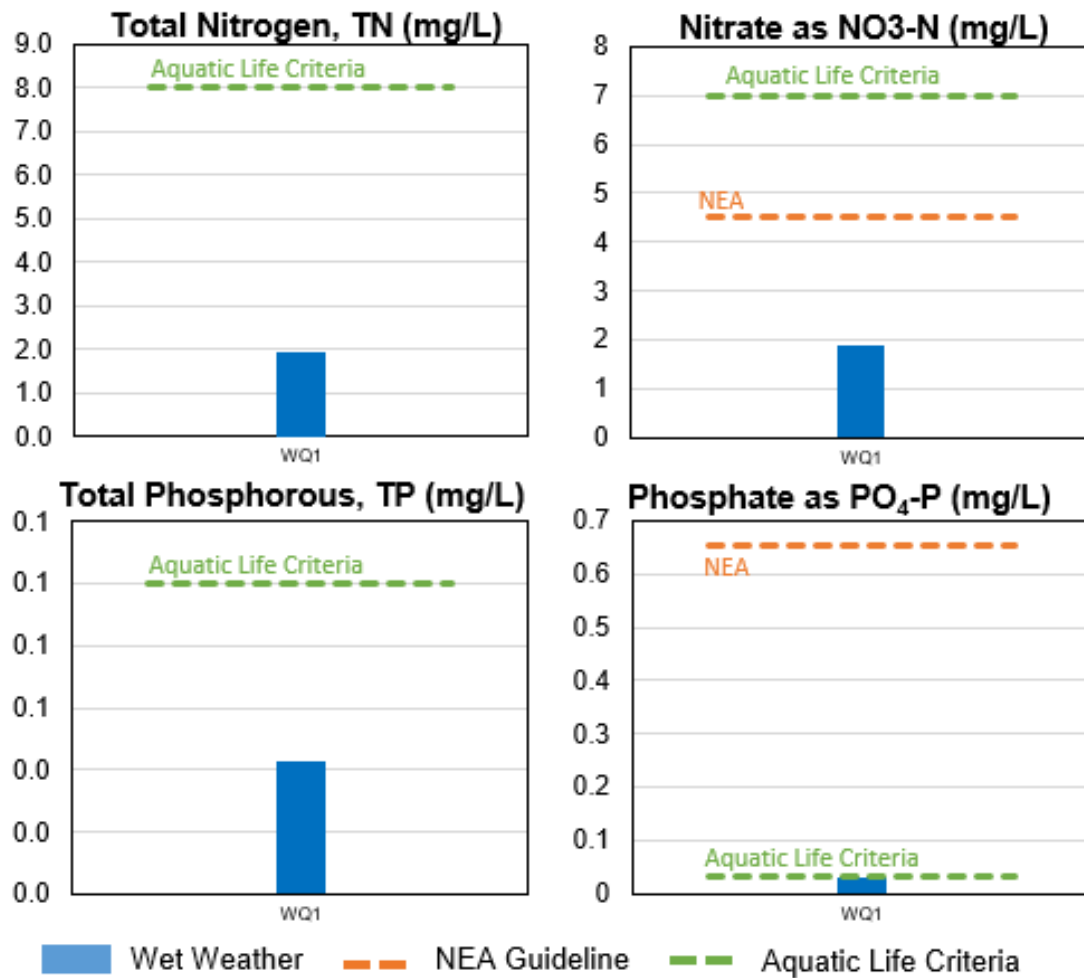


Figure 6.5.6 Monitoring results of ex-situ measured parameters (TN, Nitrate as NO₃-N, TP and Phosphate as PO₄-P) for wet weather conditions

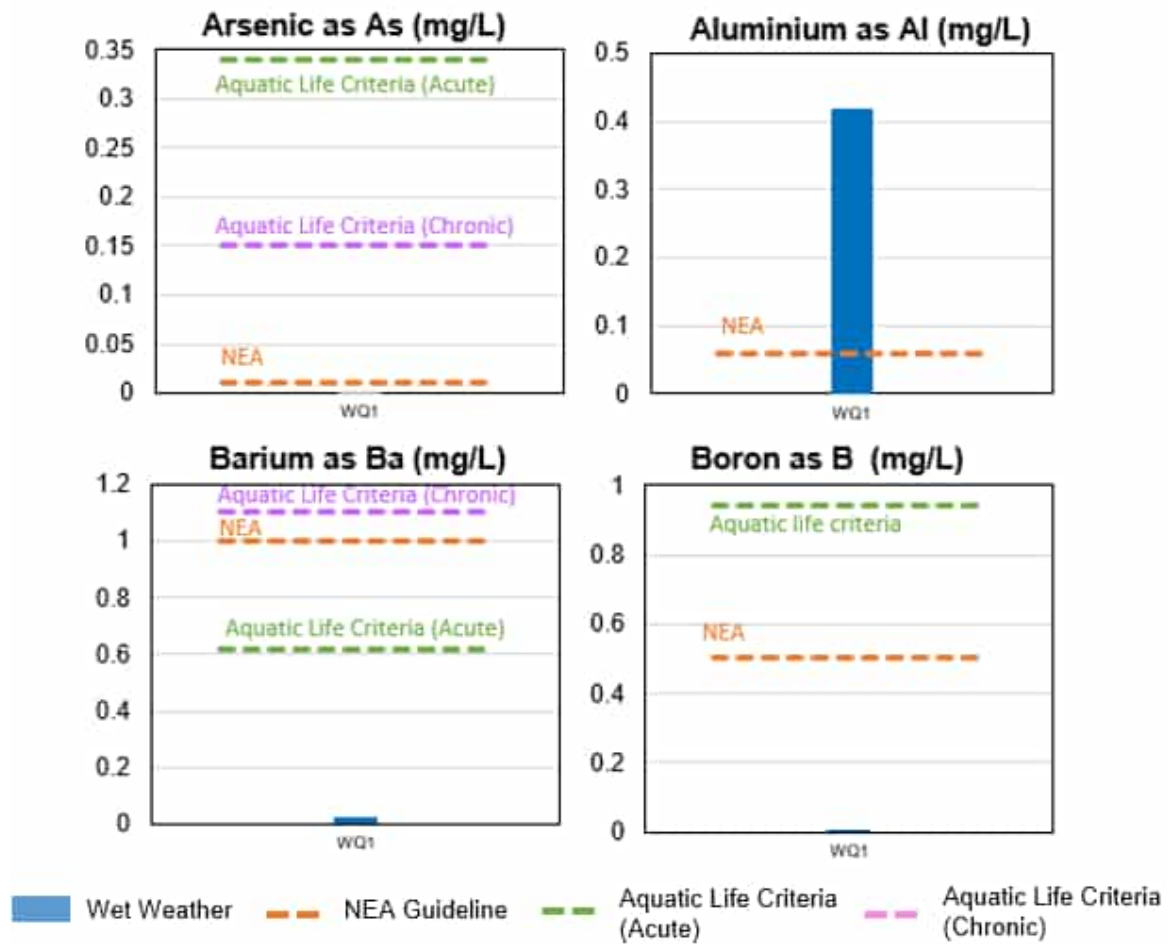


Figure 6.5.7 Monitoring results of ex-situ measured parameters (arsenic, aluminium, barium, boron) for wet weather conditions

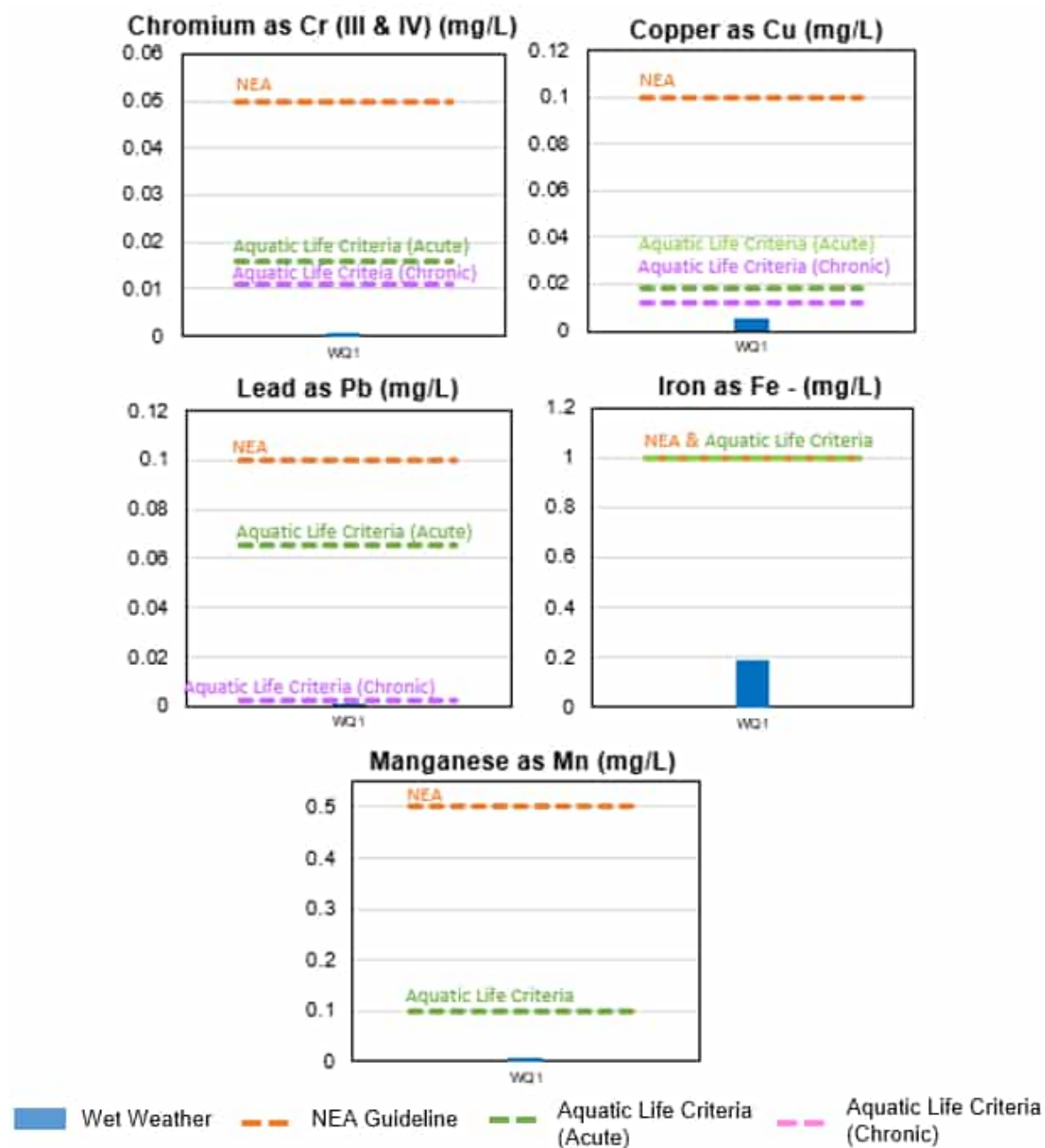


Figure 6.5.8 Monitoring results of ex-situ measured parameters (chromium, copper, lead, iron, manganese) for wet weather conditions

As shown in Figure 6.5.5, the measured turbidity was 16 NTU which is well-below selected criteria (i.e. 200 NTU), indicating clear water conditions, while the reported concentration of TSS was 12.2 mg/L, which is below NEA Trade Effluent Limit (30 mg/L) and freshwater criteria (150 mg/L).

Parameters analysed to indicate the level of nutrients in water (i.e. TP, TN, Orthophosphates, Nitrates as $\text{NO}_3\text{-N}$, shown in Figure 6.5.6) were all below the adopted NEA (where applicable) criteria and adopted aquatic life criteria. In addition, Ammonia was not detected in the collected water sample.

Other detections in collected water sample, include TOC, total alkalinity, manganese, aluminium, arsenic, chloride, sulphate, aluminium, iron, oil & grease, barium, boron, chromium, copper and lead (refer to the Figure 6.5.7 and Figure 6.5.8). All of the detections were below the selected criteria, with the exception of aluminium. The reported concentration of aluminium was 0.42 mg/L, which is above the adopted freshwater aquatic life criteria for (i.e. 0.06 mg/L). The source of higher concentrations of aluminium in collected water sample could not be conclusively ascertained. As detailed studies about soil composition in Singapore do not exist, it cannot be excluded that aluminium originates due to the natural occurring processes in the soil. Reported concentration of enterococcus was 700 CFU/ 100 mL). Other tested parameters did not report any detections.

Water quality sampling location and aluminium exceedance are shown in Figure 6.5.9.



Parameter	Reading (mg/L)	Freshwater Aquatic Life Criteria (mg/L)
Aluminium	0.42	0.06

Legend

- Surface Water Quality Sampling Location
- Watercourse**
 - Underground
 - Above
- Project Site

N

						Qualified Person Endorsement : NA	Consultant : AECOM	Client: HOUSING & DEVELOPMENT BOARD						
								HDB Endorsement : NA	Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT WOODLANDS N1		Figure Title : Water quality sampling location with baseline exceedance			
									Designed KRT	Checked LL	Approved JAG	Figure No. : 6.5.9	Rev. 1	Sheet 1 of 1
										Drawn SAG	Date JUL 2024	CAD File Name : NA		A3
1	JUL 2024	SAG	Final Report	LL	JAG									
Rev.	Date	By	Description	Chk'd	App'd									

6.5.4 Baseline Groundwater Elevations

Based on the gauging records of MW01 through MW03, measured during the groundwater sampling session on 19 February 2024, the stabilized water level (SWL) ranges from 18.173 m reduced level (mRL) in MW01 to 10.366 m RL in MW02. Table 6-13 below presents the SWL obtained from the groundwater sampling event.

Table 6-14 Groundwater Elevation Data for Woodlands N1 (m RL)

Monitoring Well I.D.	Date	Well Coordinates (m)		Stabilised Water Level Elevation (m SHD ¹)
		Northing	Easting	
MW01	19-Feb-24	46845.549	21226.339	18.173
MW02	19-Feb-24	46742.442	21348.507	10.366
MW03	19-Feb-24	46664.857	21191.318	12.388

Note:
All levels shown here are based on Singapore Height Datum (SHD) 0.000m.

6.5.4.1 Groundwater Flow Direction and Velocity

Hydrogeology is described as follows:

- Stabilised groundwater levels ranged from 5.265 m (MW01) to 5.435 m (MW03) from the top of casing (TOC);
- Stabilised groundwater elevations ranged from 18.173 m reduced level (RL) (MW01) to 10.366 m RL (MW02);
- Purged monitoring wells exhibited slow recovery rates;
- The hydraulic gradient, calculated using the EPA On-line Tools for Site Assessment, is 1.628×10^{-1} metre/metre (m/m); and
- The linear velocity of groundwater flow was calculated based on Darcy's Equation as follows:

$$V = \frac{(K \cdot i)}{n}$$

Where

V =	Groundwater flow velocity
K =	Hydraulic Conductivity (1×10^{-5} cm/s for clay)
n =	Effective porosity (0.46 for clay)
i =	Hydraulic gradient (1.628×10^{-1} m/m)

Groundwater seepage velocity is calculated to be 1.1 metres per year (m/yr) with an interpolated radial flow direction from the central portion of the Site. Based on the groundwater elevation contour maps (Figure 6.5.10) the topography of the site indicates the supposed groundwater flow direction within the Project site, which demonstrates a flow direction towards the southeastern.



Legend Project Site Monitoring Well Location Groundwater Isocontour Inferred Groundwater Flow Direction

N

6.5.5 Baseline Groundwater Quality

The assessed groundwater physiochemical parameters in Woodlands N1 are presented in the table below.

Table 6-15 Summary of In-Situ groundwater physiochemical parameters for Woodlands N1

Monitoring Well I.D.	Temperature (°C)	pH	Conductivity (µS/cm)	Redox Potential (mV)	Total Dissolved Solid (mg/L)	Dissolved Oxygen (mg/L)
MW01	26.8	4.44	53.4	+242.2	38	4.05
MW02	26.9	5.31	97.4	+96.5	59	3.49
MW03	27.0	4.73	80.0	+195.3	50	6.28

Based on the physiochemical parameters assessed, the following can be observed:

- The groundwater beneath the Site is moderately acidic, with low conductivity and total dissolved solids concentrations indicating freshwater characteristics; and
- Measured redox potential shows that all groundwater samples obtained through MW01 to MW03 have oxidising conditions.

6.5.5.1 Groundwater Baseline Results

A summary of reported constituents in groundwater and a comparison of the groundwater analytical results with the DIVs for groundwater are summarised in Table 6-15 and Figure 6.5.11. A copy of the full laboratory report for the groundwater samples is included in Appendix S.

Table 6-16 Summary of groundwater analytical results for Woodlands N1

Test Parameters	Units	DIV (2013)	Sampling point - MW01	Sampling point - MW02	Sampling point - MW03
Metals					
Aluminum	µg/L	Not Available	76.4	68.6	168
Boron	µg/L	Not Available	4.69	7.1	N.D.
Barium	µg/L	625	4.521	6.02	7.857
Iron	µg/L	Not Available	4.14	10.4	92.5
Manganese	µg/L	Not Available	10.5	12.3	41.9
Tin	µg/L	Not Available	N.D.	N.D.	1.88
Zinc	µg/L	800	12.697	17.184	39.2
Thirteen (13) other metals	µg/L	Various	N.D.	N.D.	N.D.
Cyanide					
Cyanide (Total)	µg/L	1500	N.D.	N.D.	N.D.
Volatile Organic Compounds (VOCs)					
25 Compounds	µg/L	Various	N.D.	N.D.	N.D.
Semi-Volatile Organic Compounds (SVOCs)					
51 Compounds	µg/L	Various	N.D.	N.D.	N.D.
Total Petroleum Hydrocarbon (TPH)					
C6-C26 (Sum) / Mineral Oils	µg/L	600	N.D.	N.D.	N.D.
Major Anions and Cations					
Chloride as Cl	mg/L	Not Available	7.6	6.9	3.3

Test Parameters	Units	DIV (2013)	Sampling point - MW01	Sampling point - MW02	Sampling point - MW03
Nitrate as NO ₃ -N	mg/L	Not Available	0.36	1.77	5.84
Sulphate as SO ₄	mg/L	Not Available	1.9	3.0	N.D.
Total Nitrogen as TN	mg/L	Not Available	0.38	1.8	6.36
Total Phosphorus as TP	mg/L	Not Available	0.045	0.045	0.044
Nine (9) Other Compounds	mg/L	Not Available	N.D.	N.D.	N.D.
Miscellaneous Parameters					
Total Suspended Solids, TSS	mg/L	Not Available	5734	5407	18436
Total Dissolved Solids, TDS	mg/L	Not Available	31	39	50
Total Alkalinity	mg/L	Not Available	ND	ND	ND
Oil & Grease (Total)	mg/L	Not Available	0.191	0.5758	0.1442
Enterococcus	mg/L	Not Available	440	230	420
Notes: 123 - Exceedance of the DIV (2013) Not Available- value not specified in standard N.D. – Not Detectable above the LOR DIV – Dutch Intervention Value a – Intervention value for mineral oil; This applies to contamination due to mixtures (e.g. gasoline or domestic heating oil), then not only the alkane content but also the content of aromatic and/or polycyclic aromatic hydrocarbons must be determined. This aggregate parameter has been adopted for practical reasons. Further toxicological and chemical disaggregation is under study.					

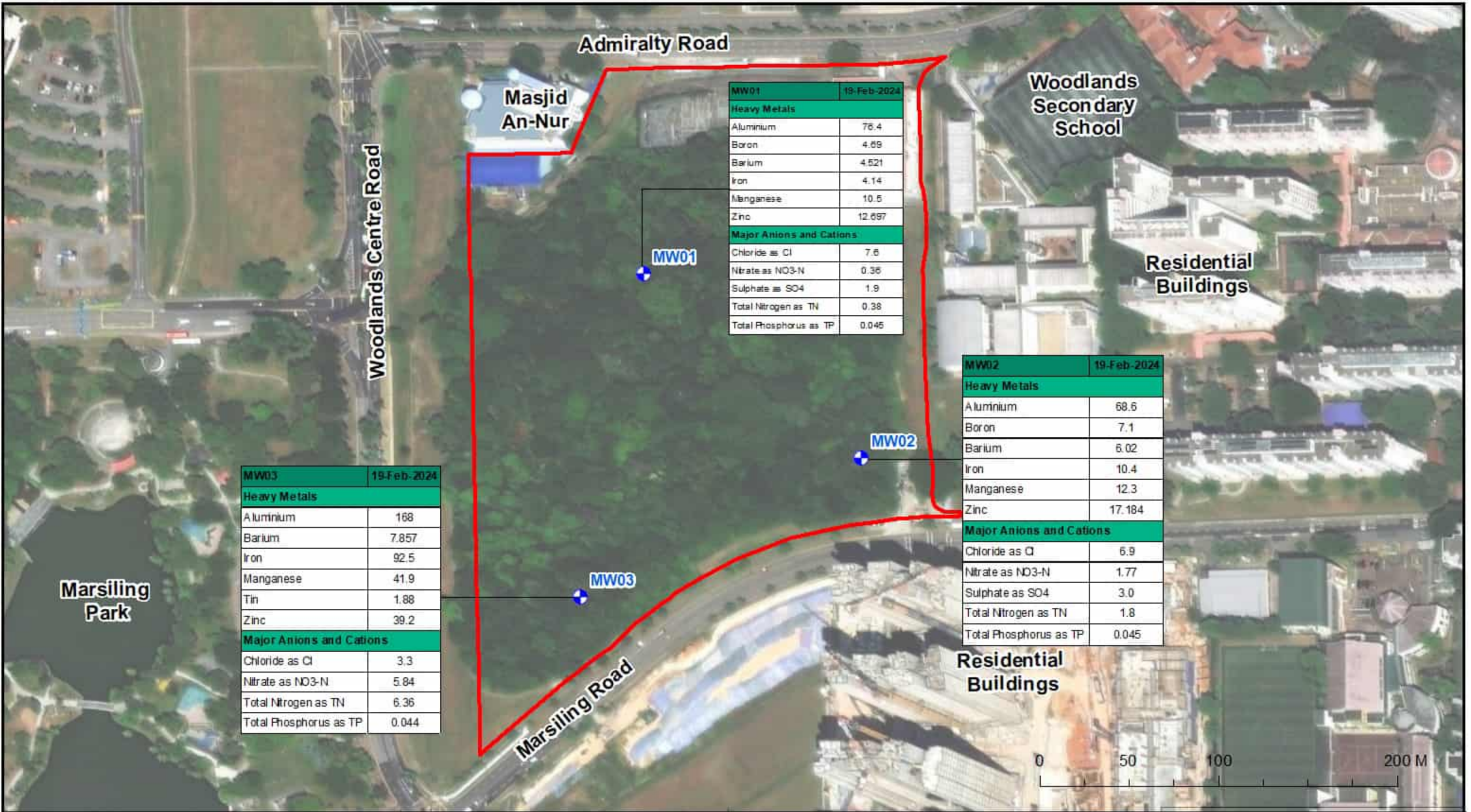
Metals, including aluminium, barium, iron, manganese, tin, and zinc were reported in all three (3) groundwater samples (MW01, MW02, MW03) at concentrations above their respective Limits of Reporting (LORs). Concentration of boron was only reported in two (2) samples (i.e., MW01 and MW02). The detections of these metals were all below their respective DIVs. The remaining thirteen (13) metals compounds were not detected above their respective LORs.

No detection above the LORs was reported for cyanide, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) and total petroleum hydrocarbon (TPH).

Major anions and cations, such as chloride, nitrate, total nitrogen, and total phosphorus were reported in all groundwater samples above their respective LORs. Concentration of sulphate was only reported in two (2) samples (i.e. MW01 and MW02). The remaining nine (9) compounds were not detected above their respective LORs.

Miscellaneous parameters, such as total suspended solids, total dissolved solids, oil and grease (total) and enterococcus were detected above the respective LORs.

All respective tested parameters did not exceed the respective DIVs where applicable.



MW03	19-Feb-2024
Heavy Metals	
Aluminium	168
Barium	7.857
Iron	92.5
Manganese	41.9
Tin	1.88
Zinc	39.2
Major Anions and Cations	
Chloride as Cl	3.3
Nitrate as NO3-N	5.84
Total Nitrogen as TN	6.36
Total Phosphorus as TP	0.044

MW01	19-Feb-2024
Heavy Metals	
Aluminium	76.4
Boron	4.69
Barium	4.521
Iron	4.14
Manganese	10.5
Zinc	12.697
Major Anions and Cations	
Chloride as Cl	7.6
Nitrate as NO3-N	0.36
Sulphate as SO4	1.9
Total Nitrogen as TN	0.38
Total Phosphorus as TP	0.045

MW02	19-Feb-2024
Heavy Metals	
Aluminium	68.6
Boron	7.1
Barium	6.02
Iron	10.4
Manganese	12.3
Zinc	17.184
Major Anions and Cations	
Chloride as Cl	6.9
Nitrate as NO3-N	1.77
Sulphate as SO4	3.0
Total Nitrogen as TN	1.8
Total Phosphorus as TP	0.045

Legend Project Site Monitoring Well Location Notes: 123 Results in yellow highlight indicate exceedance of OIV 1. All concentration were reported in milligram/litre (mg/L) 2. The concentrations of all other parameters were below the laboratory limit of reporting (LLOR) and do not exceed applicable screening criteria							Qualified Person Endorsement : NA HDB Endorsement : NA	Consultant: AECOM	Client: HOUSING & DEVELOPMENT BOARD	Figure Title : Groundwater Analytical Results					
										Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT WOODLANDS N1	Figure No. : 6.5.11	Rev. 1	Sheet 1 of 1		
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6.6 Airborne Noise Baseline Conditions

Baseline conditions of noise monitoring collected until August 2023 are presented in the following sections.

6.6.1 Baseline Monitoring Personnel

The assessment and site surveys were conducted by the following personnel:

- Ms. Jagriti Dawra, AECOM (Noise Technical Lead);
- Mr. Zay Phyo, AECOM (Noise Consultant);
- Ms. Sim Yi Ting, AECOM (Noise Consultant);
- Dr. Shayok Ghosh, AECOM (Noise Consultant): and

To understand the ambient noise environment within the 150m Airborne Noise Study Area, baseline noise monitoring was conducted between the dates listed below with baseline noise levels captured to develop the specific noise criteria applicable for the assessment of noise impacts arising from the construction and operational phases.

The baseline monitoring dates are as follows:

- 21st July 2023 to 27th July 2023 (for NM01)

6.6.2 Airborne Noise Monitoring Results

Baseline monitoring was conducted to understand the ambient noise levels at locations in proximity of the Airborne Noise Study Area to develop the applicable corrected noise criteria for the construction phase and operational phase of the housing estate.

6.6.2.1 Baseline Conditions and Construction Phase Impact Assessment Criteria

The overall baseline airborne noise monitoring results captured through Monday – Sunday/ Public Holidays at locations NM1 for $L_{Aeq}(12 \text{ hrs})$, $L_{Aeq}(1 \text{ hr})$, and $L_{Aeq}(5 \text{ mins})$ and on Weekdays (Monday – Saturday) and Weekends (Sunday/ Public Holidays) are summarized in Table 6-17 in accordance with local noise legislations for the construction phase. The overall baseline airborne noise monitoring results captured through Monday – Sunday/ Public Holidays at locations NM1 for $L_{Aeq}(12 \text{ hrs})$, $L_{Aeq}(1 \text{ hr})$, and $L_{Aeq}(5 \text{ mins})$ and on Weekdays (Monday – Saturday) and Weekends (Sunday/ Public Holidays) are summarized in Table 6-17 in accordance with local noise legislation for the construction phase. Please refer to Appendix U for the Baseline Airborne Noise Monitoring Report detailing the daily recorded noise levels.

Baseline noise monitoring results at NM01 are representative of noise levels experienced by fauna species within Marsiling Park which is situated on the western side of the study area and is identified as an ecologically sensitive site. Noise levels showed relatively low variation across weekends and weekdays, as well as during different times of the day—day, evening, and night.

Table 6-17 Summary of baseline noise monitoring results for construction noise impact assessment.

Location	Date of Monitoring	L _{Aeq} (12 hour), dB				L _{Aeq} (1 hr), dB				L _{Aeq} (5 min), dB								
		7am -7pm		7pm -7am		7pm - 10pm		10pm - 7am		7am - 7pm			7pm - 10pm			10pm - 7am		
		Ave		Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
Weekdays (Monday – Saturday)																		
NM01: Marsiling Park	21 July – 27 July 2023	62	60	58	61	60	57	64	60	59	67	62	57	64	60	56	65	60
Weekend/ Public Holidays (Sunday/ Public Holidays)																		
NM01: Marsiling Park	21 July – 27 July 2023	60	61	N.A.						58	62	60	59	63	60	57	65	61
Overall (Monday – Sunday/Public Holidays)																		
NM01: Marsiling Park	21 July – 27 July 2023	61	60	58	61	60	57	64	60	58	67	61	57	64	60	56	65	60
Note: N.A.– Not Applicable In accordance with the EPM 2008 Regulation, L _{Aeq} (1 hour) is not assessed for Weekend/ Public Holidays and is hence not applicable.																		

There are currently no guidelines or standards available to assess construction noise impacts on the ecological receptors. Thus, the average baseline monitoring results in Table 6-17 were used to establish the assessment criteria for construction noise impact on ecological receptors as reflected in Table 6-18.

Unlike human receptors which are defined as fixed establishments/ buildings, it is difficult to pinpoint the exact locations of mobile ecological receptors to conduct construction noise impact assessment. As such, baseline noise monitoring results at NM01 were selected as representative of the noise levels experienced by the ecological receptors residing/ traversing through the various patches within the Project site.

This approach was taken as part of a conservative means that if no noise exceedances are predicted when compared to these stringent criteria, the airborne noise impact on fauna in the vicinity will also not experience noise levels exceeding the established criteria.

It should be noted that only ground-dwelling fauna found at heights of up to 0.5 m were assessed in this EIA under the assumption that ground-dwelling fauna will face the most severe impacts due to noise emissions arising from the construction phase while arboreal fauna typically found at height are likely to flee the area during periods of high noise/ light disturbances and human presence/ activities.

Table 6-18 Noise criteria established for Ecological Receptors for construction.

Location	Noise Criteria* for LAeq(12 hrs), dB(A)		Noise Criteria* for LAeq(1 hr), dB(A)		Noise Criteria* for LAeq(5 mins), dB(A)		
	7am- 7pm	7pm- 7am	7pm- 10pm	10pm- 7am**	7am- 7pm	7pm- 10pm	10pm- 7am**
	Overall (Monday – Sunday/ Public Holiday)						
NM01	61	60	60	60	61	60	60
Note: * - Average baseline monitoring results were used to establish the noise impact assessment criteria.							
** - It should be noted that, as informed by the HDB, no construction activities will take place between 10 pm and 7 am.							

6.6.2.2 Baseline noise and Operational Phase Criteria

The typical potential noise sources during the operational phase of the Project includes the following:

- Air Conditioning and Mechanical Ventilation Noise (ACMV) noise emitted from non-industrial buildings as part of the Project development; and
- Traffic noise due to increase in vehicular volume and new road networks due to the development of the Project and in the vicinity of the Airborne Noise Study Area.

6.6.2.2.1 Air Conditioning and Mechanical Ventilation Noise

The overall baseline airborne noise monitoring results recorded at locations NM01 for L_{Aeq}(15 mins) are summarized in Table 6-19 Summary below in accordance with the local noise guidelines for the impact assessment of noise emitted by Air Conditioning and Mechanical Ventilation (ACMV) Systems during operational phase. Please refer to Appendix U for the Baseline Airborne Noise Monitoring Report detailing the daily recorded noise levels.

It should be noted that the recorded L_{Aeq}(15 mins) for the operational phase are only indicative at this stage as baseline noise levels captured are not aligned with the requirements for operational noise impact assessment detailed in the *NEA Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings, 2018* [R-37] due to the lack of detailed information on building boundaries, and building type, at the current pre-design stage.

Hence, to meet requirements mandated by law, AECOM recommends that HDB/ the contractor contracted by HDB appoint a Noise Consultant(s) upon finalising of design plans at the detailed design stage to determine the appropriate baseline noise levels for the operational phase in accordance with the respective NEA guidelines (refer to Section 8.5.3.2).

Table 6-19 Summary of baseline noise monitoring results for operational noise impact assessment due to ACMV

Location	Date of Monitoring	L _{Aeq} (15 mins), dB								
		Day 7am - 7pm			Evening 7pm - 11pm			Night 11pm - 7am		
		Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
Overall (Monday – Sunday/Public Holidays)										
NM01: Marsiling Park	21 August – 28 August 2023	58	65	61	57	62	59	56	64	60

There are currently no guidelines or standards available to assess noise impacts from ACMV during the operational phase on the ecological receptors. Thus, the average baseline monitoring results in Table 6-17 were used to establish the assessment criteria for the assessment of noise impact due to the operation of ACMV on ecological receptors as reflected in Table 6-20.

Table 6-20 Noise criteria established for Ecological Receptors due to ACMV during the operational phase.

Location	Noise Criteria* for L _{Aeq} (15 mins), dB(A)		
	7am-7pm	7pm-10pm	10pm-7am
Overall (Monday – Sunday/ Public Holiday)			
NM01	61	59	60
Note: * - Average baseline monitoring results were used to establish the noise impact assessment criteria.			

6.6.2.2.2 Land Traffic Noise

The overall baseline airborne noise monitoring results recorded at locations NM01 for L_{Aeq}(1 hr) are summarised in Table 6-21 below following the local noise guidelines for the impact assessment of noise due to land traffic during the operational phase. Please refer to Appendix U for the Baseline Airborne Noise Monitoring Report detailing the daily recorded noise levels.

It should be noted that the recorded L_{Aeq}(1 hr) for the operational phase are only indicative at this stage as baseline noise levels captured are not aligned with the requirements for operational noise impact assessment detailed in the *NEA Technical Guideline for Traffic Noise Impact Assessment* [R-39] due to the lack of detailed information on the new road network and traffic volume at the current pre-design stage.

Hence, to meet requirements mandated by law, AECOM recommends that HDB/ the contractor contracted by HDB appoint a Noise Consultant(s) upon finalising of design plans at the detailed design stage to determine the appropriate baseline noise levels for the operational phase in accordance with the respective NEA guidelines (refer to Section 8.5.3.2).

Table 6-21 Summary of baseline noise monitoring results for operational noise impact assessment due to Land Traffic Noise

Location	Date of Monitoring	L _{Aeq} (1 hr), dB		
		Min	7am - 7pm Max	Ave
Overall (Monday – Sunday/Public Holidays)				
NM01: Marsiling Park	21 August – 28 August 2023	59	64	61

There are currently no guidelines or standards available to assess noise impacts from land traffic during operational phase on the ecological receptors. Thus, the average baseline monitoring results in Table 6-21 were used to establish the assessment criteria for the assessment of noise impact due to the land traffic on ecological receptors as reflected in Table 6-22

Table 6-22 Noise criteria established for Ecological Receptors due to Land Traffic during operational phase.

Location	Noise Criteria* for $L_{Aeq}(1 \text{ hr})$, dB(A)
	7am-7pm
Overall (Monday – Sunday/ Public Holiday)	
NM01	61
Note: * - Average baseline monitoring results were used to establish the noise impact assessment criteria.	

7 Prediction and Evaluation of Impacts During Construction Phase

7.1 Potential Sources of Impact

During the construction phase of the Project, the Project site will go through significant changes. Activities assumed to occur during the construction phase are detailed in Section 3.3 of this Report and they will include demolition of existing structures (i.e. Marsiling CC and accompanying facilities as well as temporary structures behind the An-Nur Mosque) within the site, clearance of vegetation, earthworks, construction of temporary roads and utility diversion, followed by main construction works such as foundation works, superstructure works (residential buildings and roads) and utilities/services laying.

Abovementioned activities have a potential to directly and indirectly affect currently present flora and fauna within the site. Potentially impacted sensitive receptors, sources of impact, minimum control measures and assessment of impacts are detailed in the following sub-sections.

7.1.1 Impacts on Biodiversity

As detailed in Section 3.3 of this Report, proposed development plans would likely result in complete clearance of the Study Area. Therefore, it is expected that direct impact such as loss of vegetation to habitats, mortality in plant species, and the loss of/reduction in habitats and food sources for faunal species will occur during the construction phase.

There are two main categories in which the impacts fall into, namely, (1) direct, i.e., impacts to habitats and species within the worksites; and (2) indirect, i.e., impacts to habitats and species outside the worksites but within the impact zone. **Impact zones** for habitat and plant species receptors are defined as areas within 30 m from worksites of the proposed development while the impact zone for faunal receptors is defined as the entire Study Area as fauna are mobile and can use the whole Study Area.

Table 7-1 details a list of potential impacts on Habitats, Plant Species and Fauna Species during the construction phase. A total of ten impact types were assessed: three for Habitats, two for Plant Species and five impact types for faunal receptors where two of the impacts—human and light disturbances—will only be assessed at post mitigation where the scenario of retaining an area of high ecological value (AHEV) is considered.

Table 7-1 Potential impacts on Habitats, Plant Species and Fauna Species from construction phase

Receptor	Impact Type	Description	Impact category	Pre/post mitigation assessment
Habitats	Loss of vegetation	Direct removal of vegetation (with extensive underground root systems that protect against soil erosion) to create space for construction activities	Direct	Pre and post mitigation
	Habitat degradation	Improper disposal of construction waste, accidental release of hazardous materials (such as construction slurry, paint, and/ or solvents), increase in dust, noise, and light levels, changes in forest hydrology	Indirect	Pre and post mitigation
	Formation of forest edge	Formation of forest edge habitats from the removal of forested areas	Indirect	Pre and post mitigation

Receptor	Impact Type	Description	Impact category	Pre/post mitigation assessment
Plant Species	Mortality	Direct removal of vegetation to create space for construction activities	Direct	Pre and post mitigation
	Decline in plant health and survival	Changes in microclimatic conditions (i.e., dust, noise, and light, temperature, and humidity) and hydrology	Indirect	Pre and post mitigation
Faunal Species	Loss of/ reduction in habitats and food sources	Loss of/ reduction in habitats and food sources	Direct	Pre and post mitigation
	Accidental injury or mortality	Collisions with machineries, entrapments in construction materials (such as non-biodegradable erosion control blankets) and structures (such as exposed pits or drains), accidental kills by construction personnel, and/ or modifications to habitats (e.g., increased pollution levels, edge effects) that cause direct injury or mortality of fauna	Direct	Pre and post mitigation
	Human-wildlife conflict	Negative consequences of human-wildlife interactions, such as deliberate killing and depopulation of faunal species perceived as nuisances or threats by construction personnel	Indirect	Pre and post mitigation
	Human disturbance	Increase in human traffic flow, such as workers and site personnel	Indirect	Post mitigation
	Light disturbance	Increase in light levels from construction activities	Indirect	Post mitigation

7.1.2 Impacts on Biodiversity Due to Changes in Other Environmental Parameters

As part of this EIA, indirect impacts on biodiversity due to changes in water resources (i.e. surface water quality, groundwater quality and level) and airborne noise will be assessed. In addition, impacts on potential surface water quality changes due to construction and operational phases of the Project on Upper Seletar Reservoir will also be included in this EIA, as requested by PUB during the scoping of the study (refer to Appendix T of this Report). It should also be noted that as there are no watercourses within the Project site. Hydrological impact assessment will not be required for the purposes of this EIA, as recommended by PUB.

The list of potential indirect impacts on biodiversity during the construction phase is summarised in table below.

Table 7-2 Potential indirect impacts on biodiversity from construction phase

Environmental Parameter	Potential Source(s) of Impacts	Potential Associated Impact on Environmental Parameters	Potential Associated Impacts on Ecological Receptors
Water Resources (Groundwater Level)	Temporary or permanent land use change with more impervious surfaces due to:	Reduced seepage into soil, potentially disturbing current hydrological cycle of the site (i.e.;	Disturbances in aquatic habitats due to altered dry and wet weather conditions

Environmental Parameter	Potential Source(s) of Impacts	Potential Associated Impact on Environmental Parameters	Potential Associated Impacts on Ecological Receptors
	- Site clearance (e.g. clearance of vegetation and trees within Study Area not designated to be preserved, demolition of existing structures within and in the vicinity of Study Area) - Earthworks, including site levelling and excavation works - Construction of temporary and permanent structures and infrastructure	Stormwater runoff from exposed and unstable slopes may cause soil erosion and accretion, potentially forming obstructions along the watercourses	Localised flooding may have adverse impacts on surrounding terrestrial habitats
	Groundwater extraction/ soil dewatering during construction phase activities that require dry soil conditions such as foundation works	Reduction in groundwater baseflow feeding into the watercourses	Disturbances in aquatic habitats due to altered dry and wet weather conditions
Water Resources (Surface Water Quality and Groundwater Quality)	- Discharge of potentially contaminated surface water runoff originating from exposed soil during site clearance and earthworks - Discharge of potentially contaminated stormwater and/ or groundwater pumped out from excavated areas - Discharge of construction wastewater, grouting and cement materials - Seepage of contaminants from excavated contaminated soil (if encountered) into the underlying soil and groundwater - Discharge of contaminants due to improper handling, transfer, storage and disposal of solid waste and chemical substances (e.g. construction debris); - Accidental spills and leaks of chemical substances used for construction phase activities, including the fuel and lubricants spillage from maintenance of construction vehicles and mechanical equipment - Seepage of contaminants due to inappropriate	- Elevated levels of suspended solids (e.g. silt) in receiving watercourses - Increased quantity of solid waste and contaminated material in receiving watercourses - Increase in the levels of oil, grease and other chemical substances in receiving watercourses - Discharge of contaminated water into the underlying soil and groundwater	- Changes in surface water quality could have adverse impacts on aquatic habitats of Marsiling Park Pond and potentially further downstream (i.e. Upper Seletar Reservoir, Sungei Mandai Kechil) and species that use these watercourses for scavenging and/ or movement - Some contaminants, such as metals can accumulate in the root zone, affecting vegetation growth and long-term viability - Contamination may spread to downstream watercourses, affecting downstream habitats (e.g. mangrove habitats of Sungei Mandai Kechil)

Environmental Parameter	Potential Source(s) of Impacts	Potential Associated Impact on Environmental Parameters	Potential Associated Impacts on Ecological Receptors
	discharge of domestic sewage and poor maintenance of the portable chemical toilets, storage tanks and septic tanks		
Airborne Noise	- Noise from trucks transporting spoil/equipment - Noise from traffic congestion caused due to inadequate lane compensation and traffic diversion during construction - Noise generated by the use of Powered Mechanical Equipment (PME), (such as excavators, generators, pumps, cranes, etc.) for various construction activities within the site, including construction of holding areas, site offices and road widening works	Elevation in ambient airborne noise level	Potential for terrestrial fauna to alter their natural behaviours/ activities or relocate to avoid unfamiliar noises caused by construction works in their habitats.

7.2 Identification of Sensitive Receptors

Identification of sensitive receptors with regards to physical environmental parameter (i.e. water resources, airborne noise) can be found in the respective sections of this Report. Any additional sensitive receptors (if any) will be identified in subsequent submission.

7.2.1 Habitats

Following the assessment of ecological value for habitats (Section 6.4.3.1), all habitats found within the biodiversity Study Area were identified as sensitive habitat receptors. There are four different habitat types within the biodiversity Study Area; namely native-dominated secondary forest, abandoned-land forest, scrubland and urban vegetation.

7.2.2 Flora

Following the assessment of ecological value for all plant species (Section 6.4.3.2), a total of 21 species were selected for the assessment of ecological impacts. The selection was based on the following: (1) Priority 1 species with specimens of conservation significance and/or common native trees that had their ecological value raised, large specimens, other specimens of value found inside and within 30 m from the proposed worksite area, (2) Priority 1 keystone species (3) species that are associated with important fauna, and (4) species that make up $\leq$ 1% of the total number of specimens of conservation significance.

7.2.3 Fauna

Following the assessment of ecological value for faunal species (Section 6.4.3.3), all species with a Priority 1 sensitivity level were identified as the sensitive receptors. This includes both species of conservation significance identified in the Study Area and those deemed of probable occurrence. A total of 26 sensitive receptors were identified in the biodiversity Study Area, of which four were recorded from the field assessment, and the remaining were deemed of probable occurrence. Breaking down the sensitive receptors by taxon, there are 12 birds, eight butterflies, two bats, two reptiles and two non-volant mammals.

7.3 Minimum Control Measures

This section proposes minimum controls or standard practices commonly implemented in Singapore for the purposes of impact assessment during construction phase of the Project.

7.3.1 Biodiversity

This section lists biodiversity-specific minimum control measures that are commonly implemented in Singapore for construction activities. These are assumed to be implemented for the purpose of the impact assessment and should be proposed in tandem with the measures proposed for other environmental receptors (e.g., hydrology, noise). Minimum controls for each potential impact occurring from the construction phase is listed in Table 7-3. The main construction activities that would likely occur at all worksites include vegetation clearance and excavation, followed by below and above ground construction.

Table 7-3 Minimum control measures for the construction phase

Work activities	Minimum controls for construction phase
Vegetation Clearance	- Any trees that are to be retained within worksite would require a certified arborist to clearly mark out Tree Protection Zones where no works are allowed. The Tree Protection Zones should be set up in accordance with NParks guidelines (NParks, 2019) - Before vegetation removal, pre-felling fauna inspection should be conducted by an Ecologist to identify wildlife or nesting structures that are being actively used such as bird nests, tree hollows, burrows, and bamboos clusters; to satisfy Section 10 Wildlife Act

Work activities	Minimum controls for construction phase
	Soil erosion control measures (e.g., implementation of erosion control blankets, ECM tanks etc) are to be executed once vegetation has been removed and soil is exposed as described in Section 7.1.2 under Water Resources
Excavation	- Implement soil erosion control measures as described in Section 7.3 under Water Resources - Implement dust control measures - Implement noise barrier as described in Section 7.3 under Airborne Noise
Below and Above Ground Construction	Proper storage of materials that are likely to leech harmful chemicals and fuel-powered equipment away from waterbodies or sensitive habitats as described in Section 7.1.2, under Water Resources
General	- Installation of hoarding to delineate worksite - Execute wildlife response plan when a trapped/ injured/ dead/ dangerous animal is encountered around or within the worksite according to Section 10 of the Wildlife Act - Fogging is not recommended. To implement preventive measures against mosquito breeding by removing sources of stagnant water or water-bearing receptacles. E.g., - Providing well-maintained pitched roof, clearing discarded items daily, store materials appropriately, level up ground depression/ uneven surfaces, ensure effective drainage flow - Daily checks by Environmental Control Officer on site - Use only fully biodegradable erosion control blankets (ECB) to avoid trapping fossorial fauna such as snakes

7.3.2 Water Resources

Table 7-4 has a non-exhaustive list of minimum controls for potential impacts on water resources, which is based on the local regulations and common practices.

Table 7-4 Minimum control measures during construction phase applicable for water resources

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
Water Resources (Surface Water Quality and Groundwater Quality)	Discharge of potentially contaminated surface water runoff originating from exposed soil containing elevated levels of suspended solids	- A Qualified Erosion Control Professional must plan, design, approve, and implement Earth Control Measures (ECM) plans for PUB. This includes installing, maintaining, monitoring, and reporting on erosion control blankets, CCTV at discharge points, SIDS, sedimentation tanks, to comply with PUB's COP on Surface Water Drainage. To note that this must consider the requirement for burying site hoardings 300mm deep into the ground. - The Contractor should coordinate earthworks alongside ECM provision. Progress of earthworks must be carefully regulated to avoid exposing more areas than the proposed ECM can handle. - Any interim changes to ECM during site startup, levelling (cutting and backfilling), in each phase of work, must be planned and approved before starting any work on site. - Provide biodegradable erosion blankets to areas with bare soil surfaces on the same day of soil exposure. - Schedule demolition and earthworks to minimize on-site stockpile quantities (including horticultural waste). - Design ECM tanks/ponds with sufficient capacity to hold turbid stormwater before treatment at the ECM facility. Before discharge, ensure water meets NEA Trade Effluent Criteria.

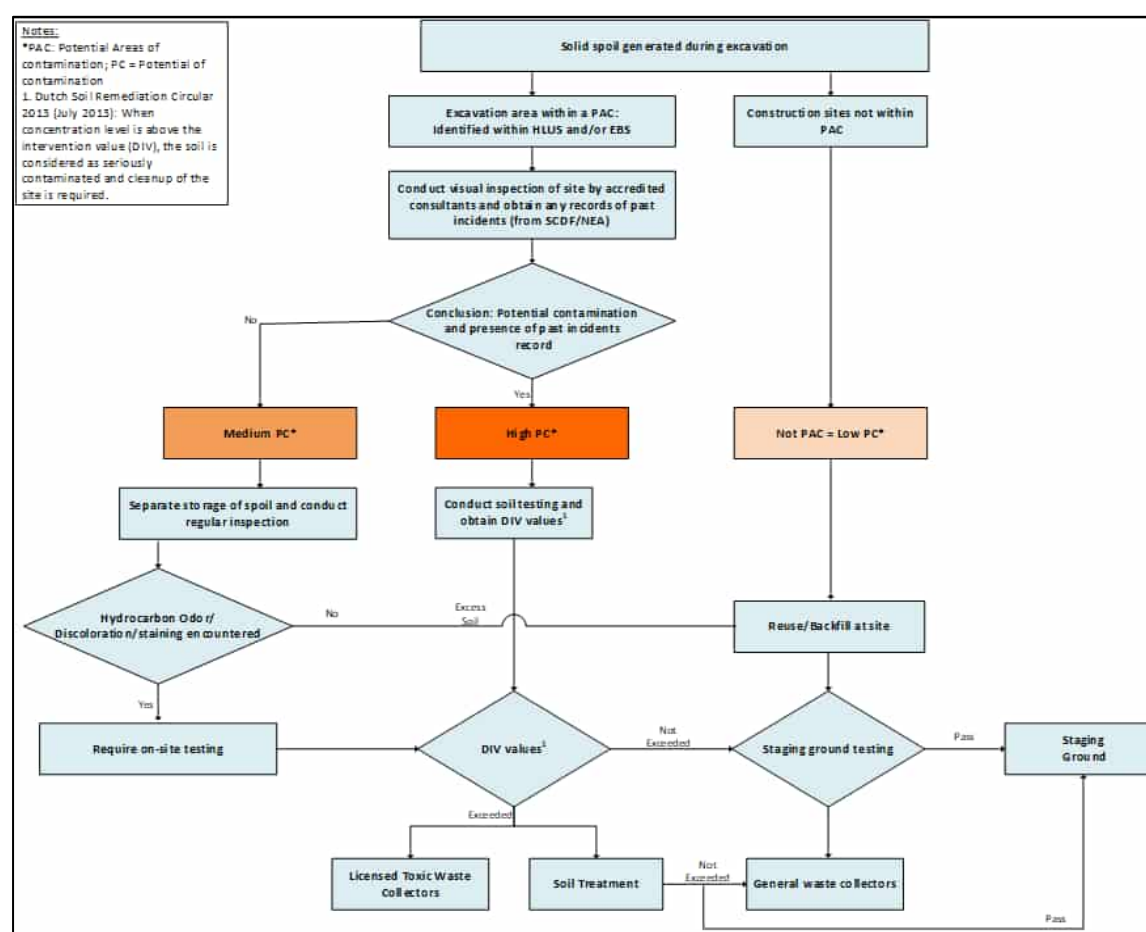
Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
		• Ensure that the Contractor's CCTV system is properly operated and maintained at all times as per PUB's circular on Preventing Muddy Waters from Construction Sites. This also aims to prevent Contractors from tampering with the CCTV system to conceal silty discharge. • Effectively implement ECM and monitoring as per the Code of Practice on Surface Water Drainage to ensure that discharge into the stormwater drainage system does not exceed prescribed limits for TSS concentrations under the Sewerage and Drainage (Surface Water Drainage) Regulations. • Prepare a Sediment Control Plan to include, but not limited to, sealing site hoarding and installing berms along site hoarding, etc. This prevents silty water from leaking out of the site and from the ramp at the site entrance. • Stockpile removed topsoil in a designated area and cover it as necessary to prevent soil loss from secondary erosion. Conserved soil can be used for backfilling, while excess soil material should be stored properly for reuse. • Use approved materials, of the same or better quality than the surrounding area, for backfilling. Ensure all backfilled material is free of debris and consists of good-quality soil. • Segregate clean water flow from silty water flow whenever possible to maximize sedimentation tank holding capacity. • Always adequately cover and temporarily seal manholes. • Implement a construction Environmental Management and Monitoring Plan (EMMP) and ensure thorough preparation of associated plans and procedures.
Water Resources (Surface Water Quality and Groundwater Quality)	Discharge of liquid waste, including construction wastewater	• Finalize a comprehensive inventory of all expected wastewater streams and volumes before commencing construction phase activities. • Maintain daily records of wastewater volumes, as well as quantities of sludge and other generated wastes, on-site. • Construct impervious containment ponds designed with adequate capacity to manage site-generated wastewater volumes, including provisions for stormwater runoff and potential firefighting wastewater. • Provide temporary storage capacity for overflow scenarios of untreated wastewater to prevent discharge into watercourses, ensuring compliance with NEA Guidelines on trade effluent discharge concentrations. • Equip containment ponds and wastewater generating areas on-site with spill clean-up kits. • Design appropriate drainage infrastructure (such as cut-off drains, sump pits, road kerbs, piping, and toe walls) to channel construction process wastewater (e.g., wash water) and stormwater runoff separately for capture and treatment in containment ponds/kerbs. Include oil-water separators where applicable. • Seek approval from relevant authorities (PUB and NEA) as per PUB Sewerage and Drainage (Trade Effluent) Regulations for wastewater disposal to public sewers, or NEA's Trade Effluent Discharge Limits for disposal to surface watercourses. If discharges are not approved,

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
		store, treat, or recycle trade effluent on-site before off-site disposal to a licensed waste collector. - Obtain comments and approval from relevant authorities (e.g., Singapore Civil Defence Force [SCDF] and NEA) for the use of treated wastewater in firefighting activities. - Establish concrete washout areas away from watercourses or ensure discharge does not drain into ECM treatment systems. - Implement a wheel washing process for all vehicles leaving the site to prevent deposition of earth, mud, debris, etc., on surrounding roads. Treat resulting wastewater in the ECM system after sedimentation. - Establish regular inspection and maintenance procedures for wastewater collection, storage, and treatment infrastructure (e.g., pipes, oil-water separators). - Develop regular procedures for managing stormwater collection, settling, testing, and discharge to watercourses. - Conduct biannual toolbox talks/training sessions for all on-site workers, including subcontractors, regarding their responsibilities for proper water quality management. - Prohibit uncontrolled discharge of any wastewater streams. - Ensure no trade effluent other than that approved by the NEA Director-General is discharged into watercourses or soil. - Prioritize the reduce, reuse, and recycle hierarchy for on-site wastewater management. - Store hazardous liquids, such as oily water, thinners, solvents, or paints, on impermeable hardstands under shelter with surrounding kerbing. Remove such wastewater for treatment and off-site disposal by an approved Waste Management Contractor, treating hazardous liquids as hazardous waste. - Dispose extracted groundwater to NEA-approved areas identified in Figure 7.3.1, following the process outlined in Figure 7.3.2. Monitor extracted groundwater regularly, especially for oily sheens or odours, and dispose of contaminated wastewater to a licensed toxic waste collector if contaminant concentrations exceed regulatory limits. - Prepare and implement a construction site-specific Environmental Management and Monitoring Plan (EMMP), ensuring comprehensive preparation of associated plans and procedures.
Water Resources (Surface Water Quality and Groundwater Quality)	Seepage and leakage of contaminants from solid waste generated, handled and stored on site	- Provide an adequate number of enclosed bins for waste disposal. - Ensure waste disposal facilities are cleared regularly to prevent accumulation. Conduct daily housekeeping checks to ensure the site is free of litter. - Develop Standard Operating Procedures (SOP) for the safe handling, transfer, storage, and disposal of solid waste. - Conduct appropriate tests to determine the presence or absence of contamination in excavated soil.

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
		- Dispose of any waste listed in the Environmental Public Health (General Waste Collection) Regulations through a licensed waste operator. - Follow the procedure outlined in Figure 7.3.1 for handling and disposing of excavated soil. This flow chart details procedures for identifying potential contamination areas and assessing Potential of Contamination (POC) in excavated soils. Contaminated soils exceeding Regulatory Concentration Limits (DIVs) should be disposed of by toxic waste collectors or treated to meet acceptable standards like the DIV. Treated soils can be disposed of in staging grounds or collected by general waste collectors, depending on contaminant levels determined during staging ground testing. - Upon receiving results indicating parameters (chemicals, heavy metals) exceed regulatory limits, conduct a risk assessment for potential inhalation and dermal contact impacts on site workers exposed to contaminated soil or groundwater areas. This assessment should precede construction activities and integrate findings into the contractor's construction risk assessment and health, safety, and environment plan. Implement necessary precautionary measures as specified in the respective chemical Safety Data Sheets (SDS) if worker health impacts are anticipated. - Implement a construction Environmental Management and Monitoring Plan (EMMP) and ensure comprehensive preparation of associated plans and procedures.
Water Resources (Surface Water Quality and Groundwater Quality)	Seepage of contaminants due to inappropriate discharge of domestic sewage and poor maintenance of portable chemical toilets, storage tanks and septic tanks	- Ensure an adequate number of proper sanitary facilities are provided and maintained. It is recommended to have one portable toilet per 10 individuals, serviced three times per week by a NEA Licensed Waste Collector (LWC) for regular sewage discharge disposal. - Position toilet facilities appropriately, away from any nearby watercourses. - If on-site dormitories exist, consider installing container toilets and obtain written approval from PUB to connect them to public sewers. - Establish a regular maintenance schedule to check cleanliness and ensure the proper functioning of sanitary facilities on site, conducting inspections at least once a week, adjusted based on facility usage. - Conduct regular inspections and audits to verify hygienic conditions on site. - Implement a construction Environmental Management and Monitoring Plan (EMMP) and ensure thorough preparation of associated plans and procedures.
Water Resources (Surface Water Quality and Groundwater Quality)	Seepage and leakage of contaminants from toxic waste generated, handled and stored on site	- Conduct periodic leak detection tests on toxic waste storage containers. - Store toxic waste and hazardous substances on a hard stand, under shelter, with a kerb around the storage area. - Provide spill trays for all waste containers and ensure they are regularly maintained to prevent pollutive substances from being washed out by rain. - Dispose of toxic waste in accordance with Environmental Public Health (Toxic Industrial Waste) Regulations through a Licensed Waste Operator/Collector.

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
		- Implement a consignment notification/tracking system and develop a transport emergency response plan for the transportation of toxic waste. - Develop Standard Operating Procedures (SOP) for the safe handling, transfer, and storage of toxic waste. Conduct daily housekeeping checks to ensure all toxic waste is promptly cleared from the site. - Implement a construction Environmental Management and Monitoring Plan (EMMP) and ensure thorough preparation of associated plans and procedures.
Water Resources (Surface Water Quality and Groundwater Quality)	Direct or indirect (e.g. via seepage into soil and groundwater) contamination of watercourses originating from chemicals used and/or stored on site	- Replace hazardous substances or chemicals with safer alternatives whenever possible. - Ensure chemical storage areas are adequate, located on paved ground, bunded, sheltered with proper ventilation, and situated away from waterways and drains. Safety Data Sheets (SDS) must be kept on-site with stored chemicals. - Use secondary containment with a capacity exceeding 10% of the volume for a single large container and 25% of the total volume for multiple containers in all chemical storage and diesel generator areas to minimize spills and prevent soil and surface water contamination, as required by COPPC/SS593. Exercise caution near watercourses to prevent leaks of toxic chemicals such as petrol, diesel, oil, paint, and thinner from equipment. - Include oil-water separators in the infrastructure designed to separately channel construction wastewater streams and stormwater runoff. This helps capture accidental spills or leaks of oils or greases, particularly near liquid storage or refuelling areas. - Immediately maintain or remove off-site any construction equipment causing water system pollution due to oil or fuel leakage. - Conduct all activities involving repair, servicing, and engine overhaul at appropriate contained areas (e.g., concreted areas with proper containment), channelling all wastes for suitable treatment or disposal in compliance with regulations. - Develop an emergency response plan, ensure the Emergency Response Team (ERT) is trained in response procedures, and provide response kits for handling spillages. - Implement good housekeeping practices to minimize careless spills and maintain storage and workspace in a tidy and clean condition. Assign a responsible person (e.g., Environmental Control Officer) to oversee the effective operation of containment ponds/kerbs where 'Good Housekeeping' practices are enforced. Regularly inspect containment ponds/kerbs at least daily to ensure proper functionality and prevent spills, leaks, and odour issues. Provide appropriate training, including safety codes and relevant manuals, to personnel regularly handling chemicals on-site. - Implement a construction Environmental Management and Monitoring Plan (EMMP) and ensure comprehensive preparation of associated plans and procedures.
Water Resources (Groundwater Levels)	Decreased infiltration into the ground due	Install piezometers to monitor groundwater level changes in accordance with Building Control Regulations 2003, as outlined in the instrumentation and monitoring plan endorsed by the Qualified Professional (QP).

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
	to increased runoff from hard standing surfaces Groundwater extraction during construction activities that require soil dewatering	- Select and design Proper Earth Retaining Stabilising Structures (ERSS) to minimize groundwater settlement. - Phase soil dewatering plans to minimize groundwater drawdown to the extent practicable.



Note: DIV standards were developed to assess the acceptability of impacted sites in the Netherlands in support of the Dutch Soil Protection Act. Therefore, it is based on local Dutch ecotoxicology, soil (consisting of 10% organic clay or 25% clay) and climate conditions for residential usage which may not be applicable to conditions in Singapore.

Figure 7.3.1 Screening and disposal of excavated soils

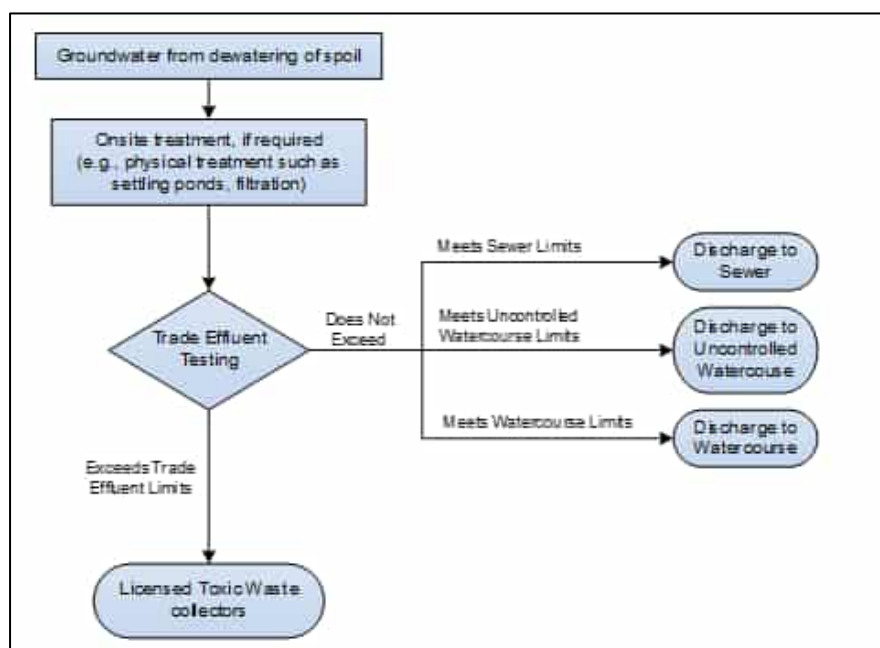


Figure 7.3.2 Disposal of the groundwater generated through dewatering or inflow into excavations

7.3.3 Airborne Noise

Table 7-5 has a non-exhaustive list of minimum controls for potential impacts on airborne noise levels, which is based on the local regulations and common practices.

Table 7-5 Minimum control measures during construction phase applicable for airborne noises

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
Airborne noise	Noise from trucks transporting spoil/equipment.	- Shut down machines (such as trucks) that may be in intermittent use between work periods or throttle down to a minimum; - Label all machinery and equipment used with a weather-proof sticker clearly indicating its noise emission level (at source) under normal operating conditions; - Utilize only well-maintained construction plants on-site, and service construction plants regularly during the entire construction period; - Reduce the number of PMEs as far as practicable when carrying out construction works at areas close to the noise-sensitive receivers; - Utilize and properly maintain silencers or mufflers on construction equipment during the construction programme; - Ensure behavioural practices including no shouting, no loud stereos/radios on site, no dropping of materials from height, and no throwing of metal items; - Restrict high noise-generating drilling activities only to continuous blocks not exceeding 3 hours each, with a minimum respite period of one hour between each block, if possible; - Conduct periodic noise monitoring by an independent third party to establish
	Noise from traffic congestion caused due to inadequate lane compensation and traffic diversion during construction.	
	Noise generated by the use of Powered Mechanical Equipment (PME), (such as excavators, generators, pumps, cranes, etc.) for various construction activities within the site, including construction of holding areas, site offices and road widening works.	

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
		compliance with requirements and to advise on equipment causing concern, and additional potential mitigation measures; • Apart from advance works/site clearance approved by Agencies, minimise noisy works after 6pm to reduce noise disturbance to nocturnal animals. • Plan the layout of the site by considering the use of materials and other large structural equipment as noise barriers; • Orient construction plants known to emit noise strongly in one direction, wherever possible, so that the noise is directed away from the nearby noise-sensitive receptors; • Utilize material stockpiles and other structures effectively, wherever practicable, to screen noise from on-site construction activities; • Ensure all handheld percussive breakers and air compressors used on site comply with local legislation and requirements; • Schedule activities to minimize noise generated at certain areas during periods particularly sensitive to noise; • Prohibit works using machines or vehicles that generate noise during the night and at dawn; • Personnel operating the plant or equipment should use appropriate hearing protectors, which must attenuate the user's exposure to sound pressure levels below 85dB (A). Put up signage to remind personnel to use hearing protection at work areas that emit excessive noise. Choose hearing protectors such as ear plugs (for < 100 dB (A)), earmuffs (for 100 dB (A) to 120 dB (A)), or ear plugs and earmuffs (for > 120dB (A)) according to various noise exposure levels; • Conduct noise awareness briefings regularly and highlight the noise mitigation measures such as positioning machinery, using portable noise barriers, and the dos and don'ts for using machinery at night; • If noise remains an issue even after implementation of recommended mitigation measures such as noise barriers, contractor should consider implementation of proprietary noise barriers of high noise reduction capabilities to further reduce noise to acceptable levels.

7.4 Impacts on Biodiversity

Identified biodiversity sensitive receptors were evaluated based on impact intensity and likelihood, which eventually gives the impact significance. The impact intensity and likelihood of each impact type during construction phase are defined for habitats (Table 7-6 and Table 7-7), flora species (Table 7-8 and Table 7-9) and fauna species (Table 7-10 and Table 7-11) receptors below.

Three assumptions made in defining the levels of impact intensity and likelihood during the construction phase are:

1. Habitats and plant species within 30 m from the worksites are assumed to experience the greatest extent of indirect effects.
2. The likelihood of habit degradation (i.e., improper disposal of construction waste, accidental release of hazardous materials [such as construction slurry, paint, and/ or solvents], increase in dust, noise, and light levels, changes in forest hydrology; refer to Table 7-1) is presumed to be '**Less Likely**' for all habitat receptors, based on the assumption that all minimum controls (Section 7.3.1) are adequately and properly implemented.
3. Other factors that will most likely cause habitat degradation (e.g., excessive water surface runoff during monsoon reasons, littering from construction staff, lack of general compliance by contractors) were also considered in this assumption.

Table 7-6 Definitions of each level of impact intensity for impact types during construction for habitat receptors

Impact Type	Negligible	Low	Medium	High
Loss of habitat	The habitat does not overlap with the worksites	≤ 10% of the habitat overlaps with the worksites	10–40% of the habitat overlaps with the worksites	> 40% of the habitat overlaps with the worksites
Habitat degradation	<u>Terrestrial habitat</u> The habitat type does not overlap with areas 30 m from the worksites	<u>Terrestrial habitat</u> ≤ 10% of the habitat type overlaps with areas 30 m from the worksites	<u>Terrestrial habitat</u> 10–40% of the habitat type overlaps with areas 30 m from the worksites	<u>Terrestrial habitat</u> > 40% of the habitat type overlaps with areas 30 m from the worksites
Formation of forest edge				

Table 7-7 Definitions of each level of likelihood for all impact types during construction for habitat receptors

Likelihood	Loss of Vegetation	Habitat Degradation	Formation of forest edge
Unlikely/ Remote	The habitat does not overlap with the worksites	N.A.	The habitat does not overlap with the worksites
Less Likely/ Rare	N.A.	N.A. (see assumption above)	The worksites are small (e.g., trails, boardwalks) and/or is not expected to change vegetation structure significantly to effect changes in microclimatic conditions (e.g., minimal tree or vegetation removal)

Likelihood	Loss of Vegetation	Habitat Degradation	Formation of forest edge
Possible/ Occasional	N.A.	N.A.	The worksites are of considerable size (e.g., single lane roads) and/or is expected to change some vegetation structure significantly to effect changes in microclimatic condition (e.g., some tree or vegetation removal)
Likely/ Regular	N.A.	N.A.	The worksites are large (e.g., buildings, multiple lane roads) and/or is expected to change vegetation structure significantly to effect changes in microclimatic conditions (e.g., extensive tree or vegetation removal)
Certain/ Continuous	The habitat overlaps with the worksites	N.A.	N.A.

Table 7-8 Definitions of each level of impact intensity for impact types during construction for plant species receptors

Impact Type	Negligible	Low	Medium	High
Mortality	No plant specimens of this species are within the worksites	Less than 50% of all plant specimens of this species are within the worksites	More than or exactly 50% of all plant specimens of this species are within the worksites	All plant specimens of this species are within the worksites
Decline in plant health and survival				

Table 7-9 Definitions of each level of likelihood for impact types during construction for plant species receptors

Likelihood	Mortality	Decline in plant health and survival
Unlikely/Remote	No plant specimens of this species are within the worksites	No formation of forest edges (i.e., construction activities are fully underground and/or in existing built-up areas outside the mangrove or forest) that changes the existing microclimate conditions
Less Likely/ Rare	Plants specimens of this species located in the worksite is less likely to be inflicted with mechanical injuries during construction	Formation of scrubland edges in scrubland areas only.
Possible/ Occasional	No count data and/or locations of specimens of this species is available, but specimens could possibly be within the worksites or	Formation of some forest and scrubland edges in urban vegetation, scrubland and/or mangrove/forested areas.
Likely/ Regular	N.A.	N.A.

Likelihood	Mortality	Decline in plant health and survival
Almost Certain/ Continuous	Plant specimens of this species located within the worksite are cleared	Formation of new forest edges (i.e., complete clearance within mangrove/forested areas) or

Table 7-10 Definitions of level of impact intensity for all impact types during construction for faunal species receptors

Impact type	Negligible	Low	Medium	High
Loss of/reduction in habitats and food sources	No loss of habitat, raptor nests, or roosts	Loss of <10% of habitat, or roosts	Loss of 10–40% of habitat, or roosts	Loss of >40% of habitat or roosts; loss of any raptor nests
Accidental injury or mortality	Species with negligible susceptibility to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills	Species with low susceptibility to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills: – Volant species (e.g., odonates, butterflies, highly volant birds, most bats) – Aquatic species (most fishes, crabs, shrimps)	Species that are mobile but possibly susceptible to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills: – Less volant birds – All amphibians – Some mammals (e.g., squirrels, shrews)	Species with high susceptibility to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills: – Reptiles – Some mammals (e.g., Sunda pangolin, long-tailed macaque, smooth-coated otter)
Human-wildlife conflict	Species that are not perceived as nuisances or threats by construction personnel: – Odonates – Butterflies – Most birds – Aquatic species	Species that are possibly perceived as both nuisances and threats by construction personnel, less tolerant of human presence and urban environments: – Some reptiles – Most amphibians – Most bats	Species that are typically perceived as nuisances and possibly as threats by construction personnel, highly tolerant of human presence and urban environments, and frequently implicated in human-wildlife conflict: – Smooth-coated otter – Aculeate hymenopterans	Species that are typically perceived as both nuisances and threats by construction personnel, highly tolerant of human presence and urban environments, and are frequently implicated in human-wildlife conflict: – Long-tailed macaque – Some snakes
Light disturbances	Species that are not sensitive to changes in light levels: aculeate hymenopterans, most aquatic and marine species	Species that are slightly sensitive to changes in light levels: odonates, butterflies	Species that are sensitive to changes in light levels: diurnal birds, reptiles and mammals	Species that are extremely sensitive to changes in light levels: nocturnal, crepuscular fauna and nesting/hatching sea turtle species, migratory birds
Human disturbances	Species that are not sensitive to human presence	Species that are slightly sensitive to human presence	Species that are sensitive to human presence	Species that are extremely sensitive to human presence, and nesting birds

Table 7-11 Definitions of each level of likelihood for all six impact types during construction for faunal species receptors

Likelihood	Loss of/ reduction in habitats and food sources	Accidental injury or mortality	Human- wildlife conflict	Loss of/ reduction in ecological connectivity for faunal movement	Light disturbances	Human disturbances
Unlikely/ Remote	Impact is not expected to happen during the construction phase of the project					
Less Likely/ Rare	Impact is not likely to happen during the construction phase of the project					
Possible/ Occasional	Impact could possibly happen or known to occur during the construction phase of the project					
Likely/ Regular	Impact is a common occurrence during the construction phase of the project					
Almost Certain/ Continuous	Impact is a continual or repeated process during the construction phase of the project					

7.4.1 Habitats

Three construction phase impacts were assessed for the identified habitat receptors: (1) Loss of vegetation, (2) Habitat degradation and (3) Formation of forest edge.

Loss of vegetation

Only loss of vegetation resulted in “Major” impact significance for all habitat receptors as more than 40% of each habitat (resulting in “High” impact intensity; refer to Table 7-10) is “Certain” (Table 7-9) to be removed due to proposed development.

Habitat degradation and Formation of forest edge

For habitat degradation and formation of forest edge impact type, only the native-dominated secondary forest and urban vegetation habitats were assessed as proposed development would result in complete clearance of abandoned-land forest and scrubland habitats and therefore these habitats will not be present for the assessment. Subsequently, as more than 40% of the native-dominated secondary forest habitat types overlap with the impact zone (areas 30 m from work site), impact intensity was considered “High”. Together with a likelihood of “Less Likely” (see assumption in Section 7.4.), impact significance was assessed as “Minor”. As the urban vegetation is outside of the impact zone, impact intensity was considered “Low” with a likelihood of “Less Likely” resulted in impact significance of “Negligible”.

A summary of the key biodiversity habitat receptors impacted during construction phase is shown in Table 7-12 while the detailed evaluation for each habitat is provided in Appendix L.

Table 7-12 Summary of pre-mitigated construction phase impacts to habitat receptors

Impact type	Impact Significance			
	Major	Moderate	Minor	Negligible
Loss of vegetation	- Native-dominated secondary forest - Abandoned-land Forest	Scrubland	Urban vegetation	-

Impact type	Impact Significance			
	Major	Moderate	Minor	Negligible
Habitat degradation	-	-	• Native-dominated secondary forest	• Urban vegetation
Formation of forest edge	-	-	• Native-dominated secondary forest	• Urban vegetation

7.4.2 Flora

In the assessment of the two types of impact for individual species during the construction phase – (1) mortality, (2) decline in plant health and survival – the impact significance was Minor, Moderate, or Major. Only the most severe impact for each species from the assessment of all two impact types is presented.

Mortality

All 21 flora species receptors were assessed to be Major for mortality, owing to the total site clearance of the Study Area.

Decline in plant health

All the 21 flora species receptors within the Study Area will be removed during site clearance (i.e., subjected to mortality impact). Therefore, it is assumed that there will be no remaining plants in the Study Area to assess this impact type and the impact significance will be N.A. for all 21 flora receptor species.

A summary of the impact to flora receptors is provided in Table 7-13. The detailed evaluation for each species is provided in Appendix M.

Table 7-13 Summary of pre-mitigated construction phase impacts to flora species receptors

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Mortality	21	—	—	—
Decline in plant health	—	—	—	—

7.4.3 Fauna

Three construction phase impacts were identified and assessed for faunal receptors for the pre-mitigated impact assessment: (1) loss of or reduction in habitats and food sources, (2) accidental injury or mortality, and (3) human-wildlife conflict. Impact significance was assessed for the faunal receptors identified in Section 7.2.3. The resulting impact significance ranges from Negligible to Major, with the assumption that minimum controls (detailed in Section 7.3.1) are properly implemented and enforced.

Loss of or reduction in habitats and food source

There will be a 100% loss of the entire Woodlands N1 study area due to residential development. The likelihood is "Certain" for 26 species and thus impact significance was assigned as "Major".

Accidental injury or mortality

Due to total clearance of the site, there is a probable chance where fauna would come into accidental injury or mortality.

After considering key minimum control measures such as implementing proper hoarding around the worksite to prevent fauna entry, pre-felling inspections, establishing a wildlife response plan, and utilizing wildlife-friendly soil erosion measures (such as biodegradable erosion control blankets), accidental injury or mortality of fauna during construction are deemed "Minor" for all species.

Human-wildlife conflict

Fauna species that tend to avoid human presence and thus not seen as a nuisance to construction personnel such as butterflies, birds and bats have "Negligible" impact significance.

As for the remaining species, Long-tailed macaque (*Macaca fascicularis*) have been assessed to have a likelihood of "Possible" for human-wildlife conflict. They might be attracted to food waste and other materials in the worksite, which could potentially lead to a possible encounter on site. Hence, the impact assessment for this species is "Moderate".

A summary of the impact to fauna receptors is provided in Table 7-14. The detailed evaluation for each species is provided in Appendix N.

Table 7-14 Summary of pre-mitigated construction phase impacts to fauna species receptors

Impact Type	Impact Significance/No. of Species			
	Major	Moderate	Minor	Negligible
Loss of or reduction in habitats and food sources	26	0	0	0
Accidental injury or mortality	0	0	26	0
Human-wildlife conflict	0	1	0	25
Human disturbances	NA	NA	NA	NA
Light disturbances	NA	NA	NA	NA

7.4.4 Recommended Mitigation Measure

This section discusses the mitigation measures for future residential developments, which are implemented based on the mitigation hierarchy in the following order: (1) avoidance, (2) minimisation, and (3) enhancement/rehabilitation as well as compensation. Avoidance of the impact is first attempted. If avoidance is not possible, efforts are made to minimize construction impacts. Finally, if habitat loss is inevitable, suggestions for compensation and enhancement/rehabilitation of remaining and/ or nearby habitats are proposed as a form of impact mitigation.

It is important to note that the successful implementation of mitigation measures relies on the commitment of contractors, arborists, and biodiversity specialists. Some of the major concerns around this project include habitat loss, accidental injury or mortality and human-wildlife conflict.

7.4.4.1 Construction Phase

7.4.4.1.1 Avoid

After much deliberation with HDB and consultation with architects and planners, HDB has agreed to make changes to its development plans to avoid AHEV as recommended in Section 6.4.4. With the future road widening along Marsiling Road and to minimise the loss of dwelling units (DUs), this would result in retaining about 90% of the native-dominated secondary forest (Figure 7.4.1). This area retained has also included a 15 m buffer from the last line of native trees within the forest patch. Nevertheless, in Section 7.4.6.2, we note that the road widening work along Marsiling Road will encroach into the proposed area to be retained. The actual working space required is not available at the current stage and only an indicative line is shown on Figure 7.4.1 to show the possible setback of the AHEV boundary in the south.

This would not only avoid vegetation loss for the native-dominated secondary forest, but it will also avoid plant mortality for rare and threatened plant species. Subsequently, this will also help reduce impact to fauna from the loss of/reduction in habitats and food sources and can also be used as a stepping stone and buffer zone to the main connectivity network for fauna and plant species.

Though forest edge effects will occur on the east of retained area, at the boundary of the forested that has been cleared for development, further mitigation measures can help reduce forest edge effects. This included providing of infill planting along the forest edge to maintain the microclimate and environment conditions, planting palette to include species that would attract fauna such as butterflies and birds, etc. These mitigation measures are also stated in Section 7.4.4.1.2 and should be implemented together to ensure the best outcome of all the mitigation measures proposed.



Legend

- Indicative working space needed from Marsiling Road for future road widening
- Proposed area to be retain
- Study Area

Vegetations

Native-dominated secondary forest	Others (Farm)
Abandoned-land forest	Others (Infrastructure)
Scrubland	Others (Construction)
Urban vegetation	

-	JUL 2024	KRT	Final Report	SAG	JAG	
Rev.	Date	By	Description	Chk'd	App'd	

Qualified Person Endorsement :
NA

HDB Endorsement : NA

Consultant :

Project Title :
SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT WOODLANDS N1

Designed KRT	Checked SAG	Approved JAG
	Drawn KRT	Date JUL 2024

Client:

Figure Title :
Area of AHEV that will be retained within the biodiversity Study Area

Figure No. : 7.4.1	Rev. -	Sheet 1 of 1
CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

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7.4.4.1.2 Minimise

In addition to minimum controls in Section 7.3.1, other measures to minimise biodiversity impacts during the construction phase are summarised in Table 7-15.

Table 7-15 Key recommended measures to minimise biodiversity impacts during construction phase

Receptors	Impact Types	Mitigation Measures
Habitats	- Habitat degradation - Formation of forest edge	- Infill planting within the 15 m buffer. - Planting palette should take reference from native-dominated secondary forest species composition.
Flora species	- Plant mortality - Decline in plant health	Transplantation / salvaging of threatened and/or rare plant species that would be impact.
Faunal species	Loss of/reduction in habitats and food sources	Planting palette should include plant species that would attract fauna such as butterflies and birds.
	- Accidental injury or mortality - Human-wildlife conflict	- Directional site clearance to shepherd fauna to an area allowing them to leave by themselves or through rescue and relocation if needed. - To minimise entry of fauna into the site, the integrity of hoarding must be maintained at all times. Gaps in hoarding facilitates entry of fauna into the construction site. Regular inspections should be conducted to ensure there are no gaps in hoarding at all times. - Adopt road calming measures such as speed bumps and speed limits (15km – 20km/h) to minimise roadkill accidents. - Conduct biodiversity awareness training to worksite personnel and educate on actions to take when encountering wildlife. - Ensure good housekeeping controls such as provision of wildlife-proof bins and indoor eating areas. - Conduct regular inspections to ensure contractor compliance to the EMMP and identify potential faunal entrapments. - Conduct roost emergence prior to bamboo felling works, ecologist to be present during bamboo felling to ensure that any bamboo bats will not be injured in the process and bamboo bat translocation.
	Human disturbances	No encroachment into proposed area to retain
	Light disturbances	- Minimum 6m noise barriers during all construction phases. - Light management plan as night works will most likely occur due to construction of D-wall.

7.4.5 Residual Impacts

The assessment of residual impacts in this section is evaluated based on the assumption that minimum controls together mitigation measures proposed in Section 7.4.4 for the assessment.

7.4.5.1 Habitats

Loss of vegetation

Due to avoidance of about 90% of the native-dominated secondary forest, impact intensity for was reduced to “Low”, resulting in residual impact significance of “Moderate”. There was no change in impact significance for

abandoned-land forest and scrubland as more than 40% of its habitat type is still proposed to be cleared for development. Subsequently, Impact significance for urban vegetation remained at minor as a large proportion of its habitat type existed outside the proposed development and will not be cleared.

Habitat degradation and Formation of forest edge

Pre-mitigated impact significance for habitat degradation to abandoned-land forest and scrubland was not assessed due to 100% clearance for proposed development. However, due to retention of AHEV, a small percentage (<10%) of abandoned-land forest and scrubland would be safeguarded as part of the 15m buffer to AHEV. As these habitats are now part of the 15m buffer, it is inevitable that these habitats will face “High” impact intensity from habitat degradation and edge effects. In addition, with implementation of mitigation measures such as infill planting and proper water resource and construction management (Section 7.3.2) during construction phase, impact intensity can be reduced to “Medium”. Together with likelihood of “Less Likely”, residual impact significance is “Minor” to “Negligible”.

A summary of the impact to habitat receptors is provided in Table 7-16. The detailed evaluation for each species is provided in Appendix L.

Table 7-16 Summary of post-mitigated construction phase impacts to habitat receptors

Impact type	Impact Significance			
	Major	Moderate	Minor	Negligible
Loss of vegetation	Abandoned-land Forest	- Native-dominated secondary forest - Scrubland	Urban vegetation	-
Habitat degradation	-	-	- Native-dominated secondary forest - Abandoned-land forest	- Scrubland - Urban vegetation
Formation of forest edge	-	-	- Native-dominated secondary forest - Abandoned-land forest	- Scrubland - Urban vegetation

7.4.5.2 Flora

Mortality

Major impact significance was assessed for all 21 plant species at the pre-mitigated scenario. With the implementation of mitigation measures, especially with avoidance of AHEV, the impact could be reduced to either Moderate, Minor or Negligible. For plant species that was not included within the retained AHEV area, transplantation or salvation of plant specimens can help minimise species mortality. For example, it is recommended to transplant the *Dioscorea hispida* and plant it back into the remaining native-dominated secondary forest that will be retained. It is noteworthy that this assessment does not account for the success rate of transplantation and/or salvaging procedures as this is determined by several external factors, such as adaptation of the specimens and/or microclimate condition of the new relocation venue.

Decline in plant health

Pre-mitigated impact significance for decline in plant health was not assessed for all 21 flora species receptors and all will be removed during site clearance. With the implementation of mitigation measures, the impact significance was assessed as either Moderate, Minor or Negligible. This was largely depended on several factors, including distance from development and how likely the retained area was accessible to public.

A summary of the impact to flora receptors is provided in Table 7-17. The detailed evaluation for each species is provided in Appendix M.

Table 7-17 Summary of post-mitigated construction phase impacts to flora receptors

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Mortality	—	8	3	10
Decline in plant health	—	1	9	11

7.4.5.3 Fauna

For assessing residual impacts, the scenario where retaining the AHEV is considered. Thus, all 26 faunal species receptors are assessed for five ecological impact types instead of the three in the pre-mitigated assessment. Two additional impact types considered are human disturbance and light disturbance.

Loss of or reduction in habitats and food sources

The residual likelihood remains “Certain” for all species as retaining the AHEV still results in more than 40% clearance of preferred habitats for all species. Therefore, residual impact significance remains as “Major” for all species.

Accidental injury or mortality and human-wildlife conflict

The likelihood of accidental injury or mortality remained the same as “Less likely” for all species as there is still a chance of animals getting injured due to a large area of their habitat being cleared (more than 40%).

The likelihood of human-wildlife conflict occurring for Long-tailed macaques (*Macaca fascicularis*) can be reduced if mitigation measures recommended in Section 7.4.4 are followed, thus reducing the impact significance from Moderate to Minor. Mitigation measures to reduce these impacts include biodiversity awareness training, implementing macaque proof bins and designated eating areas.

For the impact of human-wildlife conflict, Black-headed collared snake (*Sibynophis melanocephalus*) and Sunda Pangolin (*Manis javanica*) increased to “Less likely” for impact significance as there is a higher chance of encountering them after retaining the area of high ecological value (additional green space). In addition, there might also still be a slight chance that snakes would still be viewed as a nuisance/and or threat even with mitigation measures such as biodiversity awareness training.

Human disturbance

Impact significance for all species is deemed “Minor” after considering the mitigation of no encroachment into the retained AHEV. There is still a slight chance of humans entering the retained area as construction is adjacent to it.

Light disturbance

Construction of the HDB is located adjacent to the retained AHEV.

There will be night works for building construction works. As such, a light management plan should be implemented to minimise light disturbance into the retained area of high ecological value.

A minimum of 6m noise barrier is also suggested as a mitigation measure to block the light from coming into the retained area of high ecological value. However, there might still be light disturbance as the 6m noise barrier might not be sufficient to block off the lights due to the topography of the site.

After considering mitigation measures, impact significance for all species is deemed “Minor” for the impact light disturbance.

A summary of the impact to fauna receptors is provided in Table 7-18. The detailed evaluation for each species is provided Appendix N.

Table 7-18 Summary of post-mitigated construction phase impacts to fauna receptors

Impact Type	Residual Impact Significance/No. Of Species			
	Major	Moderate	Minor	Negligible
Loss of or reduction in habitats and food sources	26	0	0	0
Accidental injury or mortality	0	0	26	0
Human-wildlife conflict	0	0	3	23
Human disturbance	0	0	26	0
Light disturbance	0	0	26	0

7.4.6 Cumulative Impacts

Two major concurrent developments have been identified in Section 3.5 to be in the vicinity of Woodlands N1 worksite.

7.4.6.1 HDB Marsiling Cascadia

The HDB Construction of Marsiling Cascadia is located at the south of the Woodlands N1 Project Site. This construction site are new placement flats that are estimated to be completed by 2027/2028.

7.4.6.2 Woodlands Checkpoint Redevelopment External Infrastructure Works

There will be road widening along Marsiling Road by ICA as part of the extension from 2026 onwards.

Impacts to habitat and flora

The impact from road widening depends on the slope stabilization method used. If the slope is going to be graded from road level to top of slope, there will be tree removal along the forest edge. This will lead to new formation of forest edges and habitat degradation, especially in the south where the AHEV interfaces the Marsiling Road. Cumulative impact likely significantly increases in this situation.

However, if slope stabilization methods such as contiguous bore piles are deployed, the proposed retained area will not be touched. Thus, the cumulative impact would be minimal instead.

Impacts to fauna

With considerations to these works, cumulative impacts to fauna would be minimal in terms of noise and dust. Proper hoarding is in place to mitigate impacts.

7.5 Impacts of Biodiversity due to changes in other Environmental Parameters

7.5.1 Impacts due Surface Water Quality Changes

Construction phase of the Project will entail various on-site activities which could directly, or indirectly cause the pollution of the receiving watercourses in the vicinity of the Project site. Consequently, this may cause disturbances and have adverse impacts on the surrounding habitats, flora and fauna. Given the variety of the activities planned for the construction phase, it is expected that sources (and therefore potential pollutants), pathways and mechanisms of pollution will vary. Following sub-sections provide the key considerations and detail prediction and evaluation of impacts on water resources and consequent impacts on identified ecological receptors, expected to arise from the construction phase of the Project. As mentioned earlier, Project site is partially located within the catchment area of Upper Seletar Reservoir. Once the water reaches the reservoir, it will be treated and used for beneficial purposes such as drinking or industrial processes. Detailed assessment of impacts on Upper Seletar Reservoir due to potential changes in water quality can be found in Appendix T.

7.5.1.1 Identification and Categorisation of Sensitive Receptors

Screening of ecological sensitive receptors with regards to potential surface water quality changes was conducted for the Study Area for construction phase of the Project, with reference to biodiversity baseline findings (refer to Section 6.4 of this Report), as well as taking into consideration proposed future land use plans. Sensitivity of identified ecological receptors was based on the criteria detailed in Table 5-2.

Biodiversity baseline study has found that the area currently consists of 4 vegetation habitats: abandoned-land forest (38.1%), urban vegetation (24.2%), native-dominated secondary forest (15%) and scrubland (5.5%). Other habitats include farmland (3.1%), infrastructure (13.2%) and construction area (1%). As there are no watercourses within the Study Area, no aquatic habitats were observed.

As per development plans, majority of the site will get cleared to make way for the new developments. As per biodiversity baseline findings and recommendations, only the habitats at the southwest portion of the site (i.e. AHEV, as described in Section 6.4.4) were recommended to be preserved. Based on the current elevation of the AHEV (refer to Figure 6.3.2) and proposed future platform levels (approx. 13 mRL – 16 mRL), it can be observed that the majority of AHEV will be above the future ground levels. In addition, hydrological baseline study has found that the AHEV falls within the 2 sub-catchments (i.e. northern and southern, denoted as 1 and 4 on Figure 6.5.3), placing the AHEV upstream of the developments. Based on these considerations, in the event that any surface water and groundwater contamination occurs within the developments, it is unlikely that that contamination would propagate towards AHEV. Therefore, AHEV was not taken as an ecological sensitive receptor. As detailed in the hydrological baseline analysis (refer to Section 5.2.3.2.1 of this Report), water from southern portion of the site eventually gets discharged into Marsiling Park Pond. Therefore, the Pond and its associated habitats was taken as a potential sensitive ecological receptor. The water from the northern portion of the Project site flows into drain along Admiralty Road, towards northern urbanised areas.

Table 7-19 Classification of water resources ecological sensitive receptors identified within the Study Area for construction phase

Sensitive Receptor	Receptor Description	Receptor Classification
Pond at Marsiling Park and Associated Habitat	- Man-made pond with concretised banks and recreational infrastructure - Water from the Pond flows in two directions – one flows north, towards the concrete canal and from there towards the Sungei Mandai Kechil and sea, while in the south the water flows into the canal via which the water eventually reaches Upper Seletar Reservoir - Northwestern portion of the Marsiling Park, adjacent to the Pond is dominated by mangrove habitats which are generally uncommon in Singapore due to anthropogenic activities and land developments	Priority 1

7.5.1.2 Impact Assessment

As detailed in Section 7.1.2 of this Report, surface water quality of the watercourses in the vicinity of the Project site could be impacted due to various pollution sources and waste streams expected to be generated during the construction phase. If not managed properly, these potential pollution sources may have adverse impacts on the surrounding environment, including the receiving waterbodies and their associated habitats. Based on the proposed construction phase activities, the following key sources of impacts were identified:

- Silty effluent originating from surface runoff from exposed soil
- Extracted groundwater
- Other liquid effluents and construction wastewater
- Leachate of pollutants from waste stored on-site
- Accidental spills and leaks of pollutants due to improper managements (storage, handling, disposal) of chemicals and waste

Silty Effluent

Construction phase activities such as site clearance, earthworks and foundation works are expected to increase the amount of bare soil within the Study Area. If the exposed soil is left uncovered, rainfall events could cause erosion, resulting in elevated concentrations of suspended solids (e.g. silt) and any pollutants within the soil (if any) within the generated surface runoff. Untreated, such discharges with high concentration of suspended solids could deteriorate the quality of the downstream receiving watercourses by increasing its sedimentation rates and turbidity. Besides reducing the aesthetic value of the waterbody, increased turbidity could cause water quality changes which have a potential to be fatal for the aquatic environment.

As mentioned earlier, there are no watercourses present within the site and surface runoff from the southern portion of the site gets discharged into Pond at Marsiling Park (via drains and culvert). As the pond is connected to the potentially sensitive mangrove habitats in the northwest, in the event that silty effluent gets discharged into roadside drains accidentally, baseline conditions of the immediate receiving waterbody may alter, consequently impacting associated habitats. The impact intensity of this impact was assessed to be **Medium**, taking into account that the current water quality baseline shows that the surface runoff from the site has relatively low concentrations of TDS and TSS. Although the Pond within Marsiling Park is a manmade waterbody with concretised banks, it is adjacent to mangrove habitats which are not common in Singapore and therefore was categorised as Priority 1 sensitive receptor. Therefore, impact consequence on this receptor was assessed to be **Medium**. As a part of the mandatory practices, the Contractor should provide biodegradable erosion control blankets (ECB) to cover any bare soil/ stockpiles within the site. Besides limiting soil shifting and moving, ECBs also filter the water, reducing the overall concentration of suspended sediments in surface runoff originating from these areas. Furthermore, appropriate ECM have to be implemented on the site to ensure that the water meets the NEA Trade Effluent criteria, prior to any discharge into the surrounding drains. The discharge into public drains is also controlled by continuous monitoring of discharge via CCTV which monitors the among of suspended solids in the discharged effluent. Other minimum controls such as sealing of site hoarding, construction of berms along the site hoarding and construction of cut-off drains are expected to further reduce the potential for the uncontrolled discharges of silty effluent into the surrounding environment. Under the assumption that these as well as other minimum controls (as detailed in Table 7-4) have been successfully implemented, it was assessed that it is **Less Likely** that the uncontrolled discharges of silty effluent would occur during the construction phase of the Project. The overall impact significance was therefore assessed to be **Minor** (as per Impact Significance Matrix, as shown in Table 5-16).

Other Liquid Effluents and Construction Wastewater

Besides silty effluents, it is expected that the proposed construction activities will result in significant amount of other liquid effluents and construction wastewater which may include sanitary discharges, stormwater runoff from waste storage facilities etc. Such effluents besides elevated silty content may also contain variety of other pollutants ranging from human pathogens (e.g. from sanitary discharges) to heavy metals and other toxic substances (e.g. from waste storage areas). Given the variety of pollutants, both in nature and concentration, uncontrolled discharge of such effluent could affect the baseline quality of receiving watercourse, potentially affecting the associated habitats. Therefore, the impact intensity was assessed to be **Medium**.

As Pond at Marsiling Park with its associated habitats was categorised as Priority 1 sensitive receptor, impact consequence was assessed to be **Medium** (as per Table 5-14). As detailed in Section 7.3.2, dedicated procedures for inspection and maintenance of wastewater collection, storage and treatment infrastructure (e.g. pipes, separators, etc.) should be developed prior to construction works and implemented during the construction phase. The hazardous material (e.g. oil water, thinners, solvents) have to be stored under shelter with a kerb around the storage area, to prevent uncontrolled discharges to the surrounding area, in the event of spillages or leakages of such chemicals. Therefore, the likelihood of this impact was assessed to be **Rare** and the overall impact significance was assessed to be **Minor** (as per Impact Significance Matrix, as shown in Table 5-16).

Leachate of pollutants from waste stored on-site

Based on the planned activities during the construction phase of the Project, it is expected that significant amount of solid waste would be generated. This includes waste such as faulty construction material, solid materials from excavation and site clearance activities, empty containers, etc. If not stored and managed properly, pollutants originating from these materials/ waste may seep into the ground, potentially contaminating groundwater and consequently downgradient surface watercourses either via transmission through soil or direct discharge of groundwater via soil drainage pipe. If these contaminants reach downgradient watercourses, they can alter the water quality of the receiving watercourse, potentially impacting the related habitats.

Given the fact that baseline surface water quality indicates generally low concentrations of tested parameters, vast majority of which do not exceed the adopted aquatic life criteria, potential leachate of pollutants could alter the baseline quality and hence the impact intensity was assessed to be **Medium**. With regards to Pond in Marsiling Park and associated habitats, these potential pollutive leachates may contaminate the receiving water bodies surrounding the site, eventually reaching the Pond. Since the Pond at Marsiling Park was categorised as Priority 1 sensitive receptor, as per Impact Consequence Matrix (Table 5-14) the impact consequence was assessed to be **Medium**. However, successful implementation of recommended minimum control measures, such as regular clearing of disposal facilities/ areas, as well as development and implementation of appropriate management and disposal procedures for various waste streams is expected to significantly reduce the possibility of uncontrolled leachate of pollutants. Therefore, the likelihood of this impact was assessed to be **Rare** and the overall impact significance was assessed to be **Minor**, as per Impact Significance Matrix (refer to Table 5-16).

Accidental spills and leaks of pollutants

Another potential mechanism to surface water contamination during construction phase of the Project could be through accidental spills and leaks of chemicals used and stored on site due to improper management practices, human mistakes and faulty equipment. In the event of such releases, contaminants could either be discharged directly into the watercourse or it can reach watercourse via soil and groundwater. Taking into consideration the localised nature of such uncontrolled discharges into the environment (if any) and dilution effects that naturally occur in water, the impact intensity was assessed to be **Low**. As the Marsiling Park Pond was assessed to be Priority 1 sensitive receptor, and as per Impact Consequence Matrix (Table 5-14), the impact consequence was assessed to be **Low**. In order to reduce the potential of such accidental spills that could have adverse effects to the baseline water quality, the Contractor should assure that the dedicated procedure for storage, maintenance and management of chemicals during the construction phase of the Project have been developed and implemented. These may include, but are not limited to, assuring the storage of the chemicals to be on the paved ground, bunded and with appropriate ventilation, located away from the closest receiving watercourse and using multiple containers for chemicals and diesel generators. Construction equipment and machinery should be checked regularly and any equipment/ machinery that is found to be faulty should be repaired in the designated area which is appropriately contained. Similarly, any servicing of the machinery and equipment should be carried out in designated areas. Emergency response kits should always be kept on the site, ready for competent emergency response team to use in the case of unexpected discharges. Based on the beforementioned considerations, the likelihood of accidental spills was assessed to be **Rare** during the construction phase. Therefore, the overall impact significance of this impact to Marsiling Park Pond and associated habitats was assessed to be **Minor**.

7.5.1.3 Proposed Mitigation Measures

No additional mitigation measures aside from the proposed minimum controls were proposed to further minimise the adverse impacts on the surface water quality as none of the impacts on the ecological sensitive receptors have been assessed to be Moderate or Major.

7.5.1.4 Residual Impact Assessment

No residual impact assessment has been undertaken as no Moderate or Major impact significance on sensitive receptors were assessed.

7.5.1.5 Cumulative Impacts

It is assumed that all the concurrent developments will comply with the construction standards and environmental management and control. Therefore, it is not expected that they will increase impacts on water resources.

Table 7-20 Summary of surface water quality impact assessment during construction phase of the Project

Impact	Source of Impact	Sensitive Receptor	Receptor Sensitivity	Impact Intensity	Impact Consequence	Impact Likelihood	Impact Significance
Disturbances in habitat and/ or reduction in size of species population due to contamination of receiving watercourses	Silty effluent originating from the site from exposed soil	Pond at Marsiling Park and Associated Habitat	Priority 1	Medium	Medium	Less Likely/ Rare	Minor
	Other liquid effluents and construction wastewater generated as by-product of proposed activities			Medium	Medium	Less Likely/ Rare	Minor
	Leachate of pollutants from solid waste managed on site			Medium	Medium	Less Likely/ Rare	Minor
	Accidental spills and leaks of pollutants due to improper management of chemicals and toxic waste			Low	Low	Less Likely/ Rare	Minor

7.5.2 Impacts due to Groundwater Changes

As detailed in the Section 7.1.2, the activities planned during the construction phase of the Project may cause groundwater contamination and/ or reduction of groundwater levels, which subsequently could have adverse effects on ecological receptors. The following sub-sections detail the identified sensitive receptors as well as corresponding assessment of impacts to these receptors.

7.5.2.1 Identification and Categorisation of Sensitive Receptors

The receptor screening for groundwater changes was conducted within the Study Area, and classified based on the methodology outlined in Table 5-2. The following table identifies potential groundwater sensitive receptors and summarises sensitivity of each of the receptors.

Table 7-21 Classification of groundwater ecological sensitive receptors identified within the Study Area for construction phase

Sensitive Receptor	Receptor Description	Environmental Parameter	Receptor Classification
Area of High Ecological Value (AHEV)	- Native-dominated secondary forest, including a 15-m buffer from the last row of native trees - AHEV will also be used as a stepping stone and bigger zone to the main ecological connectivity network - As the groundwater levels within the site are monitored to be low (i.e. more than 5 m bgs), it is unlikely that this habitat is dependent on the groundwater quantities or quality	Groundwater Level	Priority 3
		Groundwater Quality	Priority 3
Pond at Marsiling Park and Associated Habitat	- Man-made pond with concretised banks and recreational infrastructure - Part of the water from the Pond eventually reaches Sungei Mandai Kechil - Northwestern portion of the Marsiling Park, adjacent to the Pond is dominated by mangrove habitats which are generally uncommon in Singapore due to anthropogenic activities and land developments - Inferred groundwater flow within the site is towards southeast, away from the Pond	Groundwater Level	Priority 3
		Groundwater Quality	Priority 3

7.5.2.2 Impact Assessment

7.5.2.2.1 Impacts due to Groundwater Level Decrease

Certain pre-construction and construction activities (e.g. earthworks, foundation works) that are planned to be carried out within Project site will require extraction of groundwater from the soil. This will enable dry ground conditions of the excavation areas which is a pre-requisite for safe and successful earthworks. Consequently, soil dewatering might have an impact on current groundwater levels by lowering the water table to required depths. Furthermore, as the pre-construction and construction works progress, more areas which are currently vegetated (and hence pervious) will be replaced with various structures (e.g. buildings, platforms, roads) which are impervious. This might reduce the infiltration of surface water and rainfall into the soil, potentially reducing the current groundwater level.

The potential importance of groundwater level to ecological receptors is twofold – it may feed the surface watercourses and hence support natural habitats and it also may be the main source of water for various plant species that are dependent of groundwater due to the lack of surface water sources.

AHEV was identified as one of the potential ecological receptors. It comprises mostly of native-dominated secondary forest and is located at the central-western part of the site. However, based on the data collected as

part of the groundwater baseline study, the groundwater levels in this part of the site were measured to be 12.39 mRL (approx. 5.4 m bgs). This indicates that the habitats and flora specimens found within AHEV are likely not going to be dependent on the groundwater levels and were categorised as **Priority 3**. Due to the existing low groundwater levels, and unlikely dependency of AHEV to the groundwater resources, in the event that the current groundwater levels further reduce as a consequence of construction phase activities, it is **Unlikely** that such changes will have impact on this receptor. The overall impact significance was therefore assessed to be **Negligible** (as per Impact Significance Matrix, as shown in Table 5-16).

As the Pond at Marsiling Park is a man-made pond with concretised banks, it is unlikely that the Pond will be primarily fed by the groundwater resources. Furthermore, hydrological analysis shows that the pond receives the water from the wider catchment/ drainage network. In addition, the inferred groundwater flow (based on the baseline findings) suggest that the groundwater flows towards southeast, away from the Pond. Based on the beforementioned, the potential changes in groundwater level are **Unlikely** going to have impact on the Pond and associated habitats and therefore the overall impact significance was assessed to be **Negligible**.

7.5.2.2.2 Impacts due to Groundwater Contamination

The activities planned for the construction phase of the Project are expected to generate large amounts of spoil material. The quantity of solid waste stored on site (e.g. excavated soil, debris resulting from demolition activities, construction debris, etc.) is expected to be limited, given the periodical disposal by licenced general and toxic waste contractors as part of minimal controls. In the event that contaminated groundwater is encountered during excavations, implementation of the measures detailed in Figure 7.3.1 and Figure 7.3.2 will ensure that the contaminated soil and/or groundwater is properly managed and disposed.

Besides historical contamination, another potential mechanism to groundwater contamination is through leakage and seepage of contaminants originating from toxic waste that is stored on site as well as from chemicals used and stored on site. The quantity of toxic waste stored on-site is expected to be limited, with the assumption that generated waste will be periodically removed and disposed off-site by licensed Toxic Industrial Waste (TIW) contractors during the construction phase. Chemicals used during the construction phase will be stored at designated sheltered area with access-controlled entrance and concrete bund walls or in storage containers with good ventilation or on spill pallets. In the event of chemical spillage, spill kits will be available on site to be operated by an emergency response team competent in their use.

Groundwater baseline study has found that the inferred groundwater flow is southeast, away from both AHEV and Pond at Marsiling Park. This suggests that it is **Unlikely** that in the event of any groundwater contamination (if it occurs) contaminants will be carried towards any of the identified receptors. In addition, due to the relatively deep groundwater levels, flora found within AHEV is less likely going to be disturbed by such contaminants as they have been assumed to have low dependency of groundwater. Similarly, as the Pond within Marsiling Park has concretised banks, any contamination is unlikely to enter the pond. Therefore, the overall impact significance was assessed to be **Negligible**.

7.5.2.3 Proposed Mitigation Measures

No additional mitigation measures aside from the proposed minimum controls were proposed to further minimise the adverse impacts on the groundwater level and quality as none of the impacts on the ecological sensitive receptors have been assessed to be Moderate or Major.

7.5.2.4 Residual Impact Assessment

No residual impact assessment has been undertaken as no Moderate or Major impact significance on sensitive receptors were assessed.

7.5.2.5 Cumulative Impacts

It is assumed that all the concurrent developments will comply with the construction standards and environmental management and control. Therefore, it is not expected that they will increase impacts on ecological receptors.

7.5.3 Impacts due to Noise Level Change

7.5.3.1 Identification and Categorisation of Sensitive Receptors

The prioritization of the ecological receptors within and surrounding the Study Area follows the approach listed in the below factors:

- The actual presence or likely presence (from records) from faunistic field assessment conducted
- The conservation significance or importance of the identified ecological receptors
- The ecological receptor's likelihood to be sensitive to airborne noise impacts

Based on faunistic field assessment conducted within and surrounding the Study Area of the Project, a summary of the identified ecological receptors of concern in line with the biodiversity section are shown in Table 7-23. These identified fauna species, mainly Priority 1 and Priority 2, are of particular concern due to their auditory sensitivities to airborne noise. The following paragraphs discuss the ecological receptors and the rationale for their respective auditory sensitivity. The classification of auditory sensitivities of the ecological receptors are applicable for both the construction and operational phases. The priority levels for auditory sensitivity reflected in Table 7-22 were assigned based on the following general framework provided by the biodiversity specialists of this Project:

- Priority 1: Animals that vocalise during important life cycle stages such as courtship, territorial claims and/or mating
- Priority 2: Animals that have auditory sensory systems but do not necessarily need to vocalise during important life cycle stages
- Priority 3: Animals that are not likely to be affected by airborne noise

Amphibians such as frogs are considered to have highly auditory sensitive as studies have demonstrated that anthropogenic noise is likely to substantially decrease the reproductive success in frogs [P-32]. Hence, amphibians are classified as Priority 1 ecological receptors. Birds are considered to be highly auditory sensitive as most make use of sound for communication and. Studies have also shown that birds are impacted negatively by anthropogenic noise [P-20]. Hence, birds are classified as Priority 1 ecological receptors. However, birds will fly away and the only unavoidable impact will be due to the presence of human. Therefore, this study focusses on the assessment of impact of noise on ground-dwelling fauna due to the proposed activities.

While for volant mammals such as bats, anthropogenic noise is known to impact bats negatively by disrupting foraging patterns [P-25] and are hence classified as highly auditory sensitive. Hence, they are classified as Priority 1 ecological receptors. Based on faunistic surveys, a total of six species of bats was observed including one bat of conservation significance (Cave nectar bat) was observed for this Project (refer to Table 7-23).

Non-volant mammals such as rodents are known to display stressed behaviour in response to sounds of heavy machinery which could be common occurrence from construction noise [P-35]. Hence, non-volant mammals are deemed to be auditory sensitive and classified as Priority 2 ecological receptors.

Lepidoptera such as the butterflies are known to behaviourally respond to low-frequency vibrations and sounds to avoid insect predators and parasites [P-21]. Adult butterflies are known to make use of existing airborne noise in order to avoid predators [P-22]. Based on the above, lepidopterans are considered highly auditory. Hence, are classified as Priority 2 ecological receptors. Reptiles such as lizards are considered to be highly auditory sensitive due to studies showing these species exhibiting stress responses when exposed to anthropogenic noise [P-24]. For snakes, though not equipped with outer-ears and tympanic middle ear, have vestiges for hearing inside their heads and can feel low-frequency airborne sounds [P-27]. Turtles on the other hand, follows the classification of aquatic species such as decapod crustaceans and fish due to their ability to traverse land and water [P-28]. As such, reptiles are classified as Priority 2 sensitive ecological receptors.

It is documented that adult odonates appear to be able to hear however sound does not appear to cause significant behavioural change [P-34]. Odonates are consequently regarded as being less auditory sensitive. Hence, they are classified as Priority 3 ecological receptors, dependant on conservation significance. Since there is no aquatic body within the Project site, the auditory classification of marine/aquatic fauna has not been illustrated in Table 7-22.

Table 7-22 Ecological Receptors and Airborne Noise Auditory Sensitivity Classification

S/N	Receptors	Auditory Sensitivity Classification
Terrestrial Fauna		
1	Amphibians - Frogs - Toads	Priority 1
2	Bird	Priority 1
3	Butterfly	Priority 2
4	Non-volant Mammals	Priority 2
5	Volant Mammals (Bats)	Priority 1
6	Odonates - Damselfly - Dragonfly	Priority 3
7	Reptiles - Snakes - Turtles - Lizards	Priority 2

Table 7-23 List of Ecological Receptors with Auditory Sensitivities

No.	Faunal Group	Species	Common name	National Status	Auditory Sensitivity
1	Bird	<i>Acridotheres javanicus</i>	Javan myna	NA	Priority 3
2	Bird	<i>Aegithina tiphia</i>	Common iora	Least Concern	Priority 1
3	Bird	<i>Aerodramus sp.</i>	NA	NA	Priority 1
4	Bird	<i>Amaurornis phoenicurus</i>	White-breasted waterhen	Least Concern	Priority 1
5	Bird	<i>Anthreptes malacensis</i>	Brown-throated sunbird	Least Concern	Priority 1
6	Bird	<i>Aplonis panayensis</i>	Asian glossy starling	Least Concern	Priority 1
7	Bird	<i>Caprimulgus macrurus</i>	Large-tailed nightjar	Least Concern	Priority 1
8	Bird	<i>Chalcophaps indica</i>	Common emerald dove	Least Concern	Priority 1
9	Bird	<i>Chrysophlegma miniaceum</i>	Banded woodpecker	Least Concern	Priority 1
10	Bird	<i>Cinnyris jugularis</i>	Olive-backed sunbird	Least Concern	Priority 1
11	Bird	<i>Corvus splendens</i>	House crow	NA	Priority 3
12	Bird	<i>Dicaeum cruentatum</i>	Scarlet-backed flowerpecker	Least Concern	Priority 1
13	Bird	<i>Dinopium javanense</i>	Common flameback	Least Concern	Priority 1
14	Bird	<i>Eudynamys scolopaceus</i>	Asian koel	Least Concern	Priority 1
15	Bird	<i>Eurystomus orientalis</i>	Oriental dollarbird	Least Concern	Priority 1
16	Bird	<i>Garrulax leucolophus</i>	White-crested laughingthrush	NA	Priority 3

No.	Faunal Group	Species	Common name	National Status	Auditory Sensitivity
17	Bird	<i>Geopelia striata</i>	Zebra dove	Least Concern	Priority 1
18	Bird	<i>Gracula religiosa</i>	Common hill myna	Near Threatened	Priority 1
19	Bird	<i>Halcyon smyrnensis</i>	White-throated kingfisher	Least Concern	Priority 1
20	Bird	<i>Haliastur indus</i>	Brahminy kite	Least Concern	Priority 1
21	Bird	<i>Lonchura leucogastroides</i>	Javan munia	NA	Priority 3
22	Bird	<i>Loriculus galgulus</i>	Blue-crowned hanging-parrot	Least Concern	Priority 1
23	Bird	<i>Merops viridis</i>	Blue-throated bee-eater	Least Concern	Priority 1
24	Bird	<i>Mixornis gularis</i>	Pin-striped tit-babbler	Least Concern	Priority 1
25	Bird	<i>Oriolus chinensis</i>	Black-naped oriole	Least Concern	Priority 1
26	Bird	<i>Orthotomus atrogularis</i>	Dark-necked tailorbird	Least Concern	Priority 1
27	Bird	<i>Orthotomus sutorius</i>	Common tailorbird	Least Concern	Priority 1
28	Bird	<i>Phylloscopus borealis</i>	Arctic warbler	Least Concern	Priority 1
29	Bird	<i>Picus vittatus</i>	Laced woodpecker	Least Concern	Priority 1
30	Bird	<i>Psittacula alexandri</i>	Red-breasted parakeet	NA	Priority 3
31	Bird	<i>Pycnonotus goiavier</i>	Yellow-vented bulbul	Least Concern	Priority 1
32	Bird	<i>Rallina fasciata</i>	Red-legged crane	Near Threatened	Priority 1
33	Bird	<i>Todiramphus chloris</i>	Collared kingfisher	Least Concern	Priority 1
34	Bird	<i>Treron vernans</i>	Pink-necked green pigeon	Least Concern	Priority 1
35	Bird	<i>Zosterops simplex*</i>	Swinhoe's white-eye	Vulnerable	Priority 1
36	Butterfly	<i>Acraea terpsicore</i>	Tawny coster	Least Concern	Priority 3
37	Butterfly	<i>Appias lyncida vasava</i>	Chocolate albatross	Data Deficient	Priority 3
38	Butterfly	<i>Arhopala major major</i>	NA	Least Concern	Priority 3
39	Butterfly	<i>Catopsilia pomona pomona</i>	Lemon emigrant	Least Concern	Priority 3
40	Butterfly	<i>Catopsilia pyranthe pyranthe</i>	Mottled emigrant	Least Concern	Priority 3
41	Butterfly	<i>Delias hyparete metarete</i>	Painted jezebel	Least Concern	Priority 3
42	Butterfly	<i>Doleschallia bisaltide bisaltide</i>	Autumn leaf	Least Concern	Priority 3
43	Butterfly	<i>Dryas iulia</i>	Julia heliconian	Not Evaluated	Priority 3
44	Butterfly	<i>Elymnias hypermnestra agina</i>	Common palmfly	Least Concern	Priority 3

No.	Faunal Group	Species	Common name	National Status	Auditory Sensitivity
45	Butterfly	<i>Eurema blanda snelleni</i>	Three spot grass yellow	Least Concern	Priority 3
46	Butterfly	<i>Hypolimnias anomala anomala</i>	Malayan eggfly	Least Concern	Priority 3
47	Butterfly	<i>Iambrix salsala salsala</i>	Chestnut bob	Least Concern	Priority 3
48	Butterfly	<i>Ideopsis vulgaris macrina</i>	Blue glassy tiger	Least Concern	Priority 3
49	Butterfly	<i>Jamides caeruleus caeruleus*</i>	Sky blue	Critically Endangered	Priority 2
50	Butterfly	<i>Junonia almana javana</i>	Peacock pansy	Least Concern	Priority 3
51	Butterfly	<i>Junonia hedonia ida</i>	Chocolate pansy	Least Concern	Priority 3
52	Butterfly	<i>Leptosia nina malayana</i>	Psyche	Least Concern	Priority 3
53	Butterfly	<i>Pachliopta aristolochiae asteris</i>	Common rose	Near threatened	Priority 3
54	Butterfly	<i>Papilio demoleus malayanus</i>	Lime butterfly	Least Concern	Priority 3
55	Butterfly	<i>Papilio polytes romulus</i>	Common mormon	Least Concern	Priority 3
56	Butterfly	<i>Parantica agleoides agleoides</i>	Dark glassy tiger	Least Concern	Priority 3
57	Butterfly	<i>Phaedyra columella singa</i>	Short banded sailor	Least Concern	Priority 3
58	Butterfly	<i>Phalanta phalantha phalantha</i>	Leopard	Least Concern	Priority 3
59	Butterfly	<i>Plastingia naga</i>	Chequered lancer	Least Concern	Priority 3
60	Butterfly	<i>Potanthus omaha omaha</i>	Lesser dart	Least Concern	Priority 3
61	Butterfly	<i>Troides helena cerberus*</i>	Common birdwing	Vulnerable	Priority 2
62	Butterfly	<i>Unidentified Lycaenidae</i>	Line blue sp.	NA	NA
63	Butterfly	<i>Zizina otis lampa</i>	Lesser grass blue	Least Concern	Priority 3
64	Butterfly	<i>Zizula hylax pygmaea</i>	Pygmy grass blue	Least Concern	Priority 3
65	Odonata	<i>Camacinia gigantea</i>	Sultan	Least Concern	Priority 3
66	Odonata	<i>Gynacantha sp.</i>	NA	NA	Priority 2
67	Odonata	<i>Hydrobasileus croceus</i>	Water monarch	Least Concern	Priority 3
68	Odonata	<i>Lathrecista asiatica</i>	Scarlet grenadier	Least Concern	Priority 3
69	Odonata	<i>Neurothemis fluctuans</i>	Common parasol	Least Concern	Priority 3
70	Odonata	<i>Zygomma petiolatum</i>	Slender duskdarter	Least Concern	Priority 3
71	Reptile	<i>Bronchocela cristatella</i>	Green crested lizard	Least Concern	Priority 3
72	Reptile	<i>Calotes versicolor</i>	Changeable lizard	NA	Priority 3
73	Reptile	<i>Dendrelaphis pictus</i>	Painted bronzeback	Least Concern	Priority 3

No.	Faunal Group	Species	Common name	National Status	Auditory Sensitivity
74	Reptile	<i>Draco sumatranus</i>	Sumatran flying dragon	Least Concern	Priority 3
75	Reptile	<i>Subdoluseps bowringii</i>	Bowring's agile skink	Least Concern	Priority 3
76	Reptile	<i>Malayopython reticulatus</i>	Reticulated python	Least Concern	Priority 3
77	Amphibian	<i>Duttaphrynus bengalensis</i>	Bengal toad	NA	Priority 3
78	Amphibian	<i>Eleutherodactylus planirostris</i>	Greenhouse frog	NA	Priority 3
79	Amphibian	<i>Microhyla heymonsi</i>	Dark-sided chorus frog	Least Concern	Priority 1
80	Amphibian	<i>Polypedates leucomystax</i>	Four-lined tree frog	Least Concern	Priority 1
81	Mammal	<i>Callosciurus notatus</i>	Plantain squirrel	Least Concern	Priority 1
82	Mammal	<i>Paradoxurus musangus</i>	Sumatran palm civet	Least Concern	Priority 1
83	Mammal	<i>Tupaia glis</i>	Common treeshrew	Least Concern	Priority 1
84	Mammal	<i>Suncus murinus</i>	House shrew	Least Concern	Priority 1
85	Mammal	<i>Rattus tiomanicus</i>	Malaysian wood rat	Least Concern	Priority 1
86	Mammal	<i>Rattus tanezumi</i>	Asian house rat	Least Concern	Priority 1
87	Mammal	<i>Canis lupus familiaris</i>	Feral dog	Not Listed	Priority 3
88	Mammal	<i>Cynopterus brachyotis</i>	Lesser short-nosed fruit bat	Least Concern	Priority 1
89	Mammal	<i>Eonycteris spelaea</i> *	Cave nectar bat	Least Concern	Priority 1
90	Mammal	<i>Myotis muricola</i>	Asian whiskered myotis	Least Concern	Priority 1
91	Mammal	<i>Saccolaimus saccolaimus</i>	Pouch tomb bat	Least Concern	Priority 1
92	Mammal	<i>Scotophilus kuhlii</i>	Lesser Asian house bat	Least Concern	Priority 1
93	Mammal	<i>Taphozous melanopogon</i>	Black-bearded tomb bat	Least Concern	Priority 1
Note: * represents the fauna with Conservation Significance (CS).					

7.5.3.2 Impact Assessment

7.5.3.2.1 Assessment Criteria

There are currently no guidelines or standards available to assess the impact of noise from construction activities on the ecological receptors. The current guidelines and standards available are used to assess the respective noise impacts to humans only. Baseline noise levels have been adopted as criteria for identified noise sensitive ecological receptors as mentioned in Section 7.5.3.1. The ecological impact from airborne noise is species dependent, hence the assessment will be based on the species identified by the fauna specialists during site surveys within and surrounding the Study Area as stated in Section 7.5.3.1.

7.5.3.2.2 Potential Sources of Airborne Noise Impact

Construction activities will inevitably result in some degree of noise disturbances at locations in close proximity to the proposed construction worksites of the Project. This is, however, a temporary source of noise. The noise levels generated by the construction activities will have the potential to impact the noise sensitive receptors (NSRs). Noise

levels at the receptors depends on several factors such as the number and type of Powered Mechanical Equipment (PMEs) used, the distance between the NSRs and the construction worksites, and the level of attenuation likely due to ground absorption, air absorption or barrier effects.

The study on the construction noise impacts on the NSRs shall focus on worst-case noisiest activities for the construction activities active during certain construction phases according to the tentative construction schedules and equipment inventory provided by HDB as shown in Appendix V. The intent of selecting the worst-case activity for assessment was such that if noise can be controlled in this activity by permanent features during the entire construction, the noise from other less noisy construction activities will also be mitigated.

The main source of noise is expected to originate from the powered mechanical equipment (PME) used for the different construction stages / construction elements. The potential key phases of construction noise identified and considered for assessment are reflected in Table 7-24.

Based on the construction programme proposed by HDB at the pre-design stage, a total of six (6) construction activities starting with Site Clearance and Earthworks and Road Constructions, followed by Foundation Works, Superstructure, Landscape Works and Removal of Temporary Works and Re-instatement have been planned as part of the activities involved in the residential development within the proposed construction worksite areas (refer to Table 7-24).

Table 7-24 Construction activities of the construction phase

Construction Activity	Tentative Duration*
Activity 1: Site Clearance and Earthworks	18 months (Q1 2025 – Q2 2026)
Activity 2: Road Construction	45- 48 months (Q2/Q3 2024 – Q1 2028)
Activity 3: Foundation Works (Substructures including piles and pile caps)	18 months (Q3 2025 – Q4 2026)
Activity 4: Superstructure (Prefab installation)	36 months (from Q3 2026-Q2 2029)
Activity 5: Landscape Works	12 months (from Q3 2028 – Q2 2029)
Activity 6: Removal of Temporary Works and Re-instatement	12 months (from Q3 2028 – Q2 2029)
Note: * Due to the current pre-design stage of the Project, the construction schedules of each of the six (6) activities listed above are provided tentatively.	

The PMEs and their respective sound power levels (SWL) provided in this study are listed in the equipment inventory list as shown in Appendix V. A summary of the six (6) construction activities and their overall effective SWLs derived from the PMEs engaged in each of these activities are reflected in Table 7-25 below.

Table 7-25 Effective sound power level (construction phase)

No.	Construction Activity	Tentative* Effective Sound Power Level L_{wA} , dB(A) from overall equipment inventory			
		$L_{Aeq}(12 \text{ hours})$		$L_{Aeq}(5 \text{ mins})$	
		7am – 7pm	7pm – 7 am	7am – 7pm	7pm – 10 pm
1	Site Clearance and Earthworks	118	N.A.	121	N.A.
2	Road Construction	110	N.A.	119	N.A.

No.	Construction Activity	Tentative* Effective Sound Power Level L_{wA} , dB(A) from overall equipment inventory			
		$L_{Aeq}(12 \text{ hours})$		$L_{Aeq}(5 \text{ mins})$	
		7am – 7pm	7pm – 7 am	7am – 7pm	7pm – 10 pm
3	Foundation Works (Substructures including piles and pile caps)	127	119	128	128
4	Superstructure (Prefab installation)	117	109	118	118
5	Landscape Works	119	111	120	120
6	Removal of Temporary Works and Re-instatement	120	111	120	120

7.5.3.2.3 Determination of Assessment Scenarios

Considering the noise level generated during different construction activities as per Table 7-25 and the probable schedule of works according to Table 7-24, the cumulative effective sound power levels were calculated from overall equipment inventory for different quarters of project schedule. The scenarios chosen for assessment as discussed in Section 7.5.3.2.2 were based on the worst-case activities with the highest overall SWLs of the construction phase as reflected in Table 7-26 in **bold**. It is notable that the sound power levels (SWLs) reflected in Table 7-26 represents the levels of noise emitted from source (i.e. from PMEs within the proposed construction worksites) which serves as an indicator towards the potential perceived level of noise experienced by the noise sensitive receptors in the vicinity of the Study Area at the receiving end and how noticeable the noise impacts may be, to the receptors.

- **Scenario 1: Road Construction, Site Clearance and Earthworks, and Foundation Works – Day Time (7am to 7pm)**
- **Scenario 2: Road Construction, Foundation Works, and Superstructure – Day Time (7am to 7pm)**
- **Scenario 3: Foundation Works –Night Time (7pm – 7 am for L_{Aeq} (12 hours) and 7 pm -10 pm for L_{Aeq} (5 mins))**
- **Scenario 4: Foundation Works, and Superstructure– Night Time (7pm – 7 am for L_{Aeq} (12 hours) and 7 pm -10 pm for L_{Aeq} (5 mins))**

Table 7-26 Cumulative Effective Sound Power Levels

Timeline	Construction Activities	Cumulative Effective Sound Power Level from overall equipment inventory $L_{Aeq}(12 \text{ hours})$, dB(A)	Cumulative Effective Sound Power Level from overall equipment inventory $L_{Aeq}(5 \text{ mins})$, dB(A)
Day Time (7am - 7pm)			
Q2/Q3 2024 - Q4 2024	•Road Construction	110	119
Q1 2025- Q2 2025	•Road Construction •Site Clearance and Earthworks	119	123
Q3 2025 - Q2 2026	•Road Construction Site •Site Clearance and Earthworks •Foundation Works	128	129
Q3 2026 - Q4 2026	•Road Construction •Foundation Works •Superstructure	128	129

Timeline	Construction Activities	Cumulative Effective Sound Power Level from overall equipment inventory $L_{Aeq}(12 \text{ hours}), \text{dB(A)}$	Cumulative Effective Sound Power Level from overall equipment inventory $L_{Aeq}(5 \text{ mins}), \text{dB(A)}$
Q1 2027 - Q1 2028	•Road Construction •Superstructure	118	121
Q2 2028	•Superstructure	117	118
Q3 2028 - Q2 2029	•Superstructure •Landscape Works •Removal of Temporary Works and Re-instatement	124	124
Night Time (7pm - 7am)			
Q3 2025 - Q2 2026	•Foundation Works	119	128
Q3 2026 - Q4 2026	•Foundation Works •Superstructure	119	128
Q1 2027 - Q2 2028	•Superstructure	109	118
Q3 2028 - Q2 2029	•Superstructure •Landscape Works •Removal of Temporary Works and Re-instatement	115	124

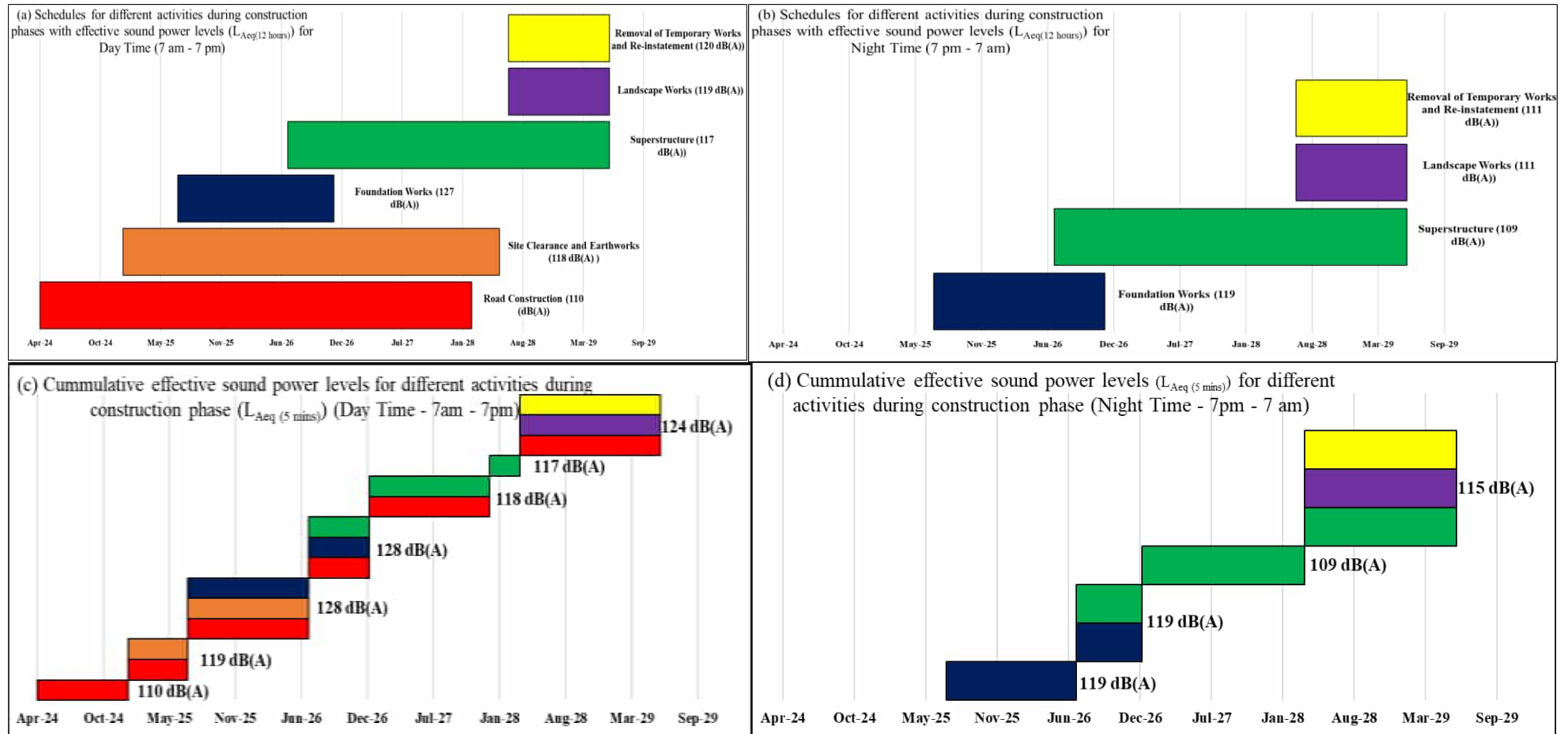


Figure 7.5.1 (a) Tentative schedules and effective power levels ($L_{Aeq(12 \text{ hours})}$) for different construction activities during Day-Time (7am - 7pm), (b) Tentative schedules and effective power levels ($L_{Aeq(12 \text{ hours})}$) for different construction activities during Night-Time (7pm - 7am), (c) Cumulative effective power levels ($L_{Aeq(12 \text{ hours})}$) for Day-Time (7 am - 7 pm), (d) Cumulative effective power levels ($L_{Aeq(12 \text{ hours})}$) for Night-Time (7 pm - 7 am).

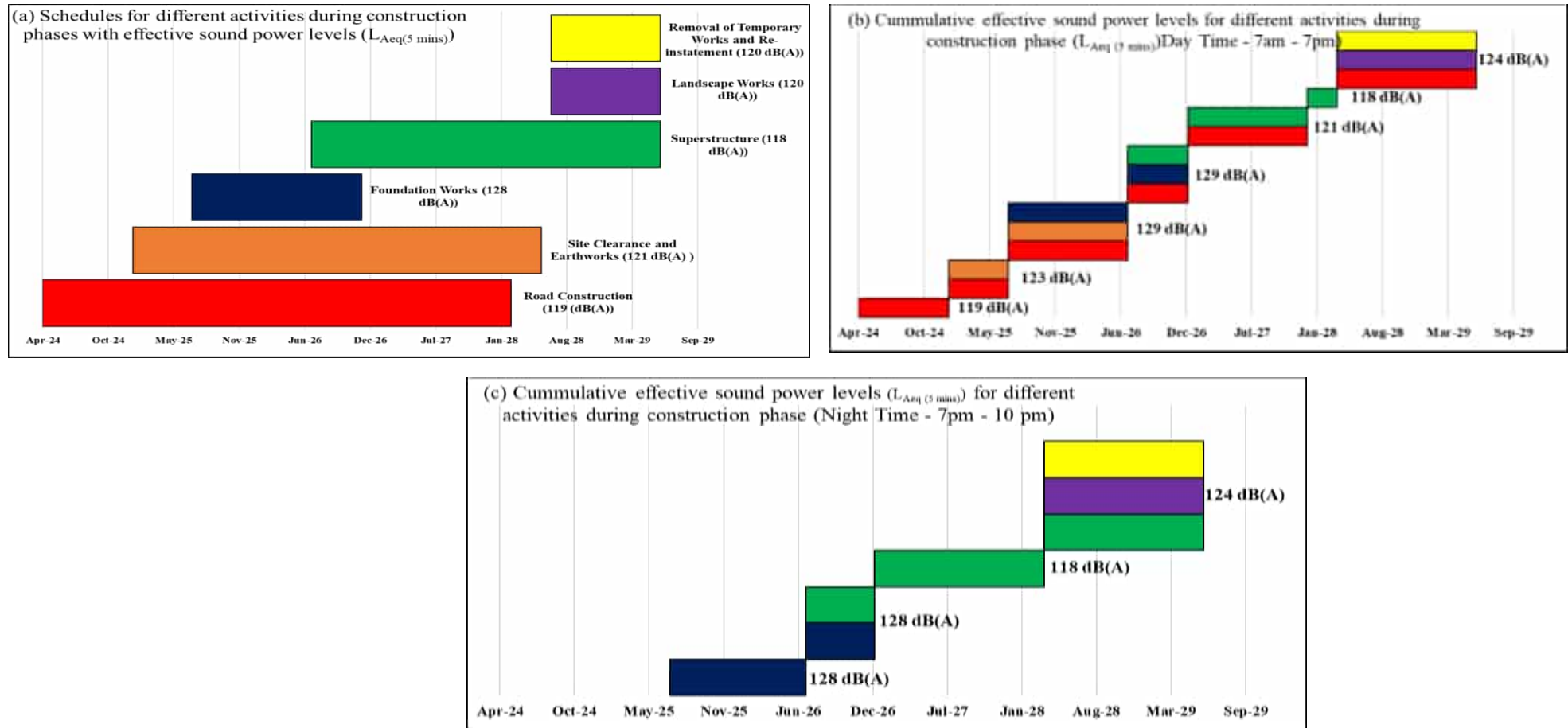


Figure 7.5.2 (a) Tentative schedules and effective power levels ($L_{Aeq}(5 \text{ mins})$) for different construction activities during Day-Time (7am - 7pm), (b) Tentative schedules and effective power levels ($L_{Aeq}(5 \text{ mins})$) for different construction activities during Night Time (7pm – 10pm), (c) Cumulative effective power levels ($L_{Aeq}(5 \text{ mins})$) for Day-Time (7 am -7 pm), (d) Cumulative effective power levels ($L_{Aeq}(5 \text{ mins})$) for Night-Time (7 pm -10 pm).

7.5.3.2.4 Likelihood of Occurrence

The Likelihood of Occurrence of airborne noise impacts were determined based on the active duration of the proposed equipment provided by HDB in Appendix W over the specified working period (e.g., 7am – 7pm, 7pm – 7am), detailed as frequency of exposure in Table 7-27.

Based on the proposed equipment inventory (refer to Appendix V), the frequency of exposure of 0.81 (for $L_{Aeq}(12 \text{ hours})$, dB(A) and Day Time) and 0.25 (for $L_{Aeq}(12 \text{ hours})$, dB(A) and Night Time) corresponds to a Likelihood of Occurrence of 'Certain/Continuous' and 'Possible/ Occasional' respectively (see Table 5-15).

Based on the proposed equipment inventory (refer to Appendix V), the frequency of exposure of 0.90 (for $L_{Aeq}(5 \text{ mins})$, dB(A) and Day Time) and 0.5 (for $L_{Aeq}(5 \text{ mins})$, dB(A) and Night Time) corresponds to a Likelihood of Occurrence of 'Certain/Continuous' and 'Likely/ Regular' respectively (see Table 5-15).

Table 7-27 Likelihood evaluation for airborne noise impact assessment (construction phase)

Assessment Scenarios	L _{Aeq} , dB(A)	Working Period over Specified Time Period	Active Duration of Equipment	Frequency of Exposure	Likelihood of Occurrence
Day Time					
Road Construction Site •Site Clearance and Earthworks •Foundation Works	L _{Aeq} (12 hours), dB(A) (7am - 7pm)	0.9	0.9	0.81	Continuous
•Road Construction Site •Foundation Works •Superstructure					
•Road Construction Site •Site Clearance and Earthworks •Foundation Works	L _{Aeq} (5 mins), dB(A) (7am - 7pm)	0.9	1	0.9	Continuous
•Road Construction Site •Foundation Works •Superstructure					
Night Time					
•Foundation Works	L _{Aeq} (12 hours), dB(A) (7pm – 7am)	0.5	0.5	0.25	Possible/ Occasional
•Foundation Works •Superstructure					
•Foundation Works	L _{Aeq} (5 mins), dB(A) (7pm – 10 pm)	0.5	1	0.5	Likely/Regular
•Foundation Works •Superstructure					

7.5.3.2.5 Prediction and Evaluation of Airborne Noise Impacts

Noise levels at noise sensitive receivers have been predicted using Equation (7-1) considering the noise source as a point source.

$$L_p = L_B - \left| 10 \times \log_{10} \left(\frac{Q}{4\pi r^2} \right) \right| \quad (7 - 1)$$

Where, L_P denote the sound power level at the ecological receptors and the boundary of factory premises (dB(A)) and L_B represents sound power level at the source (dB(A)). Q is the directivity factor which equals to 2 considering hemispherical propagation of noise. r is the distance between the receiver and the source (m).

Marsiling Park and proposed AHEV can be considered to accommodate ecological noise sensitive receptors during the construction phase of the project. A buffer width of 15-m has been proposed surrounding AHEV (refer to Section 7.4.4.1.1). Therefore, for a 15-meter buffer, the distance between the project sites and AHEV is 15 meters, with a distance of 75 meters to Marsiling Park.

7.5.3.2.5.1 Scenario 1: Road Construction, Site Clearance and Earthworks, and Foundation Works – Day Time (7am to 7pm)

The source noise levels are calculated as 128 dB(A) and 129 dB(A) for $L_{Aeq}(12 \text{ hours})$ and $L_{Aeq}(5 \text{ mins})$ respectively as per Table 7-26 arising from construction works proposed for Scenario 1: Road Construction, Site Clearance and Earthworks, and Foundation Works – Day Time (7am to 7pm). Considering the distances between project site and AHEV and Marsling Park and the noise criteria (61 dB(A)) established in Table 6-18, the resulting overall Impact Intensity was qualitatively deduced as **High** applying the matrix presented in Table 5-13, corresponds to an overall Impact Consequence ranging from **Low – High** (refer to Table 5-14). When relating the Impact Consequence to a Likelihood of Occurrence of Certain/Continuous (see Table 7-27), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios would range from **Moderate – Major** (refer to Table 5-16) for noise sensitive ecological receptors resided in both 189AVE and Marsiling Park.

7.5.3.2.5.2 Scenario 2: Road Construction, Foundation Works, and Superstructure – Day Time (7am to 7pm)

The source noise levels are calculated as 128 dB(A) and 129 dB(A) for $L_{Aeq}(12 \text{ hours})$ and $L_{Aeq}(5 \text{ mins})$ respectively as per Table 7-26 arising from construction works proposed for Scenario 2: Road Construction, Foundation Works, and Superstructure – Day Time (7am to 7pm). –Considering the distances between project site and 189AVE and Marsling Park and the noise criteria (61 dB(A)) established in Table 6-18, the resulting overall Impact Intensity was qualitatively deduced as **High** applying the matrix presented in Table 5-13, corresponds to an overall Impact Consequence ranging from **Low – High** (refer to Table 5-14). When relating the Impact Consequence to a Likelihood of Occurrence of Certain/Continuous (see Table 7-27), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios would range from **Moderate – Major** (refer to Table 5-16) for noise sensitive ecological receptors resided in both 189AVE and Marsiling Park.

7.5.3.2.5.3 Scenario 3: Foundation Works – Night Time (7pm – 7 am for $L_{Aeq}(12 \text{ hours})$ and 7pm -10 pm for $L_{Aeq}(5 \text{ mins})$)

The source noise levels are calculated as 119 dB(A) and 128 dB(A) for $L_{Aeq}(12 \text{ hours})$ and $L_{Aeq}(5 \text{ mins})$ respectively as per Table 7-26 arising from construction works proposed for Scenario 3: Foundation Works – Night Time (7pm to 7am for $L_{Aeq}(12 \text{ hours})$ and 7pm -10 pm for $L_{Aeq}(5 \text{ mins})$). –Considering the distances between project site and 189AVE and Marsling Park and the noise criteria (60 dB(A)) established in Table 6-18, the resulting overall Impact Intensity was qualitatively deduced as **High** applying the matrix presented in Table 5-13, corresponds to an overall Impact Consequence ranging from **Low – High** (refer to Table 5-14). When relating the Impact Consequence to a Likelihood of Occurrence of Possible/Occasional (see Table 7-27), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios would range from **Minor – Moderate** for $L_{Aeq}(12 \text{ hours})$ (refer to Table 5-16) for noise sensitive ecological receptors resided in both 189AVE and Marsiling Park. When relating the Impact Consequence to a Likelihood of Occurrence of Likely/Regular (see Table 7-27), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios would range from **Moderate – Major** for $L_{Aeq}(5 \text{ mins})$ (refer to Table 5-16) for noise sensitive ecological receptors resided in both 189AVE and Marsiling Park.

7.5.3.2.5.4 Scenario 4: Foundation Works and, Superstructure – Night Time (7pm – 7 am for $L_{Aeq}(12 \text{ hours})$ and 7pm -10 pm for $L_{Aeq}(5 \text{ mins})$)

The source noise levels are calculated as 119 dB(A) 128 dB(A) for $L_{Aeq}(12 \text{ hours})$ and $L_{Aeq}(5 \text{ mins})$ respectively as per Table 7-26 arising from construction works proposed for Scenario 4: Foundation Works and, Superstructure – Night Time (7pm to 7am for $L_{Aeq}(12 \text{ hours})$ and 7pm -10 pm for $L_{Aeq}(5 \text{ mins})$). –Considering the distances between project site and 189AVE and Marsling Park and the noise criteria (60 dB(A)) established in Table 6-18, the resulting overall Impact Intensity was qualitatively deduced as **High** applying the matrix presented in Table 5-13,, corresponds to

an overall Impact Consequence ranging from **Low – High** (refer to Table 5-14). When relating the Impact Consequence to a Likelihood of Occurrence of Possible/Occasional (see Table 7-27), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios would range from **Minor – Moderate** for $L_{Aeq}(12 \text{ hours})$ (refer to Table 5-16) for noise sensitive ecological receptors resided in both 190AVE and Marsiling Park for $L_{Aeq}(5 \text{ mins})$. When relating the Impact Consequence to a Likelihood of Occurrence of Likely/Regular (see Table 7-27), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios would range from **Moderate – Major** (refer to Table 5-16) for noise sensitive ecological receptors resided in both 190AVE and Marsiling Park.

It is worth mentioning that the demolition of Marsiling Community Centre will take place over the course of one year beginning in the third quarter of 2026. However, because of the greater distance between Marsiling Community Centre and AHEV, the impact significance due to the noise generated from this demolition activity is considered to be **Negligible**.

Table 7-28 Construction Noise Impacts for Ecological Receptors (Unmitigated)

Location of Noise Sensitive Receptor	Distance between Source and Receptor(m)	Assessment Scenarios	Auditory Sensitivity	LAeq	Noise Criteria, dB(A)	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
AHEV	15	Scenario 1: Road Construction, Site Clearance and Earthworks, and Foundation Works – Day Time	Priority 1	LAeq(12 hours) (7am to 7pm)	61	High	High	Certain/Continuous	Major
			Priority 2			High	Medium		Major
			Priority 3			High	Low		Moderate
			Priority 1	LAeq(5 mins) (7am to 7pm)	61	High	High	Certain/Continuous	Major
			Priority 2			High	Medium		Major
			Priority 3			High	Low		Moderate
		Scenario 2: Road Construction, Foundation Works, and Superstructure – Day Time	Priority 1	LAeq(12 hours) (7am to 7pm)	61	High	High	Certain/Continuous	Major
			Priority 2			High	Medium		Major
			Priority 3			High	Low		Moderate
			Priority 1	LAeq(5 mins) (7am to 7pm)	61	High	High	Certain/Continuous	Major
			Priority 2			High	Medium		Major
			Priority 3			High	Low		Moderate
		Scenario 3: Foundation Works – Night Time	Priority 1	LAeq(12 hours) (7pm to 7am)	60	High	High	Possible/ Occasional	Moderate
			Priority 2			High	Medium		Moderate
			Priority 3			High	Low		Minor
			Priority 1	LAeq(5 mins) (7pm to 10pm)	60	High	High	Likely/Regular	Major
			Priority 2			High	Medium		Moderate
			Priority 3			High	Low		Moderate

Location of Noise Sensitive Receptor	Distance between Source and Receptor(m)	Assessment Scenarios	Auditory Sensitivity	L _{Aeq}	Noise Criteria, dB(A)	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
		Scenario 4: Foundation Works, and Superstructure – Night Time	Priority 1	L _{Aeq} (12 hours) (7pm to 7am)	60	High	High	Possible/ Occasional	Moderate
			Priority 2			High	Medium		Moderate
			Priority 3			High	Low		Minor
			Priority 1	L _{Aeq} (5 mins) (7pm to 10pm)	60	High	High	Likely/Regular	Major
			Priority 2			High	Medium		Moderate
			Priority 3			High	Low		Moderate
Marsiling Park	75	Scenario 1: Road Construction, Site Clearance and Earthworks, and Foundation Works – Day Time (7am to 7pm)	Priority 1	L _{Aeq} (12 hours) (7am to 7pm)	61	High	High	Certain/Continuous	Major
			Priority 2			High	Medium		Major
			Priority 3			High	Low		Moderate
			Priority 1	L _{Aeq} (5 mins) (7am to 7pm)	61	High	High	Certain/Continuous	Major
			Priority 2			High	Medium		Major
			Priority 3			High	Low		Moderate
		Scenario 2: Road Construction, Foundation Works, and Superstructure – Day Time	Priority 1	L _{Aeq} (12 hours) (7am to 7pm)	61	High	High	Certain/Continuous	Major
			Priority 2			High	Medium		Major
			Priority 3			High	Low		Moderate
			Priority 1	L _{Aeq} (5 mins) (7am to 7pm)	61	High	High	Certain/Continuous	Major
			Priority 2			High	Medium		Major

Location of Noise Sensitive Receptor	Distance between Source and Receptor(m)	Assessment Scenarios	Auditory Sensitivity	LAeq	Noise Criteria, dB(A)	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
		Scenario 3: Foundation Works – Night Time	Priority 3			High	Low		Moderate
			Priority 1	LAeq(12 hours) (7pm to 7am)	60	High	High	Possible/Occasional	Moderate
			Priority 2			High	Medium		Moderate
			Priority 3			High	Low		Minor
			Priority 1	LAeq(5 mins) (7pm to 10 pm)	60	High	High	Likely/Regular	Major
			Priority 2			High	Medium		Moderate
			Priority 3			High	Low		Moderate
		Scenario 4: Foundation Works, and Superstructures – Night Time	Priority 1	LAeq(12 hours) (7pm to 7am)	60	High	High	Possible/Occasional	Moderate
			Priority 2			High	Medium		Moderate
			Priority 3			High	Low		Minor
			Priority 1	LAeq(5 mins) (7pm to 10 pm)	60	High	High	Likely/Regular	Major
			Priority 2			High	Medium		Moderate
			Priority 3			High	Low		Moderate

7.5.3.3 Proposed Mitigation Measures

Due to the proximity of the noise sensitive receptors (NSRs) to the Project proposed construction worksites boundary, mitigation measures for the control of noise at source were recommended as per the mitigation principles outlined in Section 5.3.3.3.

7.5.3.3.1 Avoid

7.5.3.3.1.1 High Noise Powered Mechanical Equipment

The equipment inventory list shall be analysed to check the equipment (PME) causing high noise levels (higher quantity and/or longer working periods of PME can cause higher noise levels). The use of equipment with lower noise level shall be prioritized, as this is the most effective way to mitigate the noise level at the source.

7.5.3.3.1.2 Access Routes facing Noise Sensitive Receptors

Access routes to the worksites should avoid facing receptors in vicinity of the proposed construction worksites to reduce noise impacts arising from increased traffic noise from heavy duty vehicles (HDV), as well as to prevent sound leak from noise barriers implemented to reduce noise impacts along the boundaries of proposed construction worksites facing the noise sensitive receptors.

7.5.3.3.2 Minimize

7.5.3.3.2.1 Stagger Building Heights

To minimise construction noise impacts to nearby noise sensitive receptors, the construction of buildings of staggered heights with low-rise, mid-rise, and high-rise buildings should be considered. Lower building heights may relate to shallower footings required as part of building foundation works (Activity 3: Foundation Works). This may help to reduce construction noise impacts on nearby noise sensitive receptors by reducing the duration of noisy construction activities near the proposed construction worksite boundaries nearest to these receptors and thereby reducing the likelihood of occurrence of noise impacts and overall impact significance.

7.5.3.3.2.2 Erect Noise Barriers

When substitution of noisy equipment is not applicable or feasible, erection of noise barriers should be considered. The barrier height and placement position of a noise barrier are the prime factors in determining its efficiency and are as follows:

- Noise barriers should be placed as close as possible to either the source, or the receiver position for maximum effectiveness; and
- Noise sensitive receptors within 150 m from construction worksites not predicted to experience exceedance will not require noise barriers;

The height of the barrier should be determined based on the heights of the receptors in the vicinity and the viability of implementation with consideration on space required to stabilize and erect the barriers. Contractors should note that the erection of noise barriers must not result in additional clearance of vegetation beyond the bounds of the proposed construction worksites area.

At the pre-design stage, it is considered viable to implement a noise barrier ranging from 5 to 9 meters in height due to the elevated elevation of the project site (refer to Figure 6.3.2). The proposed barrier needs to be erected along the proposed construction worksite near 194AVE to mitigate noise impacts arising from the construction activities on the noise sensitive receptors (NSRs) as much as possible. To deduce optimized barrier heights required at each site, AECOM recommends that quantitative noise impact assessment with noise modelling by a 3D simulating software such as SoundPLAN and CadnaA conducted by Noise Consultant(s) appointed by the Contractor (s) be it roadworks/ earthworks/ BTO contractor prior to commencement of construction works as required by NEA regulations for human impacts for HDB occupants, but also for ecological receptors and embed that part in the CEMMP for this site to be submitted to NParks before commencement of construction works.

7.5.3.3.2.3 Source Noise Control

As a last resort for engineering control, when noise barriers are also not so effective in mitigating noise, or in order to manage complaints if there are intermittent noisy works, Table 7-29 below provides information on methods of quietening PME to be adopted for further mitigation on construction noise impact.

The maximum reduction in sound power level in Table 7-29 is achievable when all source control measures stated in this table are adopted. Noise enclosures should be used at the locations of the noise generating equipment at the construction site. Acoustic sheds should be provided at the locations of the noise generating activity such as operation of hand-held breaker. Sound pressure levels reduction ranging from 0 – 3 dB can be achieved by using all or combination of the following measures.

Table 7-29 Control of noise source from worksites

Type of Equipment	Equipment	Reduction in Sound Power Level, dB(A) ¹	Description of Source Control
Compressors & Generators	Generators	-20	Acoustic dampening of metal casing of body shell; acoustic enclosure or screen between the generator and receptor. The acoustic casing for the generator shall be proprietary product supplied by the generator manufacturer. The screen, if used, shall be as close as possible to the generator and it shall be of a solid construction (minimum STC 20 or surface density > 20kg/m ²) with no gaps at the bottom or in-between panels.
	Excavator with Rock Breaker	-15	Use of an acoustic shed with adequate ventilation for the machine and bit.
	Crane	-10	Manufacturers' enclosure panels to be kept closed. The engines of these vehicles shall not be exposed and clad with the manufacturers' enclosure to reduce noise break-out.
Earth-moving Plant	Dump Truck	-10	Manufacturer-supplied silencers for the engine exhausts shall be installed and maintained.
	Excavator with Rock Breaker	-10	
	Excavator	-10	
	Concrete Mix Truck	-10	
	Lorry	-10	
Pumps	All Pumps	-10 to -20	Use of acoustic closure.
<i>Note: ¹ The noise reduction level makes reference to BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise.</i>			

Based on the Singapore Standards Code of Practice for Noise Control at Construction Sites, 2014 (SS602:2014) [R-24] the typical materials used for noise barriers and acoustic shed/enclosures is given below:

Acoustic Shed/Enclosure:

A typical machine acoustic enclosure covers the machine as fully as possible (with/without ventilation), providing adequate sound insulation that noise energy does not readily pass through it. In addition, it could also have a sound absorbing material lining, to avoid the build-up of sound energy inside. In general, an acoustic enclosure could include:

- A minimum rating of STC 18 for localized portable acoustic panels;
- Outer cover material made up of brickwork, fibreboard, or plasterboard. Thickness of the insulating cove depends on the material used;
- Inner lining of sound absorbing material such as glass fibre, mineral wool, straw slabs, wood wool slabs can be used. A thickness of at least 25 mm is to be provided in case of high frequency sound, whereas a 12 mm thick lining would suffice for low frequency sound; and
- Perforated sheet coverings can be used to protect the inner lining material, especially if it is glass wool or mineral wool-based lining.

In the case of a more permanent or substantial machine enclosure or acoustic shed, concrete breezeblock and open textured blockwork can be more effective alternatives as these are known to be durable, inexpensive, and quick to assemble, and provide a useful degree of sound absorption.

7.5.3.4 Residual Impact Assessment

Residual Impact Assessment assumes that the mitigation measures within Section 7.5.3.3 are implemented within the construction footprint. However, due to the higher elevation of the project site (refer to Figure 6.3.2), the constructed noise barrier will be ineffective in achieving a significant noise reduction. This ineffectiveness is attributed to the barrier's inability to eliminate a direct line of sight to the planned construction sites. As a result, even though noise barrier might be able to reduce line-of-sight for ground-dwelling fauna, impact intensity will remain **High** (refer to Table 5-13) due to the close proximity of the ecological receptors with the project site, corresponds to an overall Impact Consequence ranging from **Low – High** (refer to Table 5-14). When relating the Impact Consequence to a Likelihood of Occurrence of Possible/Occasional - Continuous (see Table 7-27), the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios will range from **Minor – Major** (refer to Table 5-16). Since the scope of noise impact assessment of this EIA is limited to qualitative assessment, AECOM recommends that quantitative noise impact assessment with and without barrier through noise modelling by a 3D simulating software such as SoundPLAN and CadnaA conducted by Noise Consultant(s) appointed by Contractor (s) be it roadworks/ earthworks/ BTO contractor prior to commencement of construction works as required by NEA regulations for human impacts for HDB occupants, but also for ecological receptors and embed that part in the contract-specific EMMP for this site to be submitted to NParks before commencement of construction works.

Table 7-30 Summary of Construction Noise Impacts for Ecological Receptors (Mitigated)

Location of Noise Sensitive Receptor	Distance between Source and Receptor(m)	Assessment Scenarios	Auditory Sensitivity	LAeq	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
AHEV	15	Scenario 1: Road Construction, Site Clearance and Earthworks, and Foundation Works – Day Time	Priority 1	LAeq(12 hours) (7am to 7pm)	High	High	Certain/Continuous	Major
			Priority 2		High	Medium		Major
			Priority 3		High	Low		Moderate
			Priority 1	LAeq(5 mins) (7am to 7pm)	High	High	Certain/Continuous	Major
			Priority 2		High	Medium		Major
			Priority 3		High	Low		Moderate
		Scenario 2: Road Construction, Foundation Works, and Superstructure – Day Time	Priority 1	LAeq(12 hours) (7am to 7pm)	High	High	Certain/Continuous	Major
			Priority 2		High	Medium		Major
			Priority 3		High	Low		Moderate
			Priority 1	LAeq(5 mins) (7am to 7pm)	High	High	Certain/Continuous	Major
			Priority 2		High	Medium		Major
			Priority 3		High	Low		Moderate
		Scenario 3: Foundation Works – Night Time	Priority 1	LAeq(12 hours) (7pm to 7am)	High	High	Possible/ Occasional	Moderate
			Priority 2		High	Medium		Moderate
			Priority 3		High	Low		Minor
			Priority 1	LAeq(5 mins) (7pm to 10pm)	High	High	Likely/Regular	Major
			Priority 2		High	Medium		Moderate
			Priority 3		High	Low		Moderate
		Scenario 4: Foundation Works, and Superstructure – Night Time	Priority 1	LAeq(12 hours) (7pm to 7am)	High	High	Possible/ Occasional	Moderate
			Priority 2		High	Medium		Moderate
			Priority 3		High	Low		Minor
			Priority 1	LAeq(5 mins) (7pm to 10pm)	High	High	Likely/Regular	Major
			Priority 2		High	Medium		Moderate
			Priority 3		High	Low		Moderate

Location of Noise Sensitive Receptor	Distance between Source and Receptor(m)	Assessment Scenarios	Auditory Sensitivity	L _{Aeq}	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Marsiling Park	75	Scenario 1: Road Construction, Site Clearance and Earthworks, and Foundation Works – Day Time (7am to 7pm)	Priority 1	L _{Aeq} (12 hours) (7am to 7pm)	High	High	Certain/Continuous	Major
			Priority 2		High	Medium		Major
			Priority 3		High	Low		Moderate
			Priority 1	L _{Aeq} (5 mins) (7am to 7pm)	High	High	Certain/Continuous	Major
			Priority 2		High	Medium		Major
			Priority 3		High	Low		Moderate
		Scenario 2: Road Construction, Foundation Works, and Superstructure – Day Time	Priority 1	L _{Aeq} (12 hours) (7am to 7pm)	High	High	Certain/Continuous	Major
			Priority 2		High	Medium		Major
			Priority 3		High	Low		Moderate
			Priority 1	L _{Aeq} (5 mins) (7am to 7pm)	High	High	Certain/Continuous	Major
			Priority 2		High	Medium		Major
			Priority 3		High	Low		Moderate
		Scenario 3: Foundation Works – Night Time	Priority 1	L _{Aeq} (12 hours) (7pm to 7am)	High	High	Possible/Occasional	Moderate
			Priority 2		High	Medium		Moderate
			Priority 3		High	Low		Minor
			Priority 1	L _{Aeq} (5 mins) (7pm to 10 pm)	High	High	Likely/Regular	Major
			Priority 2		High	Medium		Moderate
			Priority 3		High	Low		Moderate
		Scenario 4: Foundation Works, and Superstructures – Night Time	Priority 1	L _{Aeq} (12 hours) (7pm to 7am)	High	High	Possible/Occasional	Moderate
			Priority 2		High	Medium		Moderate
			Priority 3		High	Low		Minor
			Priority 1	L _{Aeq} (5 mins) (7pm to 10 pm)	High	High	Likely/Regular	Major
			Priority 2		High	Medium		Moderate
			Priority 3		High	Low		Moderate

7.5.3.5 Cumulative Impacts

Two major concurrent developments have been identified in Section 3.5 to be in the vicinity of Woodlands N1 worksite. It is assumed that all the concurrent developments will comply with the construction standards and environmental management and control. Therefore, it is not expected that they will increase impacts on ecological receptors.

7.6 Summary of Impacts during Construction Phase of the Project

For habitat receptors, three types of impacts were assessed during construction: (1) Loss of vegetation, (2) Habitat degradation and (3) Formation of forest edge. Pre-mitigated impact significance for loss of vegetation was assessed to be major for all habitat types due to 100% clearance of Study Area; while Moderate to Minor impact significance was assessed for habitat degradation and formation of edge. After considering mitigation measures such as the retention of AHEV, Major impact significance from loss of vegetation were largely reduce to Minor/Negligible for most habitats, except abandoned-land forest and native-dominated secondary forest which remained at Major and Moderate respectively. This is because even with retention of AHEV, more than 40% of the abandoned-land forest would still be cleared, keeping impact intensity at High. Subsequently, despite reducing area cleared for native-dominated forest to less than 10%, there is still Moderate impact significance as native-dominated forest has high ecological value. Habitat degradation and formation of forest edge impact significance were reduced to either Minor or Negligible after mitigation measure applied.

For flora receptors, two types of impacts were assessed during construction: (1) mortality, (2) decline in plant health and survival. Similar to loss of vegetation assessed for habitat receptors, pre-mitigated impact significance of mortality were Major for all 21 flora receptors. Decline in plant health was not assessed pre-mitigated scenario due to 100% clearance of Study Area. After considering mitigation measures, all Major impact significance were reduced to Moderate to Negligible.

For fauna receptors, five types of impacts were assessed during construction phase: (1) loss of or reduction in habitats and food sources, (2) accidental injury and mortality, (3) human-wildlife conflict, (4) human disturbances and (5) light disturbances, with the last two being assessed post mitigation only. The impact significance for loss of or reduction in habitats and food sources is Major for all 26 sensitive receptors assessed as the clearance with or without retaining the AHEV is >40% of the entire biodiversity Study Area. Other pre-mitigated impact types assessed ranges from Negligible to Moderate. After considering mitigation measures detailed in Section 7.4.4, the impact significance of some species increased from Negligible to Minor for the impact type "human-wildlife conflict" as retaining the AHEV would mean more spaces and food sources, thus attracting the fauna species.

With the above, it would seem that retaining the AHEV would not make a difference for biodiversity. However, this is because the impact assessment falls short in fully reflecting the reduction of habitat loss with the preservation of the AHEV as it went over the 40% threshold. Regardless, it is essential to note that retaining the AHEV would in fact still preserve the remaining native-dominated secondary forest in the Study Area, acting as a stepping stone and buffer zone to the overall main connectivity network. This would mitigate habitat loss and enhance connectivity for fauna species amidst our expanding urban environment. Thus, preserving the AHEV remains a critical priority. However, further road widening works along the Marsiling Road may encroach into the AHEV from the south, as the plans are still in discussion at the time of writing of this report. Impacts of road widening has not been assessed in this report and is recommended to be studied as part of the Woodlands Checkpoint Redevelopment External Infrastructure Works.

For surface water, four sources of impacts were assessed during construction: (1) Silty effluent, (2) Other liquid effluents and construction wastewater, (3) Leachate of pollutants from waste stored on-site and (4) Accidental spills and leaks of pollutants due to improper managements of chemicals and waste. All impacts were rated Minor, with no mitigation measures proposed. For groundwater, two impacts were assessed during construction: (1) Groundwater level decrease and (2) Groundwater contamination. Both impacts were assessed to be Negligible and no mitigation measures were proposed.

Noise-sensitive ecological receptors were qualitatively assessed, with impacts ranging from Minor to Major due to activities during the construction phase. Mitigation includes reducing the use of high-noise mechanical equipment as much as practicable, avoiding the construction of access route facing noise sensitive receptors, constructing buildings with staggered heights, and installing noise barriers. However, due to the higher elevation of the project site, the noise barriers will be ineffective, leaving post-mitigation impacts unchanged, ranging from Minor to Major.

8 Prediction and Evaluation of Impacts During Operational Phase

8.1 Potential Sources of Impact

At the operational phase of the Project, residential buildings and newly proposed road are expected to be developed. As a result, human traffic is expected to increase significantly. Increase in human traffic would inevitably increase disturbance to surrounding biodiversity in the form of noise and light generated. Increase in waste in the form of rubbish/ litter or wastewater discharge could also potentially become an impact, if not properly managed.

There are two main categories in which the impacts fall into, namely, (1) direct, i.e., impacts to habitats and species within the worksites; and (2) indirect, i.e., impacts to habitats and species outside the worksites but within the impact zone. Impact zones for habitat and species receptors are defined as areas within 30 m from worksites of the proposed development. The following sections assess the impacts on ecological sensitive receptors during the operational phase of the Project.

8.1.1 Impacts on Biodiversity

Table 8-1 details a list of potential impacts on biodiversity during the operational phase. There are a total of six impact types – two for habitats and four for fauna receptors. Both impact types for habitats and two impact types for fauna receptors—human disturbances and light disturbances will only be assessed during post mitigation where the scenario of retaining the area of high ecological value (AHEV) is considered.

Table 8-1 Potential impacts on biodiversity at operational phase

Receptor	Impact type	Description	Impact category	Pre/post mitigation assessment
Habitat	Habitat degradation	Trampling on vegetation or pollution (e.g., litter) from increased human activities	Indirect	Post mitigation
	Change in microclimatic conditions	Changes in microclimatic conditions (such as temperature, light and humidity) of the habitat due to operational activities and/or micro urban heat island from the adjacent development.	Indirect	Post mitigation
Faunal species	Accidental injury or mortality	Navigation failures into the wrong areas and entrapment in facility structures, including bird collision into buildings (distorted perceptions of reflective surfaces on buildings as flyways, greenery, and/or water) and roadkills	Indirect/Direct	Pre and post mitigation
	Human-wildlife conflict	Negative consequences of human-wildlife interactions, such as deliberate killing and depopulation of faunal species perceived as nuisances or threats by members of the public	Indirect/Direct	Pre and post mitigation
	Human disturbance	Increase in human traffic flow, such as residents and visitors	Indirect	Post mitigation
	Light disturbance	Increase in light levels from development	Indirect	Post mitigation

8.1.2 Impacts on Biodiversity due to Changes in Other Environmental Parameters

As part of this EIA, impacts on biodiversity due to changes in water resources and airborne noise were assessed. It should be noted that, as there are no watercourses within the Project site, hydrological impact assessment was omitted from the impact assessment, as agreed with Technical Agencies. Furthermore, as requested by PUB, assessment of potential impacts on Upper Seletar Reservoir due to changes in water quality was also included in this EIA. Details of this impact assessment can be found in Appendix T of this Report.

The list of potential impacts on ecological sensitive receptors due to changes in water resources and airborne noise during operational phase is summarised in table below.

Table 8-2 Potential impacts on biodiversity during operational phase due to changes in water resources and airborne noise

	Potential Source of Impacts	Potential Associated Impacts	Potential Associated Impacts on Ecological Receptors
Water Resources (Surface Water Quality)	- Discharge of potentially contaminated surface water runoff, especially during storm events in the new development area - Improper management of liquid and solid wastes generated within the site	- Elevated levels of suspended solids (e.g. silt) and anthropogenic pollutants in receiving watercourses - Solid waste can block the watercourses and lead to contamination - Inappropriate discharge of liquid wastes to the watercourses may result in contamination	Change in surface water quality can have adverse impacts on receiving waterbodies and associated habitats. Contamination may propagate further downstream, affecting the downstream habitats (e.g. mangroves at Marsiling Park)
Water Resources (Groundwater Quality)	- Discharge of potentially contaminated surface water runoff, especially during storm events in the new development area and leachate into the soil - Improper management of liquid and solid wastes generated within the site which could lead to leachate into the soil	- Elevated levels of anthropogenic pollutants in groundwater beneath the site - Inappropriate discharges and leachate of liquid wastes into soil may result in groundwater contamination	Groundwater contamination may spread further downgradient, potentially affecting natural waterbodies and associated habitats
Water Resources (Groundwater Level)	More areas with impervious surfaces within new developments (e.g. building, roads, etc.)	Decrease in groundwater level	Decrease in groundwater level may reduce the water available for groundwater-dependent habitats
Airborne Noise	- Traffic noise due to increase vehicular volume. - Air-conditioning and mechanical ventilation noise from developments	Increase in ambient noise level.	Potential impacts due to the increase in noise level includes noise disturbance to fauna affecting ecological foraging behaviour, Intra-species and inter-species communication

8.2 Identification of Sensitive Receptors

Identification of sensitive receptors with regards to physical environmental parameter (i.e. water resources, airborne noise) can be found in the respective sections of this Report. Any additional sensitive receptors (if any) will be identified in subsequent submission.

8.2.1 Habitats

Sensitive receptors are similar to receptors identified at construction stage—refer to Section 7.2.1.

8.2.2 Flora

Sensitive receptors are similar to receptors identified at construction stage—refer to Section 7.2.2.

8.2.3 Fauna

Sensitive receptors are similar to receptors identified at construction stage—refer to Section 7.2.3.

8.3 Minimum Control Measures

This section proposes minimum controls or standard practices commonly implemented in Singapore for the purposes of impact assessment during operational phase.

8.3.1 Biodiversity

This section lists biodiversity-specific minimum control measures that are commonly implemented in Singapore for operational activities. These are assumed to be implemented for the purpose of the impact assessment and should be proposed in tandem with the measures proposed for other environmental receptors (e.g., hydrology, surface water quality, airborne noise). Minimum controls for each potential impact occurring from the operational phase is listed in Table 8-3.

Table 8-3 Minimum control measures for the operational phase

Work activities	Minimum controls for operational phase
General	Ensure noise levels are within approved limits (refer to Section 8.5 under airborne noise-related impacts) Ensure dust levels are within approved limits as defined by NEA's regulated Environmental Protection and Management Act and its regulations.

8.3.2 Water Resources

Table 8-4 has a non-exhaustive list of minimum controls for each potential impact for operational phase, as identified in Section 8.1.2 of this Report.

Table 8-4 Minimum control measures during the operational phase applicable for water resources

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
Water Resources (Surface Water Quality and Groundwater Quality)	Heavy rain and stormwater wash-off pollutants built-up in the new development area and discharge to the surrounding watercourses	- Ensure adequate drainage, piping, and/or channelling of stormwater runoff is assured through detailed design for capturing and treating before discharge into receiving watercourses. - Establish regular and dedicated procedures for inspecting and maintaining stormwater collection,

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
		storage, and treatment infrastructure, such as pipes, oil-water separators, silt screens, etc. - Implement regular and dedicated procedures for managing stormwater collection, settling, testing, and eventually discharging 'clean' water to surface waters, including associated measures to prevent high sediment concentration in stormwater drainage to surface waters. - Ensure no trade effluent other than that of a nature or type approved by NEA Director-General is discharged into any watercourse or land.
	- Accidental spill and leaks (e.g., during storm event) - Improper handling, transfer, and storage of solid and liquid wastes (e.g., rubbish collection and sewage disposal)	- Prepare an adequate number of disposal bins around the Project to prevent improper waste disposal. - Conduct regular inspections of the Project's waste storage system. - Regularly monitor proposed watercourses and their surroundings with CCTV surveillance to prevent contamination. - Develop an emergency response plan and provide adequate training to maintenance workers to handle accidental water contamination. - Raise awareness among various stakeholders through community/stakeholder engagement (e.g., signage boards, warning signs, etc.).
	Discharge or leakage of waste and chemicals into the soil	- Regularly inspect the waste storage system within the Project to prevent system clogging and leachate entering the underlying soil. - Store all toxic waste and hazardous substances/chemicals (if any) in designated sheltered areas equipped with access-controlled entrances and concrete bund walls or in containers with adequate ventilation. Ensure spill trays are provided for all chemical drums and potentially pollutive substances, and maintain them regularly to prevent rain from washing out pollutive substances. - Dispose of all toxic waste chemicals to licensed Toxic Industrial waste (TIW) collectors for treatment. - Ensure all hazardous chemicals/substances (if stored on site) are properly labelled, their movements recorded, and returned to designated storage areas when not in use. - Conduct all activities involving hazardous chemicals/substances on appropriately contained areas (e.g., concreted areas with proper containment/sumps). - Provide emergency spill kits on site for immediate response to any chemical spills. Ensure the emergency response team is trained and competent in using these spill kits.
Water Resources (Groundwater Level)	More areas with impervious surfaces in the new development	- Incorporate more pervious surfaces in the development plan - Install recharge wells, if necessary

8.3.3 Airborne Noise

Mechanical ventilation would be designed and sited appropriately during detailed design phases to ensure that boundary noise levels are in compliance with the adjusted boundary noise limits to be derived by an appointed Noise Consultant by HDB/ contractor contracted by HDB as part of quantitative operational noise impact assessment as mandated by law. Some noise sources might be located close to the boundary and might require special attention for boundary noise limits compliance, and if necessary, be equipped with additional mitigation measures. These are to be provided upon assessment of noise arising from the operational phase.

Minimum control measures for noise emissions arising from the operational phase such as originating from ACMV systems and land traffic are listed below. This list is non-exhaustive and should be practised as minimum control to reduce noise levels during the operational phase of the Project:

- Ensure that exhaust outlets or intakes from the mechanical ventilation system is designed to be adequately set back as far as possible from the boundary line of the development;
- Acoustic treatment if any to be designed and implemented;
- The building design should include provisions to ensure that the condensers of individual air-conditioning systems are positioned away from noise-sensitive areas.
- Acoustic enclosures should be provided for outdoor equipment;
- Consider road design as part of land use planning to minimise potential impact of land traffic noise on NSRs;
- Consider the use of low-noise pavement mix for sections of new road networks near NSRs;
- Consider alternative siting of new road networks away from noise sensitive receptors at pre-design stage; and
- Mitigate traffic noise at drop-off points and parking areas with low-speed postings, speed humps and speed limit signages. The addition of these speed control measures will likely lower noise levels for traffic as the vehicles would be cruising at lower speeds.

8.4 Impacts on Biodiversity

Identified biodiversity sensitive receptors were evaluated based on impact intensity and likelihood, which eventually gives the impact significance. The impact intensity and likelihood of each impact type during operational phase are defined for habitats (Table 8-5 and Table 8-6), and fauna species (Table 8-7 and Table 8-8) receptors below.

Table 8-5 Definitions of each level of impact intensity for impact types during operational phase for habitat receptors

Impact type	Negligible	Low	Medium	High
Habitat degradation	<u>Terrestrial habitat</u> The habitat type does not overlap with areas 30 m from the development	<u>Terrestrial habitat</u> ≤ 10% of the habitat type overlaps with areas 30 m from the development	<u>Terrestrial habitat</u> 10–40% of the habitat type overlaps with areas 30 m from the development	<u>Terrestrial habitat</u> > 40% of the habitat type overlaps with areas 30 m from the development
Changes in microclimatic conditions				

Table 8-6 Definitions of each level of likelihood for impact types during operational for habitat receptors

Likelihood	Habitat Degradation	Changes in microclimatic conditions
Unlikely/ Remote	Developed area is not accessible to public. Surrounding natural habitats are not accessible to public	Development is largely green and human activity is limited (e.g., Thomson Nature Park)

Likelihood	Habitat Degradation	Changes in microclimatic conditions
Less likely/ Rare	Developed area is designed with the intention for the public to use or visit. Surrounding natural habitats are accessible but public use is restricted/ controlled	Development involves the building of urban structures but will be heavily landscaped (e.g., Gardens by the Bay)
Possible/ Occasional	Developed area is designed for members of the public to visit. Surrounding natural habitats are accessible and have infrastructure for the public to use, such as boardwalks (but people can still stray off track)	Development involves the building of structures that are designed to release heat, light, noise or dust (e.g., ventilation shafts)
Likely/ Regular	Developed area and surroundings are designed for large groups of people to live or work in the long run. Surrounding natural habitats are easily accessible and do not have infrastructure for the public to use, such as boardwalks (thus public are off track)	Development involves the building of extensive pavements, structures, and other infrastructure with surfaces that absorb and retain heat, constantly produce dust and noise disturbances (e.g., residential estate)
Certain/ Continuous	N.A.	N.A

Table 8-7 Definitions of each level of impact intensity for all four impact types during operational phase for faunal species receptors

Impact type	Negligible	Low	Medium	High
Accidental injury or mortality	Species with negligible susceptibility to accidental injury/mortality from operation activities, roadkills, and collision with buildings	Species with low susceptibility to accidental injury/mortality from operation activities, roadkills, and collision with buildings: – Birds with low susceptibility to collision with buildings – Volant species (e.g., odonates, butterflies, raptors and bats) – Aquatic species (most fishes, crabs, shrimps)	Species that are mobile but possibly susceptible to accidental injury/mortality from operation activities and roadkills, and collision with buildings: – Birds that are possibly susceptible to collision with buildings (e.g., resident species with known records of bird-building collisions – All amphibians – Some mammals (e.g., squirrels, shrews)	Species with high susceptibility to accidental injury/mortality from operation activities and roadkills, and collision with buildings: – Birds with high susceptibility to collision with buildings (e.g., forest-edge frugivores, migratory species) – Reptiles – Some mammals (e.g., Sunda pangolin, long-tailed macaque, smooth-coated otter)
Human-wildlife conflict	Species that are not perceived as nuisances or threats by members of the public: – Odonates – Butterflies – Most birds – Aquatic species	Species that are possibly perceived as both nuisances and threats by members of the public, less tolerant of human presence and urban environments: – Some reptiles – Most amphibians – Most bats	Species that are typically perceived as nuisances and possibly as threats by members of the public, highly tolerant of human presence and urban environments, and frequently implicated in human-wildlife conflict: – Smooth-coated otter – Red junglefowl – Aculeate hymenopterans	Species that are typically perceived as both nuisances and threats by members of the public, highly tolerant of human presence and urban environments, and are frequently implicated in human-wildlife conflict: – Long-tailed macaque – Some snakes

Impact type	Negligible	Low	Medium	High
Light disturbances	Species that are not sensitive to changes in light levels: aculeate hymenopterans, aquatic and marine species	Species that are slightly sensitive to changes in light levels: odonates, butterflies	Species that are sensitive to changes in light levels: diurnal birds, reptiles, and mammals	Species that are highly sensitive to changes in light levels: nocturnal, crepuscular fauna
Human disturbances	Species that are not sensitive to human presence	Species that are slightly sensitive to human presence	Species that are possibly sensitive to human presence	Species that are sensitive to human presence

Table 8-8 Definitions of each level of likelihood for all impact types during operational phase for faunal species receptors

Likelihood	Accidental injury or Mortality	Human-Wildlife Conflict	Light Disturbances	Human Disturbances
Unlikely/ Remote	Impact is not expected to happen during the operational phase of the project			
Less Likely/ Rare	Impact is not likely to happen during the operational phase of the project			
Possible/ Occasional	Impact could possibly happen or known to occur during the operational phase of the project			
Likely/ Regular	Impact is a common occurrence during the operational phase of the project			
Certain/ Continuous	Impact is a continual or repeated process during the operational phase of the project			

8.4.1 Habitats

Two operational phase impacts were assessed for the identified habitat receptors: (1) Habitat degradation and (2) Changes in microclimatic conditions.

Habitat degradation and Changes in microclimatic conditions

For habitat degradation and changes in microclimatic conditions impact type, only the native-dominated secondary forest and urban vegetation habitats were assessed as proposed development would result in complete clearance of abandoned-land forest and scrubland habitats and therefore these habitats will not be present in the operational phase for the assessment. Subsequently, as more than 40% of the native-dominated secondary forest habitat type overlaps with areas 30 m from the development, impact intensity was considered “High”. Together with a likelihood of “Less Likely”, impact significance was assessed as “Minor”. As the urban vegetation is outside of the impact zone, impact intensity was considered “Low” with a likelihood of “Less Likely” resulted in impact significance of “Negligible”.

Table 8-10 shows a summary of the operation phase impacts to fauna receptors in the study area. Detailed assessment to be found in Appendix N.

Table 8-9 Summary of pre-mitigated operational phase impacts to habitat receptors

Impact type	Impact Significance			
	Major	Moderate	Minor	Negligible
Habitat degradation	-	-	• Native-dominated secondary forest	• Urban vegetation
Changes in microclimatic conditions				

8.4.2 Fauna

Two operational impacts were identified and assessed for 26 faunal receptors identified in section 8.2.2: (1) Accidental injury or mortality and (2) Human-wildlife conflict.

Accidental injury and mortality

Due to the newly erected high-rise residential building, birds face the risk of colliding into windows as they are unable to perceive reflective surfaces on buildings as barriers, leading to injury or death. The impact significance for these fauna species ranges from Minor to Moderate.

Long-tailed macaques (*Macaca fascicularis*) are highly mobile animals and lone males are known to be traveling around urban spaces at times. This coupled with the fact that roads will be built in the study area, likelihood for macaques to face accidental injury would be deemed "Possible" and thus impact significance would be "Moderate".

In contrast, other species such as butterflies are unlikely to be exposed to accidental injury and mortality. Their ability to move away quickly also helps ensure their limited exposure to potential harm.

Human-wildlife conflict

Certain widespread fauna species may occasionally venture into urban spaces and the upcoming high-rise buildings. For instance, lone mature males of Long-tailed macaques (*Macaca fascicularis*) might pass through our urban areas when seeking another forest patch. If there are food sources available, they might prolong their stay in the vicinity. Lack of education among residents about these wildlife encounters could lead to human-wildlife conflict, especially if the macaque's behaviour is influenced by feeding or accessing food sources, making them less deterred by human presence.

As for other species, since there is total clearance of the site, there is a lack of suitable habitats for them. As such, impact significance would be "Negligible".

Table 8-10 shows a summary of the operation phase impacts to fauna receptors in the study area. Detailed assessment to be found in Appendix N.

Table 8-10 Summary of pre-mitigated operational phase impacts to fauna species receptors

Impact Type	Impact Significance/No. Of Species			
	Major	Moderate	Minor	Negligible
Accidental injury or mortality	0	12	1	13
Human-wildlife conflict	0	1	0	25
Human disturbances	NA	NA	NA	NA
Light disturbances	NA	NA	NA	NA

8.4.3 Recommended Mitigation Measure

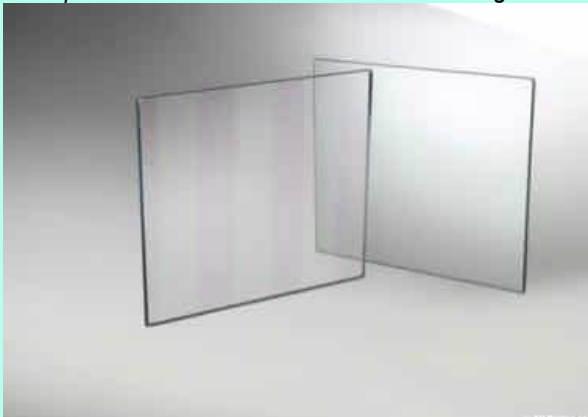
8.4.3.1 Design Phase

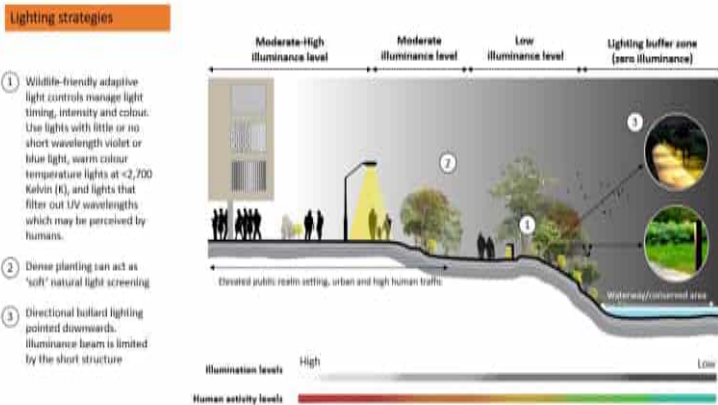
The design of the Woodlands N1 development should be considered first in the mitigation plan as it has the potential to influence the extent and types of impacts that can influence any sensitive ecological receptors at the operational phase.

8.4.3.1.1 Minimise

The key mitigation measures to minimise biodiversity impacts through the design of the proposed development at Woodlands N1 are summarised in Table 8-11.

Table 8-11 Summary of design measures to minimise biodiversity impacts during design phase

Receptors	Impact Types	Mitigation Measures
Faunal species	Accidental injury or mortality	NPark's Bird-Safe Building Guidelines (2022) detail innovative and simple strategies that can be integrated into the building's design to reduce the incidents of bird-building collisions. An example of such strategies includes installation of ultraviolet glass that do not compromise the aesthetic of the building's glass while also being beneficial to birds e.g. Example of Guardian Bird 1st™ UV <i>Example of Guardian Bird1st™ UV ultra violet glass Faunal species</i> 
	Light disturbances	Road calming measures such as speed bumps and speed limits (15km – 20km/h) can be incorporated as part of the newly built roads to minimise roadkill accidents Artificial lighting at night (ALAN) can disorient birds, bats, and insects and alter their behaviour causing them to be more vulnerable to predation and other risks. ALAN is also known to disrupt patterns of foraging and mating, as well as the circadian rhythm; For example, ALAN may deter light-averse bats from lit areas and restrict their use of commuting or feeding space. Moderate impacts owing to light disturbances are expected during the operational phase. <i>Illustration of general lighting strategies:</i>

Receptors	Impact Types	Mitigation Measures
		Lighting strategies  - Wildlife-friendly adaptive light controls manage light timing, intensity and colour. Use lights with little or no short wavelength violet or blue light, warm colour temperature lights at <2,700 Kelvin (K), and lights that filter out UV wavelengths which may be perceived by humans. - Dense planting can act as 'soft' natural light screening - Directional bollard lighting pointed downwards. Illuminance beam is limited by the short structure - Use adaptive light controls to manage light's timing, intensity, and colour e.g. smart controlled LED lights - Minimise the use of lights during hours just before dawn and after dusk when crepuscular and nocturnal animals are the most active - Minimise light spills by mounting luminaries horizontally, controlling the light output below 90° with no upward tilt. Accessories such as baffles, hoods or louvres can be integrated to reduce light spill and direct the light to only where it is needed - Use a minimal number of luminaires while achieving the necessary lighting levels - Use low-glare lighting and lights with reduced or filtered blue, violet, and ultraviolet wavelengths - Use warm colour temperature light sources to be preferably at <2,700 Kelvin - Provide physical screening through landscaping or hard structures (e.g., walls, fences, bunds), especially at areas near the residential estate. An example of the physical screening is erecting fences that can be planted with climbers to soften the appearance. This method should be considered together with other lighting strategies.

8.4.3.1.2 Compensatory Measures

The key mitigation measures to minimise biodiversity impacts through the design of the proposed development at Woodlands N1 are summarised in Table 8-12.

Table 8-12 Summary of design measures to rehabilitate/restore biodiversity during design phase

Receptors	Impact Types	Mitigation Measures
Habitats	Loss of habitats	Design for native planting/retained trees within the development.
Faunal species	Loss of/reduction in habitats and food sources	Habitat creation of butterfly gardens to attract biodiversity that are unlikely to be perceived as nuisance or threats e.g., butterflies and birds, can be considered to compensate for habitat loss. It is also important to note that integrating biodiversity-attracting features into

Receptors	Impact Types	Mitigation Measures
		future residential areas should first consider bird building collision strategies detailed in Table 8-11 above. Note to avoid planting fruit trees as it could attract fauna that humans might view as a nuisance such as the macaques, civets and fruit-eating bats.

8.4.3.2 Operational Phase

Mitigation measures stated here should be relevant for Woodlands N1 development and enforced if applicable. However, most of the strategies for enhancement should have been considered during the design phase. Minimisation, restoration, and compensation measures would be the most applicable at the operational phase.

8.4.3.2.1 Minimise

The key mitigation measures to minimise biodiversity impacts through the design of the proposed development at Woodlands N1 are summarised in Table 8-13.

Table 8-13 Summary of measures to minimise biodiversity impacts during operational phase

Receptors	Impact Types	Mitigation Measures
Faunal species	Human-wildlife conflict	Advisories can be displayed near HDB's lift lobbies or near-by bus stops to educate the residents on how to identify and respond to wildlife. Sign boards should include information on rescue hotline i.e., ACRES or NParks
	Human disturbances	Limit public accessibility to AHEV

8.4.4 Residual Impact

8.4.4.1 Habitats

Habitat degradation and Changes in microclimatic conditions

Pre-mitigated impact significance for habitat degradation to abandoned-land forest and scrubland was not assessed due to 100% clearance for development. However, due to retention of AHEV, a small percentage (<10%) of abandoned-land forest and scrubland would be safeguarded as part of the 15m buffer to AHEV. As these habitats are now part of the 15m buffer, it is inevitable that these habitats will face "High" impact intensity from habitat degradation and changes in microclimatic conditions. However, with implementation of mitigation measures such as infill planting and proper water resource and construction management (Section 7.5.1.3) during construction phase, impact intensity can be reduced to "Medium". Together with likelihood of "Less Likely", residual impact significance is "Minor" to "Negligible".

A summary of the impact to habitat receptors is provided in Table 8-14. The detailed evaluation for each species is provided in Appendix L.

Table 8-14 Summary of post-mitigated operational phase impacts to habitat receptors

Impact type	Impact Significance			
	Major	Moderate	Minor	Negligible
Habitat degradation	-	-	• Native-dominated secondary forest	• Urban vegetation
Changes in microclimatic conditions				

8.4.4.2 Fauna

For assessing residual impacts, the assessment considers mitigation measures for the operational phase detailed in Section 8.4.3. Subsequently, because the AHEV is considered, 26 faunal species receptors are assessed for four ecological impact types instead of the two in the pre-mitigated assessment. Two additional impact types considered are human disturbance and light disturbance. Bamboo bats are included as a receptor in this section but are not assessed as the bamboos would have been cleared during the construction phase.

Accidental injury or mortality

The likelihood of accidental injury or mortality can be reduced for birds and Long-tailed macaque (*Macaca fascicularis*) if mitigation measures recommended in Section 8.4.3 are followed, thus reducing the impact significance from “Moderate” to “Minor”. Mitigation measures to reduce these impacts include integrating bird-friendly designs and implementing road calming measures to minimise chances of roadkills.

Due to the presence of the retained AHEV, there are more green spaces for fauna, which might encourage fauna species to be in the area. Likelihood of accidental injury or mortality with presence of roads after consideration of road calming measures would increase from “Negligible” to “Less likely”. As such impact significance is “Minor” for three fauna species - Malayan box terrapin (*Cuora cuora*), Sunda pangolin (*Manis javanica*) and Black-headed collared snake (*Sibynophis melanocephalus*).

Human-wildlife conflict

The likelihood of human-wildlife conflict occurring can be reduced to “Less likely” for Long-tailed macaque (*Macaca fascicularis*) if mitigation measures such as placing advisories at lift lobbies/AHEV could be placed up to educate people about wildlife encounters. This drops the impact significance from “Moderate” to “Minor”.

However, due to the presence of the retained AHEV, likelihood of human wildlife conflict for Sunda pangolin (*Manis javanica*) and Black-headed collared snake (*Sibynophis melanocephalus*) would increase to “Less likely” even after considering the mitigation measure of advisories as retaining the AHEV could increase chances of encounters with humans. Thus, both species are deemed to have a “Minor” impact significance.

Human disturbances and light disturbances

Impact significance for all species is deemed “Minor” after considering the mitigation of limiting public accessibility to AHEV and considering light strategies in the design phase of the HDB. There is still a slight chance of humans entering the retained area and light penetrating through the AHEV as the AHEV is adjacent to the newly constructed HDB flats.

A summary of residual impacts to fauna receptors is given in Table 8-15 and detailed in Appendix N.

Table 8-15 Summary of post-mitigated operational phase impacts to fauna receptors

Impact Type	Residual Impact Significance/No. Of Species			
	Major	Moderate	Minor	Negligible
Accidental injury or mortality	0	0	16	9

Impact Type	Residual Impact Significance/No. Of Species			
	Major	Moderate	Minor	Negligible
Human-wildlife conflict	0	0	3	22
Human disturbance	0	0	25	0
Light disturbance	0	0	25	0

8.5 Biodiversity Impact Assessment

8.5.1 Impacts due to Surface Water Quality Changes

Based on the proposed land use plan, the majority of the existing habitats and structures within the Project site will be permanently removed and the area will be redeveloped into residential area and proposed new road. If preserved, AHEV will be the only remaining habitat within the Project site. However, as the majority of AHEV is on the higher elevation compared to the future proposed platform levels and is located upstream from the developments, the potential contamination is **Unlikely** to spread towards AHEV. Therefore, AHEV was not selected as an ecological sensitive receptor. Marsiling Park Pond and associated habitats is the only potential ecological sensitive receptor as the water from the southern portion of the site eventually discharges into it. Assessment of impacts to the Upper Seletar Reservoir due to surface water quality changes is included in Appendix T.

8.5.1.1 Identification of Sensitive Receptors

Based on the proposed land use plan, the majority of the existing habitats and structures within the Project site will be permanently removed and the area will be redeveloped into residential area and proposed new road. If preserved, AHEV will be the only remaining habitat within the Project site. However, as the majority of AHEV is on the higher elevation compared to the future proposed platform levels and is located upstream from the developments, the potential contamination is Unlikely to spread towards AHEV. Therefore, AHEV was not selected as an ecological sensitive receptor. Marsiling Park Pond is the only potential ecological sensitive receptor as the water from the site eventually discharges into it.

Table 8-16 Classification of water resources ecological sensitive receptors identified within the Study Area for operational phase

Sensitive Receptor	Receptor Description	Receptor Classification
Pond at Marsiling Park and Associated Habitat	- Man-made pond with concretised banks and recreational infrastructure - Water from the Pond flows in two directions – one flows north, towards the concrete canal and from there towards the sea, while in the south the water flows into the canal via which the water eventually reaches Upper Seletar Reservoir - Northwestern portion of the Marsiling Park, adjacent to the Pond is dominated by mangrove habitats which are generally uncommon in Singapore due to anthropogenic activities and land developments	Priority 1

8.5.1.2 Impact Assessment

The key surface water quality impacts associated with operational phase of the Project include the discharge of stormwater runoff potentially contaminated with pollutant build-up from urbanised areas and discharge of

contaminants into the watercourses and soil due to inappropriate disposal and storage of liquid and solid wastes generated within the site.

Potentially Contaminated Stormwater Runoff

As the majority of the Project site will eventually become urbanised, imperviousness of the site will significantly increase. Consequently, potential pollutants that may fall onto the ground (e.g. domestic waste, chemicals due to accidental spills, etc.) will remain on the surfaces until removed (by dedicated procedures) or flashed out via stormwater. If these pollutants reach the downstream watercourses, they have a potential to alter existing water quality conditions, consequently affecting associated habitats. Although the runoff may be significantly contaminated with various pollutants, taking into consideration the volume of water present within Marsiling Park Pond and dilution effects, impact intensity was assessed to be **Medium**. As this receptor was categorised as Priority 1 sensitive receptor, impact consequence was assessed to be **Medium**. As detailed in Section 8.3.2, regular and dedicated procedures for stormwater collection settling, testing and eventual discharge should be implemented to assure that the water is of appropriate quality before the discharge. As the uncontrolled discharges of water with potential pollutants are expected to occur only during the heavy storm events and in the case of the system failure, likelihood was assessed to be **Rare**. Therefore, the overall impact significance was assessed to be **Minor**, as per impact consequence matrix (Table 5-14).

Direct Discharge of Contaminants into Soil and/ or Watercourses due to Inappropriate Disposal and Storage of Liquid and Solid Wastes

During the operational phase, solid and liquid waste will be generated frequently by the residents in the proposed development (e.g. domestic waste, car wash wastewater, etc.). In addition, as the site will be highly urbanised, there is a potential for point discharge of contaminants due to accidental spillages and leakages of chemicals (e.g. car oil, faulty car parts, etc.), implying that there could be a great variety of chemicals to enter the environment. Adequate waste management practices are expected to be successfully implemented within the Project site (e.g. sufficient disposal bins, regular inspection of waste storage systems, etc.) which is expected to significantly reduce the likelihood of discharge of contaminants into the surrounding area. Localised point discharges due to human errors (e.g. accidental spillages) and/ or use of faulty vehicles are more difficult to prevent, even with the implemented minimum controls (e.g. emergency response plan, raising awareness of stakeholders, etc.). However, given the small quantities of such discharges and dilution effect by the time they reach watercourses (if they reach), impact intensity was assessed to be **Low**. As Pond at Marsiling Park was assessed as Priority 1 receptor, the impact consequence was assessed to be **Low**. The likelihood would be **Rare**, hence the overall significance was assessed to be **Minor**.

8.5.1.3 Proposed Mitigation Measures

No additional mitigation measures aside from the proposed minimum controls were proposed to further minimise the adverse impacts on the water resources as none of the impacts on the ecological sensitive receptors have been assessed Moderate to Major.

8.5.1.4 Residual Impact Assessment

No residual impact assessment has been undertaken as no Moderate or Major impact significance on the ecological receptors were assessed.

8.5.1.5 Cumulative Impacts

It is assumed that all the concurrent developments will comply with the construction standards and environmental management and control. Therefore, it is not expected that they will increase impacts on water resources.

Table 8-17 Summary of surface water quality impact assessment during operational phase of the Project

Impact	Source of Impact	Sensitive Receptor	Receptor Sensitivity	Impact Intensity	Impact Consequence	Impact Likelihood	Impact Significance
Disturbances in habitat and/ or reduction in size of species population due to contamination of receiving watercourses	Discharge of potentially contaminated surface water runoff during storm events	Pond at Marsiling Park and Associated Habitats	Priority 1	Medium	Medium	Less Likely/ Rare	Minor
	Direct discharge of contaminants into soil and/ or watercourses due to inappropriate disposal and storage of liquid and solid wastes			Low	Low	Less Likely/ Rare	Minor

8.5.2 Impacts due to Groundwater Changes

After the construction phase has been completed, it is expected that human activity will increase within the Study Area. The permanent land use change (i.e. increase in impervious surfaces) might cause decreased infiltration of surface water and rainfall into the ground, potentially causing the reduction of groundwater levels. Furthermore, chemicals used during the maintenance and landscaping activities might accidentally leak into the ground, affecting underlying groundwater's quality.

8.5.2.1 Identification and Categorisation of Sensitive Receptors

Based on the proposed land use plan, the majority of the existing habitats within the Project site will be permanently removed, leaving proposed AHEV the only remaining vegetated area within the site. Therefore, AHEV was identified as potential ecological sensitive receptors. Other identified ecological sensitive receptor includes Marsiling Park Pond and associated habitats, as they too may be affected by potential changes within the site.

Table 8-18 Classification of groundwater ecological sensitive receptors identified within the Study Area for operational phase

Sensitive Receptor	Receptor Description	Environmental Parameter	Receptor Classification
Area of High Ecological Value (AHEV)	- Native-dominated secondary forest, including a 15-m buffer from the last row of native trees - AHEV will also be used as a stepping stone and bigger zone to the main ecological connectivity network - As the groundwater levels within the site are monitored to be low (i.e. more than 5 m bgs), it is unlikely that this habitat is dependent on the groundwater quantities or quality	Groundwater Level	Priority 3
		Groundwater Quality	Priority 3
Pond at Marsiling Park and Associated Habitat	- Man-made pond with concretised banks and recreational infrastructure - Part of the water from the Pond eventually reaches Sungei Mandai Kechil - Northwestern portion of the Marsiling Park, adjacent to the Pond is dominated by mangrove habitats which are generally uncommon in Singapore due to anthropogenic activities and land developments - Inferred groundwater flow within the site is towards southeast, away from the Pond	Groundwater Level	Priority 3
		Groundwater Quality	Priority 3

8.5.2.2 Impact Assessment

8.5.2.2.1 Impacts due to Groundwater Level Decrease

Based on the footprint of the future development, the majority of the site will be converted into residential building developments and road. This will increase the percentage of impervious surfaces, consequently reducing the infiltration of surface water and rainfall into the ground which could possibly impact the groundwater levels on the site. Furthermore, high-rise developments might require deep foundations which could also impact the groundwater levels and baseflow. However, it is anticipated that after the construction phase, the water table will equilibrate to its new groundwater level.

As mentioned in previous section, based on the groundwater baseline data, it is **Unlikely** that the future AHEV to be retained is dependent on the groundwater resources. Therefore, the overall impact significance to this ecological receptor was assessed to be **Negligible**. Similarly, as the Pond at Marsiling Park has concretised banks and is primarily fed from the surface water of the surrounding catchment area, any changes in groundwater quantity/levels are **Unlikely** to have adverse effects to the Pond. Hence, the overall impact significance to this receptor was also assessed to be **Negligible**.

8.5.2.2 Impacts due to Groundwater Contamination

As the area becomes operational, increased human activity (both from permanent future residents and visitors) will possibly lead to higher generation of solid and liquid waste. Furthermore, the maintenance of the potential future green spaces within the residential developments might require the usage of certain chemicals which may or may not be stored within the site. If not managed properly, leachate from waste generated and collected on the site may infiltrate the ground, potentially affecting groundwater quality. However, it is expected that during the operational phase, the Study Area will have little use of hazardous substances and chemicals. Furthermore, small, localised contamination that may happen in certain areas as a result of accidental spillages and leakages will most likely cause limited impacts to groundwater quality. Based on the collected groundwater level data, it can be inferred that the groundwater likely flows towards southeast. This means that in the event that any contamination does happen, the pollution will likely reach AHEV. In addition, as the groundwater levels are currently low, it is unlikely that the existing habitats and flora species are using/ extracting this groundwater. As is it **Unlikely** that the potential groundwater contamination will have any impact on AHEV, impact significance was assessed to be **Negligible**. Similarly, as the groundwater flow is inferred to be southeast, away from the Marsiling Park Pond and its associated habitats, it is **Unlikely** that potential groundwater pollutants (if any) would reach this receptor. Therefore, the overall impact significance was assessed to be **Negligible**.

8.5.2.3 Proposed Mitigation Measures

No additional mitigation measures aside from the proposed minimum controls were proposed to further minimise the adverse impacts on the groundwater level and quality as none of the impacts on the ecological sensitive receptors have been assessed to be Moderate or Major.

8.5.2.4 Residual Impact Assessment

No residual impact assessment has been undertaken as no Moderate or Major impact significance on sensitive receptors were assessed.

8.5.2.5 Cumulative Impacts

It is assumed that all the concurrent developments will comply with the construction standards and environmental management and control. Therefore, it is not expected that they will increase impacts on ecological receptors.

8.5.3 Impacts due to Noise Level Changes

8.5.3.1 Identification and Categorization of Sensitive Receptors

Ecological receptors considered for assessment of noise impacts will remain the same for the construction and operational phase of the Project as discussed in Section 7.5.3.1. With necessary and adequate mitigation measures implemented for the construction phase to reduce noise impacts on the ecological receptors, similar fauna species identified surrounding the proposed construction worksites and within/ surrounding the Project site prior to construction works, should continue to inhabit the surrounding areas.

It is advised that faunistic survey and baseline noise monitoring be conducted upon completion of the construction phase and commencement of the operational phase to determine the new baseline conditions and fauna species that remain in the vicinity of the proposed construction worksites to determine actual operational noise impacts.

8.5.3.2 Impact Assessment

8.5.3.2.1 Assessment Criteria

This section discusses on the noise impacts associated with noise emissions arising from ACMV systems of non-industrial buildings and vehicular noise on new/ existing traffic networks within the vicinity of the Project site. As discussed in Section 5.3, a qualitative means of assessment has been adopted in the assessment for operational noise impacts due to the lack of detailed design information required for the assessment of operational noise impacts relating to ACMV systems and land traffic noise.

There are currently no guidelines or standards available to assess the impact of noise from operational activities on the ecological receptors. The current guidelines and standards available are used to assess the respective noise impacts to humans only. Baseline noise levels have been adopted as criteria for identified noise sensitive ecological receptors as mentioned in Section 6.6.2. The ecological impact from airborne noise is species dependent, hence

the assessment will be based on the species identified by the fauna specialists during site surveys within and surrounding the Study Area as stated in Section 7.5.3.1.

The typical potential noise sources during the operational phase of the Project includes the following:

- ACMV noise emitted from non-industrial buildings as part of the Project development; and
- Traffic noise due to increase in vehicular volume and new road networks due to the development of the Project and in the vicinity of the Airborne Noise Study Area.

Operational noise arising from ACMV systems, if any, are expected to persist throughout the day, emitting from proposed non-industrial buildings depending on the nature of the eventual establishment. While land traffic noise emissions are expected to follow traffic trends, peaking during traffic peak hours.

8.5.3.2.1.1 Air Conditioning and Mechanical Ventilation Noise Impact

According to the *NEA Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings, 2018* [R-37], non-industrial buildings refers to any permanent or temporary building or structure used for the purposes of trade, business or commerce and includes any shopping complex, financial institution, office tower, hotel, educational institution, hospital, transport infrastructures, community infrastructure, sport and recreational infrastructure but does not include any factory and residential premises. The noise limits for ACMV systems are outlined in Table 8-19 below.

Table 8-19 Boundary noise limit from ACMV systems of non-industrial buildings

Type of Affected Premises	Boundary Noise Limits (reckoned as the equivalent continuous noise level over 15 minutes), dB(A)		
	Day 7am – 7pm	Evening 7pm – 11pm	Night 11pm – 7 am
Noise Sensitive Premises e.g. hospital, home for the aged sick, library.	60	55	50
Residential Premises	65	60	55
Others	70	65	60

8.5.3.2.1.2 Land Traffic Noise

The Technical Guideline for Land Traffic Noise Impact Assessment provides guidance to conduct for the following:

- Part 1 – Land traffic Noise Impact Assessment on new residential and noise sensitive developments located in close proximity to existing land traffic noise sources/hotspots (e.g. expressways/major arterial roads/MRT tracks); and
- Part 2 – Land traffic Noise Impact Assessment on existing residential and noise sensitive developments located in close proximity to new transport-related developments (e.g. expressway/major arterial roads/MRT track/bus interchanges/bus depots), inclusive of the expansion of existing transport-related infrastructures.

The noise emissions due to movement of traffic shall be assessed against the *NEA Technical Guideline for Land Traffic Noise Impact Assessment, 2016* [R-39] for the proposed development for operation of transportation networks in the Study Area. The noise levels of the new residential and noise sensitive development shall comply with the following NEA's noise requirement.

NEA's noise requirements are as follows:

- The noise levels at 1 m from the façade of the new residential/noise sensitive building shall not exceed $L_{Aeq(1hr)}$ 67 dB; and
- The indoor noise level of the new residential/noise sensitive building under natural ventilation shall not exceed $L_{Aeq(1hr)}$ 57 dB.

8.5.3.2.2 Prediction and Evaluation of Airborne Noise Impacts

8.5.3.2.2.1 Air Conditioning and Mechanical Ventilation Noise Impact

The average baseline noise levels $L_{Aeq(15min)}$ recorded at NM01 were 61 dB(A) for 7 am to 7 pm (day), 60 dB (A) for 7 pm to 11 pm (evening), and 60 dB (A) for 11 pm to 7 am (night) (see Table 6-17). Comparing this to the boundary noise limit established in Table 8-19, for the residential premises (60-70 dB(A) – day, 55-65 dB(A) – evening, 50-60 dB(A)-night), the existing recorded noise levels are close to the specified criteria. However, with reference to information on the proposed developments within the Project site (see Section 3.2), proposed development establishments will be residential building that may potentially emit noise from ACMV systems during periods of operation. Since the primary origin of ACMV in residential buildings is expected to be the condenser unit of each individual air conditioning system, it was qualitatively assessed that the operational noise from ACMV will be of small magnitude.

As such, the Impact Intensity for ecological receptors subjected to operational noise from ACMV systems are deduced as **Negligible** (refer to Table 5-13) with a corresponding Impact Consequence of **Imperceptible - Very Low** (refer to Table 5-16) depending on the sensitivity of the receptor. With a Likelihood of Occurrence of noise emissions affecting the ecological receptors being **Likely/ Regular** (see Table 8-20), the overall Impact Significance can be qualitatively assessed as **Negligible - Minor** (refer to Table 8-20) for operational noise impacts arising from potential ACMV systems. Therefore, no additional mitigation measures are required with regards to boundary noise from ACMV.

In accordance with the impact evaluation matrices in 5.3, the summary of operational noise impacts from ACMV as assessed qualitatively are presented in Table 8-20 below.

Table 8-20 Summary of operational noise impacts due to boundary noises from ACMV (Non-industrial).

Auditory Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Priority 1	Negligible	Very Low	Likely/ Regular	Minor
Priority 2	Negligible	Imperceptible	Likely/ Regular	Negligible
Priority 3	Negligible	Imperceptible	Likely/ Regular	Negligible

8.5.3.2.2.2 Land Traffic Noise Impact

Studies on land traffic noise impact on fauna species have found that traffic noise indirectly impacts habitat quality and can alter how fauna species use their primary sensory systems to detect or recognize important cues such as the ability to forage, communicate, find mates, and avoid predators. Species diversity, occupancy, reproductive stress, and survival can also be affected through masking induced by traffic noise of both territorial and predatory calls, eliciting avoidance behaviour and stress response [P-30, P-31].

Assuming that the proposed road and the existing road will meet criteria set by the *NEA Technical Guideline for Land Traffic Noise Impact Assessment, 2016* [R-39] for human receptors which is 67 dB(A), noise level at the roads can be computed by Equation (8.1) and Equation (8.2) mentioned in *Calculation of Road Traffic Noise, Department for Transport, Welsh Office, United Kingdom* [R-43].

$$\text{Noise Level at road} + \text{Correction factor} = 67 \text{ dB(A)} \quad (8.1)$$

$$\text{Correction factor} = -10 \log_{10} \frac{d'}{13.5} \text{ dB(A)} \quad (8.2)$$

$$d' = \text{shortest slant distance from the effective source position} = [(d + 3.5)^2 + h^2]^{\frac{1}{2}}$$

The correction factor introduces to consider the impact of horizontal distance from edge of nearside road and the relative height between the reception point and the effective source position [R-43]. A conservative approach was taken by assuming an average height (h) of 0.50 m for the reception point relative to the effective source position. The distance (d) measured at 1 meter from the facade of buildings sensitive to noise and the adjacent roads, shortest slant distances (d'), relevant correction factors and noise levels at roads have been tabulated in Table 8-21.

Table 8-21 Noise levels at roads adjacent to the Study Area during the operational phase.

Name of the road	Closest adjacent noise sensitive building	Distance at 1 m from the façade of closest adjacent noise sensitive building (m)	Shortest Slant distance (m)	Relevant Correction (dB(A))	L _{Aeq(1hr)} (dB(A))
Proposed Road along Woodlands Secondary School	Woodlands Secondary School	11.8	15.3	-0.93	68
Woodlands Centre Road	Masjid An Nur	52.6	56.1	-6.63	73
Marsiling Road	Residential Building	13.1	13.6	-0.90	68
Admiralty Road	Masjid An Nur	13.1	13.6	-0.90	68

Marsiling Park and proposed AHEV can be considered to accommodate ecological noise sensitive receptors during the operational phase of the project (refer to Section 6.4). Therefore, traffic flows at Woodlands Centre Road and Marsiling Road may have impact on ecological NSRs due to the proximity to ecological receptors.

Since the distances of the road from the existing noise sensitive building (Masjid An Nur) and proposed project sites are same, noise generated by traffic within Woodlands Centre Road should not be changed to follow the criteria set by the *NEA Technical Guideline for Land Traffic Noise Impact Assessment, 2016* [R-39] for human receptors during the operational phase of the proposed development. Therefore, the Impact Intensity for ecological receptors subjected to noise from land traffic within Woodlands Centre Road are deduced as **Negligible** (refer to Table 5-13) with a corresponding Impact Consequence of **Imperceptible - Very Low** (refer to Table 5-14) depending on the sensitivity of the receptor. With a Likelihood of Occurrence of noise emissions affecting the ecological receptors being **Possible/ Occasional** (see Table 5-15) with the mobile ecological receptors being able to retreat deeper into the nearby Biodiversity Study Area during hours of peak traffic, the overall Impact Significance can be qualitatively assessed to range from **Negligible - Minor** (refer to Table 5-16) for noise impacts arising from land traffic within Woodlands Centre Road during the operational phase of the proposed development. Therefore, no additional mitigation measures are required with regards to land traffic noises within Woodlands Centre Road.

In case of noise emitted from land traffic from Marsiling Road, considering a buffer of 15 m surrounding AHEV resulted in L_{Aeq(1hr)} of 65 dB (A) applying Equation (8.1) and Equation (8.2) [R-43] which will be experienced by ecological NSRs within AHEV. Therefore, the Impact Intensity for ecological receptors subjected to noise from land traffic within Marsiling Road are deduced as Medium (refer to Table 5-13) with a corresponding Impact Consequence of **Low – High** (refer to Table 5-14) depending on the sensitivity of the receptor. With a Likelihood of Occurrence of noise emissions affecting the ecological receptors being **Possible/ Occasional** (Table 5-15) with the mobile ecological receptors being able to retreat deeper into the nearby Biodiversity Study Area during hours of peak traffic, the overall Impact Significance can be qualitatively assessed to range from **Minor – Moderate** (refer to Table 5-16) for operational noise impacts arising from land traffic within Marsiling Road during the operational phase of the proposed development.

Summary of TNIA for roads has been presented in Table 8-22.

Table 8-22 Summary of land traffic noise impacts.

Location of Noise Source	Location of Noise Sensitive Receptors	Auditory Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Woodlands Centre Road	Marsiling Park and AHEV	Priority 1	Negligible	Very Low	Possible/ Occasional	Minor
		Priority 2	Negligible	Imperceptible	Possible/ Occasional	Negligible

Location of Noise Source	Location of Noise Sensitive Receptors	Auditory Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
		Priority 3	Negligible	Imperceptible	Possible/Occasional	Negligible
Marsiling Road	AHEV	Priority 1	Medium	Medium	Possible/Occasional	Moderate
		Priority 2	Medium	Low	Possible/Occasional	Minor
		Priority 3	Medium	Very Low	Possible/Occasional	Minor

8.5.3.3 Proposed Mitigation Measures

With regards to traffic noise emitted from land traffic from Marsiling Road, traffic noise shall be mitigated with low-speed postings, speed humps and speed limit signages. The addition of these speed control measures will likely lower noise levels for traffic as the vehicles would be cruising at lower speeds.

However, no noise monitoring programme is proposed for the operational phase due to the lack of information required regarding the ACMV system designs and land traffic volumes. Usually conducted by an appointed Noise Consultant, AECOM recommends that the works for ACMV boundary noise impact assessment and land traffic noise impact assessment be conducted as part of the detailed design process of the Project in accordance with the NEA guidelines as discussed in Section 8.5.3.2 before obtaining Temporary Occupation Permit for commencement, which should be adequate. However, HDB will need to communicate the required ecological criteria to the developers of such utility buildings as the ecological criteria is different from the NEA's usual criteria.

8.5.3.4 Residual Impact Assessment

The unmitigated impact significance of boundary noise generated from ACMV has been determined to be **Negligible to Minor** (refer to Table 8-20), no residual impact has been assessed for boundary noise. The noise impact from traffic on Woodlands Centre Road has also been reduced to **Negligible to Minor**, resulting in no residual impact being assessed (refer to Table 8-22).

The residual operational noise impact assessment assumes that the mitigation measures proposed within **Section 8.5.3.3** have been implemented at developments identified as potential sources for operational noise. With the implementation of mitigation measures, the impact intensity at the receptors due to traffic noise is expected to be reduced with the adoption of measures to reduce traffic noise by introducing speed postings, humps and speed limit signages to slow down traffic. With the considerations of current baseline conditions, the impact intensity on the ecological receptors will be **Negligible** (see Table 5-13). This will result in impact consequences of **Imperceptible – Very Low** (refer to Table 5-14). With a likelihood of occurrence of Possible/Occasional (see Table 5-15), the overall residual impact significance of TNIA from Marsiling Road on ecological receptors can be deduced to **Negligible - Minor** after reducing the speed (refer to Table 5-16). A summary of residual impact significance of TNIA has been presented in (Table 8-23).

Table 8-23 Summary of residual land traffic noise impacts.

Location of Noise Source	Location of Noise Sensitive Receptors	Auditory Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Marsiling Road	AHEV	Priority 1	Negligible	Very Low	Possible/Occasional	Minor
		Priority 2	Negligible	Imperceptible	Possible/Occasional	Negligible
		Priority 3	Negligible	Imperceptible	Possible/Occasional	Negligible

8.5.3.5 Cumulative Impacts

Two major concurrent developments have been identified in Section 3.5 to be in the vicinity of Woodlands N1 worksite. It is assumed that all the concurrent developments will comply with the environmental management and control. Therefore, it is not expected that they will increase impacts on ecological receptors.

8.6 Summary of Impacts during Operational Phase of the Project

For habitat receptors, two types of impact were assessed during operational phase: (1) habitat degradation and (2) changes in microclimatic conditions.

Only the native-dominated secondary forest and urban vegetation habitats were assessed in the pre-mitigated phase as proposed development would result in complete clearance of abandoned-land forest and scrubland habitats. With retention of AHEV, all four habitat types were assessed and impact significance ranges were either Minor/Negligible.

For flora receptors, no impacts were assessed during operational phase.

For fauna receptors, four types of impact were assessed during operational phase: (1) accidental injury or mortality, (2) human-wildlife conflict, (3) human disturbances and (4) light disturbances, with the last two impact types assessed only during post mitigation.

Negligible to moderate impacts are expected to arise from accidental injury and mortality from increased vehicular traffic and bird crashes on windows, and human-wildlife conflict incidents. After consideration of the recommended mitigation measures in both design and operational phase which considers the scenario of retaining the AHEV, (see Section 6.4.4), some impacts can be reduced to Minor/Negligible. However, through retaining the AHEV, some impacts are also increased from Negligible to minor for the impact types accidental injury or mortality and human-wildlife conflict as retaining a part of the habitat might increase chances of encountering the fauna receptors.

For surface water, two sources of impacts were assessed during operation: (1) Potentially contaminated stormwater runoff and (2) Direct discharge of contaminants into solid and/or watercourses due to inappropriate disposal and storage of liquid and solid wastes. Impact significance was assessed to be Minor for all sources of impact on the identified receptor and no mitigation measures were proposed.

For groundwater, two sources of impacts were assessed during operation: (1) Groundwater level decrease and (2) Groundwater contamination. Impact significance was assessed to be Negligible for all sources of impact on the identified receptors. No mitigation measures were proposed.

The impact significance for noise-sensitive ecological receptors was qualitatively assessed as Negligible - Minor due to ACMV noise from non-industrial buildings. For traffic noise from increased vehicular activity, the impact significance was assessed as Negligible - Moderate. Proposed mitigation measures include low-speed postings, speed humps, and speed limit signage. After implementing these measures, the post-mitigation impact significance was reduced to Negligible - Minor.

9 Preliminary EMMP

The proposed Environmental Management and Monitoring Plan (EMMP) is prepared for environmental impacts of the construction and operational phases associated with the Project, and that were assessed in this EIA, namely biodiversity, water resources (surface water quality, groundwater quality and level) and airborne noise. The EMMP details how the recommended mitigation measures prepared for the impact assessment are to be implemented and specifies recommended monitoring measures to assess the effectiveness of the mitigation measures. This document is also intended to provide a broad framework for the Environmental Control Officer (ECO) to develop a more contract-specific EMMP, as per their responsibilities in Section 9.4.5. Since the Project will evolve over time, the EMMP is an adaptive document meant to be amended where necessary. Copies of the EMMP must be kept on-site for reference at all times.

This Section outlines the objectives of the EMMP, the project organisation, describes the roles and responsibilities relevant to implementation of the EMMP, and summarises the EMMP requirements for each discipline.

9.1 EMMP Objectives

The EMMP details the implementation and deliverables of the recommended mitigation measures identified from the impact assessment for each technical discipline. The EMMP progressively scrutinizes pre-construction, construction and operational activities as they ensue and applies flexible monitoring and management procedures to protect the project's environmental values throughout the construction and operational phases. The objective of the EMMP is twofold:

- a) Environmental monitoring focuses on overseeing that impacts to the project's environmental values from construction and operation are within the anticipated level and tackle unforeseen impacts that may arise; and
- b) It also tracks the effectiveness of the recommended mitigation measures to allow amendment or review of the mitigation measures to better address any issues faced during construction and operation of the project.

Environmental management employs a more active approach to ensure that impacts to flora and fauna are directly avoided through documentation, auditing and enforcement.

9.2 Project Organisation during the Construction Phase

The roles and responsibilities of the various parties responsible for implementing the EMMP during the construction phase are outlined below. The proposed Project organization and lines of communication with respect to environmental protection works are presented in Figure 9.2.1.

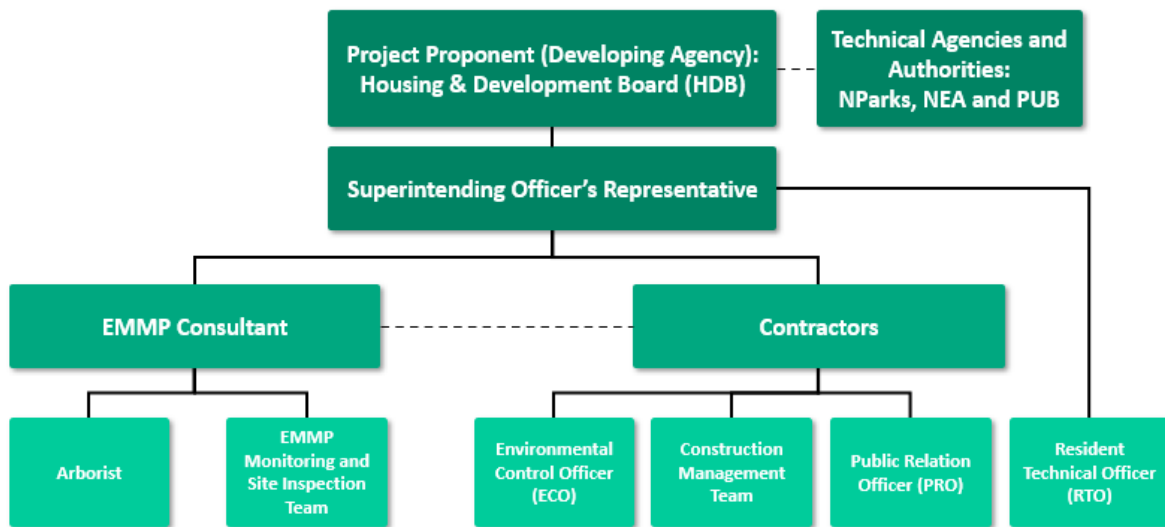


Figure 9.2.1 Project organization and lines of communication during the construction phase

9.3 Project Organisation during the Operational Phase

The roles and responsibilities of the various parties responsible for implementing the EMMP during the operational phase are outlined below. The proposed Project organization and lines of communication with respect to environmental protection works are presented in Figure 9.3.1.

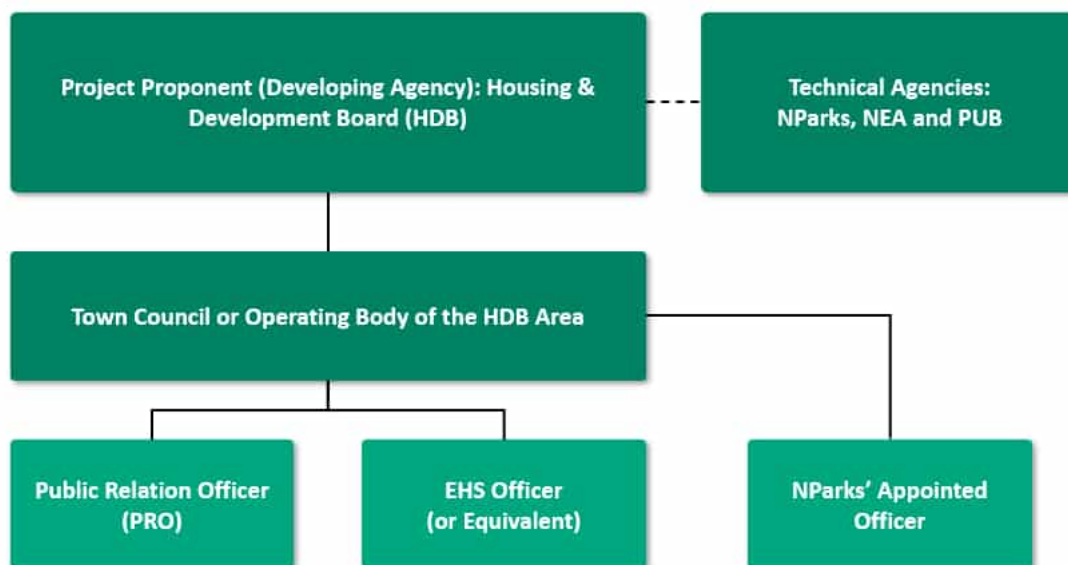


Figure 9.3.1 Project organization and lines of communication during the operational phase

9.4 Roles and Responsibilities of the EMMP for the Construction Phase

9.4.1 Technical Agencies

Technical agencies constitute, but are not limited to NParks, PUB and NEA. These agencies will assess and approve the detailed EMMP for the construction and operational phases prior to commencement of works and where required during the course of the project.

9.4.2 Developing Agency (HDB) and Resident Technical Officer (RTO)

The HDB, being the Project Owner and the developing agency, will oversee the construction phase of the Project in accordance with the design. In conjunction with the Resident Technical Officer (RTO), HDB are required to:

- Ensure resources are available to achieve the requirements of the EMMP
- Provide guidance and advise on development and implementation of the EMMP
- Ensure all environmental incidents and near misses are promptly investigated and reported
- Resolve any non-compliance issues
- Record, respond to, and action any complaints from members of the public, if any, with inputs from the Technical Agencies, if required
- Reporting to the Technical Agencies regarding implementation of the EMMP.

The Resident Technical Officer (RTO) responsible for monitoring and overseeing construction activities to ensure compliance with environmental regulations and project specifications. The RTO identifies and addresses any potential environmental risks or non-compliance issues, facilitating the adoption of sustainable practices and protecting the environment throughout the construction process. The RTO should:

- Monitor and oversee construction activities to ensure compliance with the EMMP, project specifications, and environmental regulations;
- Conduct daily site inspections to verify the implementation of environmental mitigation measures;
- Address and resolve any environmental concerns or issues raised by the SO Rep., EMMP Consultant, technical agencies, or the public by seeking advice from EMMP Consultant/SO Rep.; and

Provide guidance and support to the construction management team in implementing environmental best practices.

9.4.3 The Superintending Officer Representative (SO Rep)

The Superintending Officer Representative (SO Rep) is responsible for overseeing the construction works undertaken by various personnel, contractors and sub-contractors. The SO Rep should ensure that the construction works are performed by the contractors and personnel in accordance with the specification, contractual requirements, and EMMP. The SO Rep should also:

- Communicate the requirements of this plan to all staff, contractors and sub-contractors
- Monitor all staff, contractor's and sub-contractor's compliance with contract specifications and regulatory requirements, including the implementation of the environmental mitigation and monitoring measures and ensure their effectiveness, and other aspects of the environmental audit program
- Coordinate with the project's EHS Officer to monitor and participate in the implementation of the environmental audit program, with assistance from ECO, and ensure that the requirements in the environmental audit program are correctly followed
- Appoint third party environmental auditor to check and audit the environmental performance monitoring
- Implement measures to reduce impacts where emission/ discharge levels are exceeded. The SO Rep also acts as a point of contact between the Contractor and EMMP Consultant and should ensure all communications are passed between parties without delay

- Coordinate with the Project Owner and RTO for submission of environmental audit reports
- Carry out any complaint investigations and report to Developing Agency
- Resolve any non-compliance issues
- Promote environmental awareness and responsibility and lead by example.

9.4.4 The Contractor

The term “Contractor” refers to all construction contractors and sub-contractors working onsite at any time. In addition to reporting to the SO Rep, the Contractor should:

- Responsible for executing approved EMMP and mitigation measures on site, whilst ensuring that the requirements related to standard mitigation measures and requirements are followed
- Work under the relevant contract scope, approved EMMP specifications
- Responsible to carry out works in a manner ensuring compliance to all applicable environmental legislation, environmental policy, mitigation/ enhancement measures recommended in the EIA, etc., set by relevant authorities and the Developing Agency
- Submit proposal for mitigation measures should there be an exceedance or environmental incident/ complaint
- Ensure that the roles of RTO, SO Rep, Environmental, Health and Safety Officer (EHS Officer), ECO, Certified Arborist, and Fauna Specialist(s) are adequately resourced;
- Participate in the required environmental site audits (via the SO Rep.) undertaken by third party independent Environmental Performance Auditor and undertake corrective actions instructed by the Environmental Performance Auditor;
- Undertake all monitoring and implement all mitigation measures recommended by the Arborist, Flora Specialist, and Ecologist, as far as practicable;
- Provide up-to-date information to the RTO, SO Rep, ECO, Certified Arborist, and Fauna Specialist(s) regarding any work activities which may contribute or continuously create adverse environmental conditions, or any changes to the work plan
- Prepare a detailed contract-specific EMMP, incorporating the relevant mitigation measures and monitoring works recommended in this EIA Report and seek technical agencies’ approval prior to the commencement of any works. This detailed EMMP will include, as a minimum, a Standard Operating Procedure (SOP) detailing:
 - Handling and storage of hazardous chemicals;
 - Biodiversity management plan
 - Individual environmental management plans as detailed in the NEA’s SHE Specifications (air, vector, waste, noise, water pollution management plans)
 - Monitoring plans (including but not limited to ecology, water pollution, air, noise, waste)
 - Existing legislation and environmental best practices to be implemented
 - Contingency planning during emergency situations
 - Besides, for site and/ or vegetation clearance before the commencement of actual construction, the Contractor will engage a certified Qualified Erosion Control Professional (QECP) to prepare an Erosion Control Plan (ECP) and obtain approval from the PUB.

For tree-felling, the Contractor will also map the trees on site and the trees planned for removal or retention and NParks’ approval, where the Contractor will consider the following requirements:

- The contractor should employ a certified arborist to map the trees carefully while applying for tree felling approval. This is to gauge the health, species, size and conservation significance of the tree
- If there are trees that must be transplanted, this should be done prior to commencing site clearance

The contractor will consult wildlife specialist and prepare a wildlife shepherding plan, obtain NParks’ approval and execute it prior to/ along the site clearance process.

9.4.5 The Environmental Control Officer (ECO)

The registered Environmental Control Officer (ECO) should provide all the necessary information and assistance to the PRO in order to complete the complaint investigation. Following the investigation, the Contractor should promptly undertake the mitigation measures. The PRO and SO Rep. must ensure that the measures have been appropriately implemented. The Contractor, RTO, and SO Rep. will also be responsible for the leading and reporting of complaint investigation results and followed up actions to the Project Owner. The roles and responsibilities of an ECO include:

- To oversee/audit and manage the environmental impacts of the work sites and to ensure all works comply with the environmental requirements;
- To supervise the mitigation measures implemented by Contractors, identify gaps and to provide recommendation on monitoring and mitigation amendments (if any) to the plan where necessary to the EMMP Consultant;
- To train and educate all site personnel to work in a manner as to respect the surrounding environment e.g., toolbox talk;
- To identify, reporting and record potential and presenting environmental issues on site to the EMMP Consultant;
- To limit or advise to stop any Project activities if potential or presenting environmental issues are identified until rectified;
- To ensure site personnel working in the vicinity of forested area are regularly trained by specialists for biodiversity awareness;
- To notify EMMP Consultant of any such observation that's worthy of environmental concern;
- To discuss all environment incidences which may arise with the EMMP Consultant. ECO will work alongside EMMP Consultant to address incidences; and
- To inform EMMP Consultant and Contractors to notify NParks/PUB/NEA in the event of environmental emergency (e.g., roadkill, injured animal, and oil/chemical spill).

9.4.6 Construction Management Team

The Construction Management Team are responsible for overseeing and coordinating activities to ensure compliance with environmental regulations and the EMMP. By effectively managing construction operations, the team aims to minimize environmental impacts, mitigate risks, and promote sustainable practices, thereby contributing to the overall success of the project. Their responsibilities include:

- Coordinate and supervise construction activities in accordance with the EMMP and environmental regulations;
- Ensure the integrity of Tree Protection Zone, prevent excessive or unauthorised vegetation clearance by ensuring construction works are prohibited within the RACs and TPZs;
- Implement measures to prevent or minimize environmental pollution, such as dust control, noise management, and sedimentation control;
- Ensure proper handling, storage, and disposal of construction waste and hazardous materials;
- Conduct regular inspections to identify any potential environmental risks or non-compliance issues;
- Collaborate with subcontractors and suppliers to ensure their adherence to environmental requirements; and

Maintain records and documentation related to environmental compliance and reporting.

9.4.7 Public Relations Officer

The Public Relation Officer (PRO) is responsible for handling complaints and managing feedback and investigative work. The PRO shall be supported by the Contractors, SO Rep. and any other relevant parties.

During the construction phase, upon receipt of complaints, the PRO should undertake the following procedures:

- Log the complaint and record the date when the complaint is received onto the complaint database and inform the Contractor and SO Rep. immediately;
- Investigate the complaint with the SO Rep and Contractor(s) to determine its validity and assess whether the source of the problem is due to construction works;
- If a complaint is valid, liaise with the Contractor(s) and other relevant parties (e.g. ECO, EMMP Consultant) on the mitigation measures and seek agreement from the SO Rep.;
- Review the current situation and the implementation of the mitigation measures;
- Ensure that any valid reasons for complaints do not re-occur by revising the work methods, procedures, machines and/ or equipment;
- Submit a complaint report (as well as implementation of mitigation measures and the effectiveness of the mitigation measures, as advised by the relevant parties) to the SO Rep. and HDB;
- Log a record of the complaint, investigation, follow up actions and the results in the incident report.

9.4.8 EMMP Consultant

The responsibilities of the EMMP Consultant are as follow:

- To oversee the implementation of the EMMP by all responsible parties (refer to the Organisation Chart as shown in Figure 9.2.1);
- To provide advice on environmental issues, where appropriate, or possible;
- To ensure the EMMP Consultant's subcontractors and ECO understand their responsibilities as outlined within the EMMP;
- To advise all parties (e.g., Contractors ECO, Site Engineers, Site Supervisors, Subcontractors and Site Workers, etc.) on matters related to environmental management and promote awareness within the site;
- To prepare and deliver monthly EMMP reporting to SO Rep., Developing Agency and Technical agencies (e.g., NParks, if required) based on discussed timeline;
- To carry out bi-weekly environmental site inspection by relevant specialists (noise, ecologists, water quality etc.) depending on the ongoing activities on site;
- To discuss and resolve/mitigate any non-compliance or irregularities with Developing Agency/SO Rep./Technical Agencies; and,
- To coordinate with Developing Agency/SO Rep./Technical Agencies on environment matters.

9.4.8.1 EMMP Site Inspection Team

When required, the EMMP Inspection Team formed by the EMMP Consultant and comprising environmental personnel with experience covering biodiversity, water resources (surface water and groundwater), and noise can be called upon to assist with site inspections. The role of the EMMP Site Inspection Team will be to carry out the specific tasks listed above for the EMMP Consultant (e.g. carry out bi-weekly environmental site inspections).

9.4.8.2 Arborist

Arborist certified by the International Society of Arboriculture (ISA) plays an important role as part of the biodiversity monitoring programme during both construction and commissioning phases of this Project. He/ She will possess previous work experience in developments of similar size or complexity who is able to demonstrate capability in monitoring and managing all matters related to the adequate and successful conservation of trees and flora within and adjacent to the contract boundary. The Arborist will be employed by an EMMP Consultant. A detailed description of biodiversity monitoring programme is provided in Section 9.10, where the key responsibilities of the Arborist are listed as follows:

The key responsibilities of an ISA-certified Arborist during construction phase include but not limited to:

- Carry out tree mapping and assessment
- Implement tree protection plans

- Provide advice on tree transplanting
- Review Contractor's method statements for site clearance, tree felling and setting up of Tree Protection Zones (TPZ)
- Assess forest edge effects and its associated changes
- Implement tree maintenance and care
- Carry out monthly tree inspection and reporting.

9.5 Roles and Responsibilities of the EMMP for the Operational Phase

9.5.1 Technical Agencies

Technical agencies constitute, but are not limited to NParks, PUB, NEA, LTA and MND/ URA. These agencies will assess and approve the detailed EMMP for the construction and operational phases, prior to commencement of works and, where required, during the course of the project.

9.5.2 Project Owner (HDB)

The HDB is a statutory board in Singapore under the Ministry of National Development responsible for public housing in Singapore, which is also the Project Owner for this Project. Therefore, it is responsible for overseeing and managing the environmental monitoring detailed in the EMMP for the operational phase. The HDB is required to:

- Ensure resources and appropriate personnel are available to achieve the requirements of the EMMP
- Provide leadership in the implementation of the EMMP
- Ensure all environmental incidents and near misses are promptly investigated and reported
- Resolve any non-compliance issues
- Record, respond to, and action any complaints from members of the public, if any, with inputs from the Technical agencies, if required
- Reporting to the Technical Agencies and the HDB regarding implementation of the EMMP

9.5.3 EHS Officer (or Equivalent)

The EHS Officer will be appointed by HDB or town council and is responsible for the overall environmental, health and safety during the operational phase of the Project. With respect to the EMMP, the EHS Officer is required to:

- Carry out monitoring of environmental parameters and conduct any required laboratory analysis
- Liaise with HDB, NParks for any impact on the AHEV and subsequent actions to be taken thereof for safeguarding the area
- Conduct site inspections, report monitoring results, and coordinate environmental auditing as stipulated in the EMMP
- Coordinate with HDB regarding equipment, locations, and schedule of monitoring and auditing works
- Analyse environmental monitoring data and audit findings, review the adequacy of implementation of mitigation measures, identify adverse environmental impacts, and liaise with HDB
- Monitor compliance with conditions in the EMMP, relevant environmental protection and control regulations
- Report the results of the environmental monitoring program, and any required changes, to meet the requirements of the EMMP to HDB in a timely manner

9.5.4 Public Relation Officer

The Public Relation Officer (PRO) or relevant officer of the town council or operating body of the HDB area, is responsible for handling complaints and managing feedback and investigative work. The PRO shall be supported by the HDB, EHS Officer and any other relevant parties.

During the operational phase, upon receipt of complaints, the PRO should undertake the following procedures:

- Liaise with HDB, NParks officer on any issues with wildlife at the AHEV or Marsiling Park.
- Coordinate and support community engagement sessions for educating public on human wildlife conflict, and living in harmony with nature educational works organised by NParks or nature groups.
- Log a record of the complaint, investigation, follow-up actions if members of public, nature groups, NParks lodge any wildlife impact in the area and the results in an inspection report. Plan and execute corrective actions to prevent from these incidents to recur.

The PRO should work with HDB (e.g. HDB's representative of the town council) and EHS Officer (or equivalent) to gather all the necessary information and resources necessary to complete a complaint investigation. Following the investigation, the relevant officer of the town council or operating body of the HDB area and EHS Officer shall undertake appropriate mitigation measures. Follow-up is required by the PRO to ensure that the mitigation measures have been appropriately implemented. The complaint investigation report and corrective action plan should be prepared and approved by HDB and/ or other relevant Authorities within 24 hr upon receipt of complaints.

9.6 Construction Site Audit

Site surveillance provides a direct means to assess and ensure the Project's environmental protection and pollution control measures are in compliance with the contract specifications and the EMMP. The ECO should inspect the construction activities regularly and routinely to ensure that the appropriate environmental protection and pollution control mitigation measures are properly and timely implemented, based on the EMMP's recommendations. With well-defined pollution control and impact mitigation measures outlined, and a well-established efficient remedial action reporting system, the site inspection is an effective "tool" to ensure acceptable environmental performance at the construction site.

The ECO is responsible to formulate environmental site inspections, deficiencies and the remedial action reporting system, and to carry out the site inspections. After consultation with Project's SO Rep. and EHS Officer, the ECO should prepare a procedure for the site inspections, deficiencies, remedial action, and reporting requirements. This documentation will be agreed to by the RTO and Contractor representative and approved by the Project Owner within 21 days of the commencement of the construction contract.

Site inspections should be carried out by SO Rep's EMMP Consultant at least once every two weeks (i.e. biweekly) for all the work areas during the construction phase. The inspections should cover the onsite environmental situation, pollution control and mitigation measures. Offsite environmental situations, which may be affected by onsite activities (directly or indirectly), should also be reviewed. Observed site conditions, with regards to defined environmental parameters will be noted, collated and submitted to the Project Owner (HDB) (inclusive of recommendations for improvements to the protection and pollution control and for taking corrective actions, if any). Monthly EMMP audit reports with collated and analysed obtained data will be submitted to the Project Owner (HDB) and SO Rep.

9.7 Operational Site Audit

During the operation of the Project, annual monitoring (minimum frequency) for all environmental parameters should be conducted to ensure that all implemented measures are meeting their intended purpose, and that any potential changes in Project conditions such as increased traffic, track lighting, etc. are not having an adverse impact over and above the impacts identified in this assessment. A log tracking all maintenance procedures of equipment and carrying out of audits should be maintained by the Project Owner and the EHS Officer. Audits should be carried out by NParks and other relevant authorities (e.g. PUB, NEA) to assess the success of the implemented control measures.

A minimum of annual monitoring periods also enables the Project Owner and EHS Officer to address any potential issues, not originally identified during the current impact assessment, that may arise during the course of the

Project. In this instance, the Project Owner should consider the impacts and, in consultation with the Technical Agencies and qualified professionals, develop measures to mitigate any identified impacts.

9.8 Complaint Handling

The Public Relation Officer (PRO) is responsible for handling complaints and managing feedback and investigative work. The PRO will be supported by the Project Owner, ECO, Contractor representatives, and any other relevant party during the construction phase.

During the construction phase, upon receipt of complaints, the PRO should undertake the following procedures:

- Log the complaint and record the date when the complaint is received onto the complaint database and inform the Project Owner, SO Rep, and EHS Officer immediately
- Investigate the complaint with the ECO to determine its validity and assess whether the source of the problem is due to construction works (the target time for response to the complainant is proposed to be 48 hours)
- If a complaint is valid and due to construction works, liaise with the ECO and EHS Officer on the mitigation measures and seek agreement from SO Rep.
- Review the current situation and the ECO's and SO Rep's implementation of the mitigation measures
- Engage the ECO to undertake additional monitoring and auditing to verify the complaint if necessary. Ensure that any valid reasons for complaints do not re-occur by revising the work methods, procedures, machines and/ or equipment, etc.
- Submit complaint report (as well as the implementation of mitigation measures and the effectiveness of the mitigation measures as advised by the ECO) to the Project Owner, RTO and the SO Rep.
- Log a record of the complaint, investigation, follow-up actions and the results in the environmental audit reports

The ECO and SO Rep. should provide all the necessary information and assistance to the PRO in order to complete the complaint investigation. Following the investigation, the Contractor should promptly undertake the mitigation measures. The PRO and SO Rep. should ensure that the measures have been appropriately implemented. The Contractor, RTO, and SO Rep. should also be responsible for the reporting of complaint investigation results and followed up actions to the Project Owner.

During the operational phase, upon receipt of complaints, the PRO should undertake the following procedures:

- Log the complaint and record the date when the complaint is received onto the complaint database and inform the Project Owner and EHS Officer immediately
- Investigate the complaint with the ECO to determine its validity and assess whether the source of the problem is due to construction works (the target time for response to the complainant is proposed to be 48 hours)
- If a complaint is valid and due to construction works, liaise with the ECO and EHS Officer on the mitigation measures and seek agreement from SO Rep.
- Review the current situation and the ECO's and SO Rep's implementation of the mitigation measures
- Engage the ECO to undertake additional monitoring and auditing to verify the complaint if necessary. Ensure that any valid reasons for complaints do not re-occur by noting the root cause of the complaint and revising (if necessary) the work methods, procedures, machines and/ or equipment, etc.
- Submit complaint report (as well as the implementation of mitigation measures and the effectiveness of the mitigation measures as advised by the ECO) to the Project Owner, RTO and the SO Rep.
- Log a record of the complaint, investigation, follow-up actions and the results in the environmental audit reports

The PRO should work with the Project Owner and EHS Officer to gather all the necessary information and resources necessary to complete a complaint investigation. Following the investigation, the Project Manager and EHS Officer to undertake appropriate mitigation measures. Follow is required by the PRO to ensure that the mitigation measures have been appropriately implemented. Reporting of the complaint investigation results and followed up actions should be provided to the Project Owner and the Authorities.

9.9 Submission of Monthly Reports to Technical Agencies

During the construction phase, monthly reports on the implementation of construction EMMP should be submitted to the HDB and other Technical Agencies by the Contractor for record purposes. These reports will also be reviewed by EMMP Consultant/ Auditor, employed by SO Rep. The reports will include, but is not limited to the following:

- Results of environmental monitoring programme, or any required changes to meet the requirements of the EMMP
- Results of monthly tree, flora and fauna inspections
- Records of environmental site inspections, deficiencies/ non-compliance issues and its corresponding remedial action
- Records of all environmental incidents and near-misses, as well as their investigation and follow-up
- Records of complaints, as well as the investigation, follow-up actions/ implementation of mitigation measures and the effectiveness of these measures

9.10 Biodiversity Monitoring Programme Requirement

During the construction and operational phase of the Project, adequate EMMP for flora and fauna need to be developed in order to minimise and manage predicted construction and operational impacts. The biodiversity monitoring programme, as detailed in the sections below, will be carried out by the Contractor, under supervision of the SO Rep and Board's EMMP Consultant.

9.10.1 Construction Phase

9.10.1.1 Flora, Vegetation and Trees

The flora and arboriculture programme aims to assess and manage the impacts of construction to retained vegetation and habitat (i.e., adjacent forest), such as tree health, unauthorised vegetation removal, habitat degradation from soil erosion, and rubbish dumping.

This includes the reviewing of tree felling and site clearance plans (**Section 9.10.1.1.1**), establishment of tree protection zones (**Section 9.10.1.1.2**), verification and reviewing of site works (**Section 9.10.1.1.3**), transplantation of species of conservation significance (**Section 9.10.1.1.4**) and site inspections (**Section 9.10.1.1.5; Section 9.10.1.1.6**).

9.10.1.1.1 Review of Tree Felling and Site Clearance Plans

The Arborist's role is to determine the trees to be retained or felled before the commencement of construction activities. This includes the assessment of tree physiological health, vigour, and structural stability, photographs, as well as the geographic locations of each specimen. This should apply to trees within the development footprint, including working spaces, construction access roads, and hoarding boundaries.

Any horticultural waste resulting from vegetation clearance should be disposed of on the same day to reduce the likelihood of fauna seeking shelter among the horticultural waste.

9.10.1.1.2 Establishment of Tree Protection Zones (TPZs)

TPZs are to be erected for tree specimens recommended for retention by the Arborist, including the trees recommended for conservation from the EIA. These specimens could be within the development footprint and/or very close to but are outside the worksite boundary. Proper TPZs with a designated access for monitoring purposes should be established according to guidelines provided in Appendix O. Measures should be proposed to ensure trees remain protected from damage from adjacent construction works including site access. This should be executed in consultation with the structural engineers and in accordance with the guidelines established by the NParks. Construction works, such as tree felling and work in the 'no-go zone' for laying of trails (avoidance of tree roots), would require the Arborist to oversee the works.

In the event of observed damage to flora and trees, the Contractor shall carry out the following steps:

1. Take immediate action to avoid further damage to the surrounding flora and trees
2. Notify the Board / Board's EMMP Consultant for further assessment and determine the retention value of affected trees

Implement the proposed mitigation measures as recommended by the Board / Board's EMMP Consultant

9.10.1.1.3 Verification and Review of Footprints for Hoarding, Worksite Boundaries, and Access Roads

Following the pegging of the hoarding alignment or worksite boundaries, as well as setting out for areas required for access roads, site offices, storage yards etc., the alignment and footprints are to be verified by the Board's Flora Specialist via ground-truthing. This is to be carried out with the aid of a Global Positioning System (GPS) receiver and cross-checked with the development footprint drawings. The Flora Specialist should ensure there is no excessive vegetation and/or tree removal within the. The Flora Specialist should also review the proposed locations for access roads, site offices, storage yards, etc., to ensure vegetation removal is kept minimal.

9.10.1.1.4 Transplantation of Plant Species of Conservation Significance

For affected plant species of conservation significance located within the worksite, they should be transplanted prior to the start of hoarding installation and clearance works. The Flora Specialist should carry out consultant with NParks to determine the final list of specimens to be transplanted. Guidelines for sapling harvesting and transplantation is provided in Appendix P.

9.10.1.1.5 Monthly Arboriculture Inspection

The Arborist is to carry out the following during the monthly arboriculture inspections:

1. Assess the conditions of retained trees and trees within and around the worksite, i.e., physiological health, vigour, and structural stability, and recommended mitigation measures where necessary
 - a. Ensure they have not deteriorated and that there are no mechanical damages
 - b. Carry out rehabilitation and remediation measures of the trees exhibit signs of stress (e.g., implement a watering schedule to prevent plants from drying out)
 - c. Implement long-term mitigation solutions or recommend additional tree removal where necessary
2. Review method statements from builders for construction at proximity to trees
3. Determine if more trees need to be removed after site clearance based on the construction activities happening in proximity to the retained trees and liaise with NParks for permission where necessary
4. Ensure that works are carried in alignment with NParks' standards

9.10.1.1.6 Monthly Flora Inspection

The Flora Specialist is to carry out the following during the monthly flora inspections:

1. Identify any unauthorised removal of vegetation beyond the agreed worksite boundaries

9.10.2 Fauna

The fauna programme consists of managing of concerns related to fauna within and around all designated work areas. The objectives of fauna management plan are as follows:

- Minimize negative impacts to fauna, particularly to species of conservation interest
- Minimise fauna entrapment on site by inspecting features such as hoarding that may cause fauna entrapment as well as use of 100% biodegradable erosion control blankets
- Monitor presence of trapped/injured/dead fauna inside hoarded areas
- Prevent human-wildlife conflicts

It includes directional site clearance (Section 9.10.2.1), pre-felling tree inspections for fauna (Section 9.10.2.2), regular biodiversity awareness training for the site team and workers (Section 9.10.2.4), fauna response plan in event of animal encounters (Section 9.10.2.5), as well as site inspections (Section 9.10.2.3).

9.10.2.1 Directional Site Clearance

The objective of directional site clearance is to encourage fauna to leave the worksite before construction works begin to prevent fauna entrapment, injury and mortality, while minimising contact between human and wildlife. Directional site clearance also prevents incidents of fauna entrapment within the isolated green patches, which may otherwise occur if site clearance was to be carried in an unspecified manner.

During site clearance, clearance of vegetation is recommended to be carried out from the eastern to western part of the worksite towards the AHEV. The disturbance generated by site clearance activities is expected to encourage target fauna to move out of the worksite on their own and potentially towards the AHEV. Target fauna species include ground-dwelling mammals, as well as animals that may be implicated in human-wildlife conflicts (e.g., snakes).

The site clearance zone may be divided into smaller zones for ease of fauna management during site clearance.

The general proposed sequence and details for directional site clearance is provided below.

i. Hoarding installation

- Hoarding installation is recommended to be carried out from the eastern to western end, i.e., towards Woodlands Centre Road, AHEV
- The site clearance zones should be hoarding up with zinc sheets (minimum 2.0m height)
- Directional site clearance should be carried out from the eastern to western end, i.e., towards Woodlands Centre Road, AHEV

ii. Pre-site clearance fauna inspection

- Prior to site clearance, camera trap monitoring may be conducted to determine the presence of target fauna within site clearance. Camera traps may be deployed 50m apart within the forested area over a three-day period
- Additionally, removal of wild boars may be stipulated by NParks before site clearance. This shall be carried out according to the directions provided in Section 10 of Wildlife Act
- Before the commencement of site clearance works, the Ecologist shall conduct a fauna inspection in areas slated for clearance according to the workflow stated in Figure 9.10.1
- If fauna is found present, the Fauna Response Plan is to be activated

iii. Directional site clearance

- Directional site clearance to be carried out from the eastern to western end, i.e., towards Woodlands Centre Road, AHEV

iv. Post-site clearance fauna inspection

- After site clearance has been completed, the Ecologists will visually inspect the site for presence of target fauna species (i.e., ground-dwelling birds and snakes). If there are no remaining fauna on site, the site clearance is then completed. If there are remaining fauna on-site, the Ecologists will develop methods to remove them in consultation with the Contractor and relevant authorities (e.g., NParks)

9.10.2.2 Pre-felling Fauna Inspection

Pre-felling fauna inspections shall be carried out by Ecologists. Clearance of undergrowth will first be conducted prior to felling of trees on site. After completion of undergrowth clearance, each zone shall be left to fallow for three days to encourage arboreal fauna to leave the site, before clearance of remaining trees within the zone can take place. No vegetation clearance can take place within this fallow period of three days. Pre-felling inspections for the undergrowth and remaining trees can be conducted together on the first day of each round of inspection.

1. Conduct pre-site clearance fauna inspections for trees and non-tree vegetation to be removed. The pre-site clearance fauna inspection includes the identification and reporting of the following:
 - a. Active bird nests, including hollows, and other forms of nesting structures utilised by birds
 - b. Active mammal nests/burrows/roosts
 - c. Other less-mobile animals that are at risk of injury/mortality during tree felling or vegetation removal (e.g., Sunda pangolin)
 - d. Animals that may be implicated in human-wildlife conflict (e.g., snakes)
2. Check tree trunks, branches and canopy with binoculars from multiple angles and distances. Any cavities in tree trunks that may be utilised as nesting/roosting structures are to be noted for closer inspection if deemed potentially active. If a nest is potentially identified and activity level is uncertain, the Ecologist will conduct or supervise the closer investigation of the nest site utilising elevating equipment where required
3. Produce a pre-felling fauna inspection report, indicating any relevant information collected during the inspection, including Tree Tag ID (and/or flora location coordinates if not tagged), animal observations, recommended actions, and photographic evidence
4. Pre-felling fauna inspection is valid for seven days, i.e., if the inspected trees or vegetation are not removed within seven days of the Ecologist's inspection, the inspection will be repeated

5. If animals or active nests are found, the Contractor shall:
 - a. Not disturb the animal and allowed them to move away on their own before tree felling or vegetation removal, unless the Ecologist deems it necessary to relocate them
 - b. Allow nesting birds to fledge and leave the nests on their own before tree felling or vegetation removal

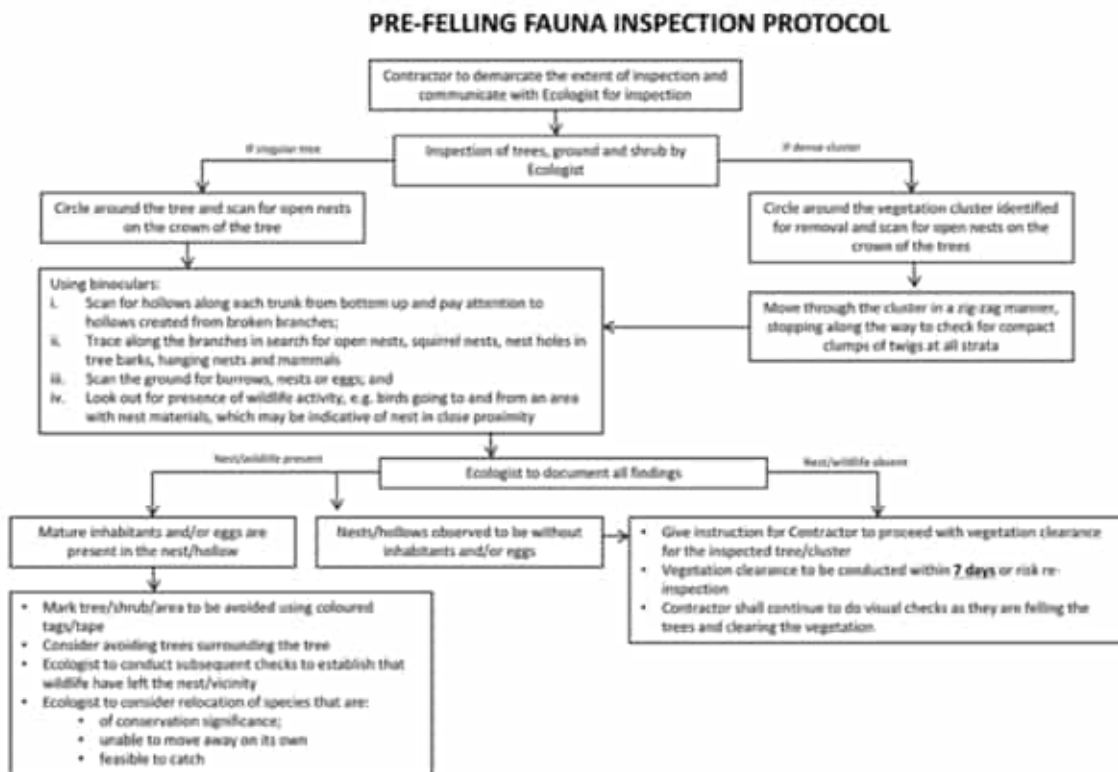


Figure 9.10.1 Pre-felling fauna inspection protocol

9.10.2.3 Monthly Fauna Inspection

Monthly fauna inspections will be conducted within the worksite boundaries. The following will be noted during the inspections:

1. Presence of trapped/injured/dead fauna
2. Potential fauna entrapments (e.g., ECBs, TPZs, pits, drains, ponds, trenches, tanks)
3. Gaps in hoarding around worksites involving heavy machinery that may allow entry of ground-dwelling fauna
4. Non-compliance of ECM measures
5. Improperly disposed/stored food and food packaging

The Contractor shall ensure that 100% bio-degradable erosion control blankets are used to prevent snake entrapment.

9.10.2.4 Biodiversity Awareness Training

The Ecologist shall conduct toolbox briefings on biodiversity awareness to inform site personnel of but not limited to the following:

- Ecological value of the site and its surrounding habitats
- Types of fauna present
- Biodiversity protection strategies
- Site personnel's responsibilities towards biodiversity
- How to respond to fauna encounters

- No feeding of wildlife
- Prevention of roadkills
- Inspection of trees before felling

All site personnel shall undergo biodiversity awareness training prior to commencing work at on-site, and regularly (every six months) throughout the duration of the construction. Documentation of such trainings and briefings shall be maintained.

Reminders on biodiversity awareness and actions to take when encountering wildlife will also be given to all site personnel during daily toolbox briefings.

9.10.2.5 Fauna Response Plan

The Fauna Response Plan will be activated whenever a trapped/injured/dead/dangerous animal is encountered around or within the worksite. The objective of the Fauna Response Plan is to minimise animal injury and mortality by responding appropriately to the different fauna encounter scenarios in Figure 3-1. This will be emphasized during the Biodiversity and Environmental Awareness Trainings (Section 9.10.2.4). All wildlife incidents shall be reported and documented in a Wildlife Incident Form (Appendix Q).

Where fauna is trapped on-site, species-specific methods (e.g., one-way flap doors) shall be formulated to remove them, in consultation with the Board.

The Contractor shall engage a Wildlife Management Company to carry out trapping, rescue, and/or relocation of trapped or injured fauna in accordance with S10 directives. The Wildlife Management Company shall be listed under NParks' public register of certified Wildlife Management Contractors.

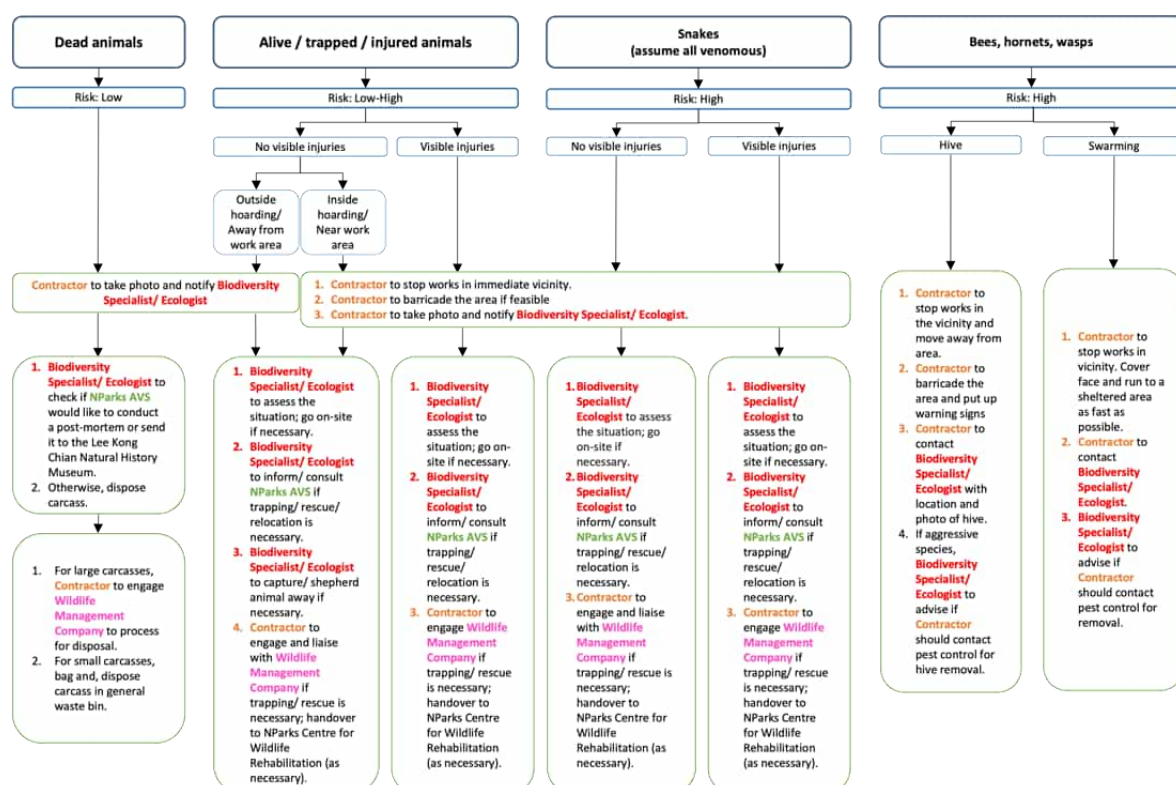


Figure 9.10.2 Fauna response plan

9.11 Water Resources Monitoring Programme Requirement

9.11.1 Construction Phase

In order to ensure that procedures are followed appropriately, the construction phase of the projects should be accompanied by an EMMP. The proposed water resources monitoring programme, as detailed below, should be carried out by the Contractor's ECO, under supervision of SO Rep. Monthly site inspection should also be carried out by EMMP consultant.

Water quality monitoring is essential as discharge of excess contaminants, especially pH, nutrients and heavy metals, may lead to severe consequences (e.g. algae blooms).

Effluent will be discharged from sedimentation ponds during the construction phase, and therefore the monitoring of sedimentation pond effluent was recommended to be undertaken to ensure that the surface water quality will be in compliance with the relevant standards. It was also recommended to monitor their water quality throughout the construction period to ensure minor construction impacts on their water quality. For all discharge points from construction worksites, it is recommended to monitor water quality following Singapore's NEA Allowable Limits for Trade Effluent Discharge to Watercourse/ Controlled Watercourse. In the event of any exceedances of these limits, follow-up actions to determine and remove pollutant sources will be required.

At this stage of the Project, location and number of discharge points from the site is uncertain. Therefore, it was proposed to monitor water quality at all discharge points from the site and ensure the discharges meet the criteria. In addition, one monitoring location upstream from the Marsiling Pond where the water from the site could potentially run is also proposed, to ensure water quality of the Pond does not get affected by potential runoff from the site.

Table 9-1 Recommended monitoring program during construction phase (surface water quality)

Test	Parameters	Monitoring Recommendation and Frequency
In-situ	Temperature	- Online real time monitoring for TSS at each discharge point location from the construction site and upstream of Marsiling Park Pond throughout the construction period - Monthly monitoring for temperature, pH, conductivity, TDS and DO at TSS at each discharge point location from the construction site throughout the construction period and upstream of Marsiling Park Pond
	pH	
	Conductivity ($\mu\text{S}/\text{cm}$)	
	Total Dissolved Solids (TDS)	
	Turbidity and Total Suspended Solids (TSS)	
	Dissolved Oxygen (DO)	
Ex-situ	Biochemical Oxygen Demand (BOD_5)	Monthly monitoring for all the ex-situ parameters at each discharge point location from the construction site and upstream of Marsiling Park Pond throughout the construction period.
	Chemical Oxygen Demand (COD)	
	Total Suspended Solids (TSS)	
	Ammoniacal Nitrogen ($\text{NH}_4\text{-N}$)	
	Total Nitrogen (TN)	
	Nitrate ($\text{NO}_3\text{-N}$)	
	Total Phosphorus (TP)	
	Orthophosphate (PO_4)	
	Total Organic Carbon (TOC)	
	Oil & Grease (Total)	
	Oil & Grease (Hydrocarbon)	
	Lead (Pb)	
	Zinc (Zn)	
	Mercury (Hg)	
	Enterococcus	

Beside the water quality monitoring, hydrological conditions of drainage system within construction site and at immediate vicinity should also be closely monitored during construction phase. Before draining to public drains or watercourses, surface runoff from the construction site should be drained to the ECM treatment system to be filtered and to reduce peak runoff. The cut-off and perimeter drains should be inspected daily to ensure no surface runoff flowing out from the site untreated and no clogging which would affect the flow capacity of the drains/ streams. During heavy storm event, site inspection should be carried out to ensure no flooding.

At this stage of the Project, location and number of discharge points from the site is uncertain. Therefore, it was proposed to monitor water quality at all discharge points from the site and ensure the discharges meet the criteria. In addition, one monitoring location upstream from the Marsiling Pond where the water from the site could potentially run is also proposed, to ensure water quality of the Pond does not get affected by potential runoff from the site.

A summary of the recommended monitoring for groundwater is provided in the table below.

Table 9-2 Recommended monitoring program during construction phase (groundwater)

Location	Parameters	Frequency and Duration
Within the development boundary	Groundwater Level	- Continuous monitoring of groundwater level throughout the lifetime of the construction phase as per the instrumentation and monitoring plan developed by the QP - Visual monitoring of spoil generated to be conducted daily. - Records on chemical waste from the waste generator should be properly kept and records produced when requested - Inspection of hazardous chemical/substances storage condition weekly during construction phase - Environmental audits, quarterly during construction phase
At locations within the Project site where excavated soil and extracted groundwater are collected and stored	Improper management of excavated soil and extracted groundwater	
At locations within the Project site where toxic chemical waste is generated/ stored	Toxic chemical waste generation and management	
At locations within the Project site where hazardous chemicals/ substances are used/ stored	Improper handling of hazardous chemicals/ substances	

9.11.2 Operational Phase

The operational phase of the Project should be accompanied by an EMMP to ensure the proposed development will have minor impact on the surrounding watercourses. Water quality monitoring is essential as discharge of excess contaminants, especially pH and suspended solids may lead to severe consequences (e.g. turbid waters) due to the operational activities. It was recommended to monitor their water quality during the first three (3) months of operational period to ensure minor operational impacts on their water quality.

At this stage of the Project, location and number of discharge points from the site is uncertain. Therefore, it was proposed to monitor water quality at all discharge points from the site and ensure the discharges meet the criteria. In addition one monitoring location upstream from the Marsiling Pond where the water from the site could potentially run is also proposed, to ensure water quality of the Pond does not get affected by potential runoff from the site. For main outlets/ drains of the proposed development, it is recommended to monitor water quality following Singapore NEA's Allowable Limits for Trade Effluent Discharge to Controlled Watercourse. In the event of any exceedances of these limits, follow-up actions to determine and remove pollutant sources will be required.

Table 9-3 Recommended monitoring program during operational phase (surface water quality)

Test	Parameters	Monitoring Recommendation and Frequency
In-situ	Temperature	Monthly monitoring for all the in-situ parameters at the main outlet/ drain of the Project site towards Marsiling Park Pond, during the first three (3) months of operation period.
	pH	
	Conductivity	
	Total Dissolved Solids (TDS)	
	Turbidity	
	Dissolved Oxygen (DO)	
Ex-situ	Biochemical Oxygen Demand (BOD ₅)	

Test	Parameters	Monitoring Recommendation and Frequency
	Chemical Oxygen Demand (COD)	Monthly monitoring for all the ex-situ parameters at the main outlets/ drains of the Project site towards Marsiling Park Pond, during the first three (3) months of operation period.
	Total Suspended Solids (TSS)	
	Total Nitrogen (TN)	
	Nitrate (NO ₃ -N)	
	Total Phosphorus (TP)	
	Orthophosphate (PO ₄)	
	Enterococcus	

For the hydrological condition monitoring during operational phase, drainage system within the site and at immediate vicinity should be inspected especially during heavy storm event to ensure no flooding. A summary of recommended monitoring for groundwater is shown in the table below. Monthly audit of the whole site should be carried out by EMMP consultant during the first three (3) months of operation period.

Table 9-4 Recommended monitoring program during operational phase (groundwater)

Location	Parameters	Frequency and Duration
At location within the Study Area where waste (e.g. liquid, solid) is generated/ stored	Solid and liquid waste generation	Monitoring records of the amount and type of waste (e.g. liquid, solid, toxic chemical) generated during the first three (3) months of operation period
At locations within the Study Area where hazardous chemicals/ substances are used/ stored	Improper handling of hazardous chemicals/ substances	Inspection of hazardous chemical/ substances storage conditions during the first three (3) months of operation period

9.12 Airborne Noise Monitoring Programme Requirement

9.12.1 Construction Phase

As noted in Section 9.12, the airborne noise monitoring programme can be implemented if required. Based on a review of the noise sensitive receptors around the Project site, a continuous monitoring programme as per Table 9-5 is proposed to be conducted during the construction phase.

Table 9-5 Recommended airborne noise monitoring programme during construction phase

No.	Location	Parameters	Frequency and Duration
1	Marsiling Park	L _{Aeq} (12 hrs), L _{Aeq} (1 hr), and L _{Aeq} (5 mins)	Before commencement of any construction works (including site clearance) One-time airborne noise monitoring for 1 week at the proposed locations, for establishment of latest baseline
2	Proposed AHEV		During Construction Phase Continuous monitoring at the proposed locations for the entire duration of construction.

9.12.2 Operational Phase

No noise monitoring programme is proposed for the operational phase due to the lack of information required regarding the ACMV system designs and land traffic volumes. Usually conducted by an appointed Noise Consultant, AECOM recommends that the works for ACMV boundary noise impact assessment and land traffic noise impact assessment be conducted as part of the detailed design process of the Project in accordance with the NEA guidelines as discussed in Section 8.5.3.2 before obtaining Temporary Occupation Permit for commencement, which should be adequate. However, HDB will need to communicate the required ecological criteria to the developers of such utility buildings as the ecological criteria is different from the NEA's usual criteria.

9.13 Proposed EMMP

The framework for the proposed EMMP is detailed below; however, it is important to note that this is not an exhaustive list of potential impacts, monitoring requirements and triggers. This EMMP is intended to be a living document and should be reviewed thoroughly by the Client/ Project Owner and the Contractor (CT) prior to implementation. Development of the following inputs, that have not been addressed in this Report, by the CT are also required, including but not limited to:

- Stakeholder Communications Plan;
- Site log for all monitoring activities and complaints;
- Construction Logistics Plan;
- Standard Operating Procedures for processes identified in Table 9-6 and Table 9-7 below;
- Emergency Response Plan;
- Inventory of wastewater streams;
- Training protocols for staff, where appropriate; and
- Maintenance and Audit Schedules.

9.13.1 Construction Phase

The EMMP for construction phase of the project is described in table below.

Table 9-6 Proposed environmental management and monitoring plan for the construction phase

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers ^{7,8}
Biodiversity	Minimisation of construction impacts to flora/vegetation	- Mark out site boundary (via hoarding); - Set up Tree Protection Zones (TPZs) around trees or other plant specimens to be retained within the worksites, if any; - Tag trees (with or without TPZs) meant to be protected or transplanted to avoid accidental removal, if required; and - Establishment of TPZs, if required	- Record locations, species and quantity of transplant candidates that are affected by construction (if any); and - Verification and review of footprints for hoarding, access roads and soil investigation works	Flora and Arboriculture	Within development boundary	Prior to site clearance	Not Applicable	CT (ECO, Specialist) Floral	Corrective actions will need to be taken if: Hoarding alignment does not follow the hoarding plans of the Project Flora specialist will report to SO for downstream reporting
		- Establishment of TPZs, if required; and - Inspect the integrity of the TPZs; - Review method statements of construction works in proximity to retained trees; - Implement soil erosion control measures as soon as vegetation has been removed and soil is exposed; and - Identify excessive or unauthorized tree removal	- Identify trees that require management and maintenance such as tree care and pruning; - Assessment of the condition of retained trees, if any, to ensure that there has been no deterioration or mechanical damage and to determine if additional tree removal is required; - Check for mechanical damage on trees that may impair stability; - Determine if there are any unauthorized removal of flora within areas of conservation (if any) or beyond the demarcated worksite; - Identify areas with soil erosion and degradation that have resulted from construction activities; - Identify areas that are responding poorly due to the development impacts		Within development boundary and 15m beyond hoarding line	Monthly for duration of construction	To be included in monthly report	CT (ECO, Specialist, Arborist) Floral	Corrective actions will need to be taken if: - Depending on the extent of the excessive clearance, flora specialist will report to SO Rep for downstream reporting to NParks; - The structure and health of the trees along the new forest edge has deteriorate and are deemed unsafe by an appointed Arborist; - Encroachment into or removal of TPZs resulting in impairment of structural stability and/or physiological

⁷ Resident Technical Officer (RTO) and Site Officers (SO, WSHO and ECO) check the Study Area for construction progress and implementation of environmental mitigation measures.
⁸ If there is trigger then all the mitigation and management measures should be audited in detail for compliance and corrective action must be taken in liaison with the Project Owner.

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers ^{7,8}
									health of trees
	- Minimisation of construction impacts to fauna - Minimisation of human-wildlife conflict	- Installation of site hoardings - Implementation of pre-site clearance fauna inspection - Implementation of directional clearing - Use of biodegradable erosion control blankets on exposed soils	- The hoarding must not have any gaps between the panels and are to extend at least 300mm into the ground; - The access gates, when shut, must not have any gaps between the panels and must be flush as close to the ground as possible; and - Implementation of directional clearing after hoarding is implemented from the side of development nearest to the road i.e. to start hoarding from boundary nearest to Admiralty Road first then move inwards towards Woodlands Centre Road - Check for presence of trapped/injured/dead fauna, potential fauna entrapments and gaps in site hoarding.	Fauna	Within development boundary	Prior to site clearance	To be included in monthly report	CT (ECO, Ecologist)	N/A
		- Ensure proper storage of machineries likely to leech harmful chemicals and fuel-powered equipment; - Store the aforementioned equipment away from waterbodies and/or sensitive habitats; and - Ensure that noise minimum control measures (as detailed in the Airborne Noise section 7.5.3.3 below) are adhered to.	Check for non-compliance		Within development boundary	Monthly for duration of construction	To be included in monthly reports.	CT (ECO, Ecologist)	Corrective actions will need to be taken if: Rubbish and/or construction waste from construction materials is observed in the AHEV; and Excessive disturbance generated by construction activities is detected
		Execute wildlife response plan when a trapped/ injured/ dead/ dangerous animal is encountered around or within the worksite according to Section 10 of Wildlife Act	- Conduct regular toolbox briefing on biodiversity awareness to remind workers not to feed wildlife on site, and enforce proper trash management and disposal.		Within development boundary	Daily monitoring and record-keeping	To be included in monthly report	CT (ECO, Ecologist)	Wildlife response plan will be activated when fauna is encountered within development boundary
Water Resources (Surface Water Quality and Groundwater Quality)	- Solid & Toxic Waste Generation - Discharge of liquid waste, including construction wastewater - Liquid Effluent and stormwater run-off Generation - Improper Management of Chemical Substances - Storage and Disposal of Domestic Liquid and Construction Solid Wastes	- A Qualified Erosion Control Professional must plan, design, approve, and implement Earth Control Measures (ECM) plans for PUB. This includes installing, maintaining, monitoring, and reporting on erosion control blankets, CCTV at discharge points, SIDS, sedimentation tanks, to comply with PUB's COP on Surface Water Drainage. To note that this must consider the requirement for burying site hoardings 300mm deep into the ground. - The Contractor should coordinate earthworks alongside ECM provision. Progress of earthworks must be carefully regulated to avoid exposing more areas than the proposed ECM can handle. - Any interim changes to ECM during site startup, levelling (cutting and backfilling), in each phase of work, must be planned and approved before starting any work on site. - Provide biodegradable erosion blankets to areas with bare soil surfaces on the same day of soil exposure. - Schedule demolition and earthworks to minimize on-site stockpile quantities (including horticultural waste). - Design ECM tanks/ponds with sufficient capacity to hold turbid stormwater before treatment at the ECM facility. Before discharge, ensure water meets NEA Trade Effluent Criteria. - Ensure that the Contractor's CCTV system is properly operated and maintained at all times as per PUB's circular on Preventing Muddy	Not Applicable	All water quality parameters identified in Table 9-1	Before discharge outlets of construction sites.	- Permanent TSS monitor installed at every discharge outlet; - Implementation of CCTV including a SIDS at every discharge outlet to monitor the surface run-off discharges from the sites; - Daily inspections of drains, to check for blockage or visual changes in water quality - Monthly water quality monitoring for all discharge point locations and other public drains during	To be included in monthly report	CT (ECO)	Investigation and corrective actions to be taken, when: - The following documentation are found inadequate/ missing: - ECM Plan; - Monitoring Log; - Training Log; - Audit Reports; - If the monitored parameters exceed applicable values of NEA Trade Effluent Discharge Limits at discharge point

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers ^{7,8}
	- Temporary Land Use Change - Direct or Indirect contamination of watercourses originating from chemicals used and/or stored on site	Waters from Construction Sites. This also aims to prevent Contractors from tampering with the CCTV system to conceal silty discharge. - Effectively implement ECM and monitoring as per the Code of Practice on Surface Water Drainage to ensure that discharge into the stormwater drainage system does not exceed prescribed limits for TSS concentrations under the Sewerage and Drainage (Surface Water Drainage) Regulations. - Prepare a Sediment Control Plan to include, but not limited to, sealing site hoarding and installing berms along site hoarding, etc. This prevents silty water from leaking out of the site and from the ramp at the site entrance. - Stockpile removed topsoil in a designated area and cover it as necessary to prevent soil loss from secondary erosion. Conserved soil can be used for backfilling, while excess soil material should be stored properly for reuse. - Use approved materials, of the same or better quality than the surrounding area, for backfilling. Ensure all backfilled material is free of debris and consists of good-quality soil. - Segregate clean water flow from silty water flow whenever possible to maximize sedimentation tank holding capacity. - Always adequately cover and temporarily seal manholes. - Finalize a comprehensive inventory of all expected wastewater streams and volumes before commencing construction phase activities. - Maintain daily records of wastewater volumes, as well as quantities of sludge and other generated wastes, on-site. - Construct impervious containment ponds designed with adequate capacity to manage site-generated wastewater volumes, including provisions for stormwater runoff and potential firefighting wastewater. - Provide temporary storage capacity for overflow scenarios of untreated wastewater to prevent discharge into watercourses, ensuring compliance with NEA Guidelines on trade effluent discharge concentrations. - Equip containment ponds and wastewater generating areas on-site with spill clean-up kits. - Design appropriate drainage infrastructure (such as cut-off drains, sump pits, road kerbs, piping, and toe walls) to channel construction process wastewater (e.g., wash water) and stormwater runoff separately for capture and treatment in containment ponds/kerbs. Include oil-water separators where applicable. - Seek approval from relevant authorities (PUB and NEA) as per PUB Sewerage and Drainage (Trade Effluent) Regulations for wastewater disposal to public sewers, or NEA's Trade Effluent Discharge Limits for disposal to surface watercourses. If discharges are not approved, store, treat, or recycle trade effluent on-site before off-site disposal to a licensed waste collector. - Obtain comments and approval from relevant authorities (e.g., Singapore Civil Defence Force [SCDF] and NEA) for the use of treated wastewater in firefighting activities. - Establish concrete washout areas away from watercourses or ensure discharge does not drain into ECM treatment systems. - Implement a wheel washing process for all vehicles leaving the site to prevent deposition of earth, mud, debris, etc., on surrounding roads. Treat resulting wastewater in the ECM system after sedimentation. - Establish regular inspection and maintenance procedures for wastewater collection, storage, and treatment infrastructure (e.g., pipes, oil-water separators). - Develop regular procedures for managing stormwater collection, settling, testing, and discharge to watercourses. - Conduct biannual toolbox talks/training sessions for all on-site workers, including subcontractors, regarding their responsibilities for proper water quality management. - Prohibit uncontrolled discharge of any wastewater streams. - Ensure no trade effluent other than that approved by the NEA Director-General is discharged into watercourses or soil. - Prioritize the reduce, reuse, and recycle hierarchy for on-site wastewater management.				construction phase; - Intensity of the laboratory analysis will be increased (e.g. fortnightly, weekly) if in-situ measurements and/or monthly laboratory results indicate deterioration in the water quality. Intensified monitoring will be carried out until in-situ measurements and/or laboratory results indicate 'normality'/consistency with earlier monitored conditions; and - Daily inspection on perimeter drains to ensure no surface runoff flowing out from the site untreated done by the site officer with monthly audit done by EMMP consultant.			(refer to Table 6-11) - If the monitored parameters exceed applicable values of Water Quality Criteria for Aquatic Life at natural stream (refer to Table 6-11); - If any flooding or clogging issues observed; - If complaints are received due to project activities; and - If visual non-compliance to any of the minimum control or mitigation measures are observed on-site.

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers ^{7,8}
		• Store hazardous liquids, such as oily water, thinners, solvents, or paints, on impermeable hardstands under shelter with surrounding kerbing. Remove such wastewater for treatment and off-site disposal by an approved Waste Management Contractor, treating hazardous liquids as hazardous waste. • Dispose extracted groundwater to NEA-approved areas identified in Figure 7.3.1, following the process outlined in Figure 7.3.2. Monitor extracted groundwater regularly, especially for oily sheens or odours, and dispose of contaminated wastewater to a licensed toxic waste collector if contaminant concentrations exceed regulatory limits. • Provide an adequate number of enclosed bins for waste disposal. • Ensure waste disposal facilities are cleared regularly to prevent accumulation. Conduct daily housekeeping checks to ensure the site is free of litter. • Develop Standard Operating Procedures (SOP) for the safe handling, transfer, storage, and disposal of solid waste. • Conduct appropriate tests to determine the presence or absence of contamination in excavated soil. • Dispose of any waste listed in the Environmental Public Health (General Waste Collection) Regulations through a licensed waste operator. • Follow the procedure outlined in Figure 7.3.1 Figure 7.3.1 for handling and disposing of excavated soil. This flow chart details procedures for identifying potential contamination areas and assessing Potential of Contamination (POC) in excavated soils. Contaminated soils exceeding Regulatory Concentration Limits (DIVs) should be disposed of by toxic waste collectors or treated to meet acceptable standards like the DIV. Treated soils can be disposed of in staging grounds or collected by general waste collectors, depending on contaminant levels determined during staging ground testing. • Upon receiving results indicating parameters (chemicals, heavy metals) exceed regulatory limits, conduct a risk assessment for potential inhalation and dermal contact impacts on site workers exposed to contaminated soil or groundwater areas. This assessment should precede construction activities and integrate findings into the contractor's construction risk assessment and health, safety, and environment plan. Implement necessary precautionary measures as specified in the respective chemical Safety Data Sheets (SDS) if worker health impacts are anticipated. • Ensure an adequate number of proper sanitary facilities are provided and maintained. It is recommended to have one portable toilet per 10 individuals, serviced three times per week by a NEA Licensed Waste Collector (LWC) for regular sewage discharge disposal. • Position toilet facilities appropriately, away from any nearby watercourses. • If on-site dormitories exist, consider installing container toilets and obtain written approval from PUB to connect them to public sewers. • Establish a regular maintenance schedule to check cleanliness and ensure the proper functioning of sanitary facilities on site, conducting inspections at least once a week, adjusted based on facility usage. • Conduct regular inspections and audits to verify hygienic conditions on site. • Conduct periodic leak detection tests on toxic waste storage containers. • Store toxic waste and hazardous substances on a hard stand, under shelter, with a kerb around the storage area. • Provide spill trays for all waste containers and ensure they are regularly maintained to prevent pollutive substances from being washed out by rain. • Dispose of toxic waste in accordance with Environmental Public Health (Toxic Industrial Waste) Regulations through a Licensed Waste Operator/Collector. • Implement a consignment notification/tracking system and develop a transport emergency response plan for the transportation of toxic waste. • Develop Standard Operating Procedures (SOP) for the safe handling, transfer, and storage of toxic waste. Conduct daily housekeeping checks to ensure all toxic waste is promptly cleared from the site.							

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers ^{7,8}
		- Replace hazardous substances or chemicals with safer alternatives whenever possible. - Ensure chemical storage areas are adequate, located on paved ground, bunded, sheltered with proper ventilation, and situated away from waterways and drains. Safety Data Sheets (SDS) must be kept on-site with stored chemicals. - Use secondary containment with a capacity exceeding 10% of the volume for a single large container and 25% of the total volume for multiple containers in all chemical storage and diesel generator areas to minimize spills and prevent soil and surface water contamination, as required by COPPC/SS593. Exercise caution near watercourses to prevent leaks of toxic chemicals such as petrol, diesel, oil, paint, and thinner from equipment. - Include oil-water separators in the infrastructure designed to separately channel construction wastewater streams and stormwater runoff. This helps capture accidental spills or leaks of oils or greases, particularly near liquid storage or refuelling areas. - Immediately maintain or remove off-site any construction equipment causing water system pollution due to oil or fuel leakage. - Conduct all activities involving repair, servicing, and engine overhaul in appropriately contained areas (e.g., concreted areas with proper containment), channelling all wastes for suitable treatment or disposal in compliance with regulations. - Develop an emergency response plan, ensure the Emergency Response Team (ERT) is trained in response procedures, and provide response kits for handling spillages. - Implement good housekeeping practices to minimize careless spills and maintain storage and workspace in a tidy and clean condition. Assign a responsible person (e.g., Environmental Control Officer) to oversee the effective operation of containment ponds/kerbs where 'Good Housekeeping' practices are enforced. Regularly inspect containment ponds/kerbs at least daily to ensure proper functionality and prevent spills, leaks, and odour issues. Provide appropriate training, including safety codes and relevant manuals, to personnel regularly handling chemicals on-site. - Implement a construction Environmental Management and Monitoring Plan (EMMP) and ensure comprehensive preparation of associated plans and procedures. - Prepare and implement a construction site-specific Environmental Management and Monitoring Plan (EMMP), ensuring comprehensive preparation of associated plans and procedures.							
Water Resources (Groundwater Level)	- Decreased infiltration into the ground due to increased runoff from hard standing surfaces - Groundwater extraction during construction activities that require soil dewatering	- Install piezometers to monitor groundwater level changes in accordance with Building Control Regulations 2003, as outlined in the instrumentation and monitoring plan endorsed by the Qualified Professional (QP). - Select and design Proper Earth Retaining Stabilising Structures (ERSS) to minimize groundwater settlement. - Phase soil dewatering plans to minimize groundwater drawdown to the extent practicable.	No additional mitigation measures needed.	Groundwater Level	Actual monitoring location to be decided by QP	To continuously monitor the groundwater level throughout the lifetime of the construction phase	To be included in monthly report	CT (ECO)	Investigation and corrective actions to be taken there is a significant drawdown of groundwater level.
Airborne Noise	- Noise from trucks transporting spoil/equipment. - Noise from traffic congestion caused due to inadequate lane compensation and traffic diversion	- Shut down machines (such as trucks) that may be in intermittent use between work periods or throttle down to a minimum; - Label all machinery and equipment used with a weather-proof sticker clearly indicating its noise emission level (at source) under normal operating conditions; - Utilize only well-maintained construction plants on-site, and service construction plants regularly during the entire construction period; - Reduce the number of PMEs as far as practicable when carrying out construction works at areas close to the noise-sensitive receivers;	MITIGATION MEASURES FOR GENERAL CONSTRUCTION NOISE CONTROL: Control of noise sources at the source from construction site – Analyse construction inventory list and check equipment causing high noise levels. Prioritize the equipment with lower noise level; and	L _{Aeq} (12 hrs), L _{Aeq} (1hr), and L _{Aeq} (5 mins)	- Marsiling Park; - AHEV	Before commencement of any construction works (including site clearance) One-time airborne noise monitoring for 1 week at the proposed locations,	To be included in monthly report	CT	Investigation and corrective actions to be taken, when any of the following documentation are found inadequate / missing: Construction Noise

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Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers ^{7,8}
	during construction. Noise generated by the use of Powered Mechanical Equipment (PME), (such as excavators, generators, pumps, cranes, etc.) for various construction activities within the site, including construction of holding areas, site offices and road widening works.	- Utilize and properly maintain silencers or mufflers on construction equipment during the construction programme; - Ensure behavioural practices including no shouting, no loud stereos/radios on site, no dropping of materials from height, and no throwing of metal items; - Restrict high noise-generating drilling activities only to continuous blocks not exceeding 3 hours each, with a minimum respite period of one hour between each block, if possible; - Conduct periodic noise monitoring by an independent third party to establish compliance with requirements and to advise on equipment causing concern, and additional potential mitigation measures; - Apart from advance works/site clearance approved by Agencies, minimise noisy works after 6pm to reduce noise disturbance to nocturnal animals. - Plan the layout of the site by considering the use of materials and other large structural equipment as noise barriers; - Orient construction plants known to emit noise strongly in one direction, wherever possible, so that the noise is directed away from the nearby noise-sensitive receptors; - Utilize material stockpiles and other structures effectively, wherever practicable, to screen noise from on-site construction activities; - Ensure all handheld percussive breakers and air compressors used on site comply with local legislation and requirements; - Schedule activities to minimize noise generated at certain areas during periods particularly sensitive to noise; - Prohibit works using machines or vehicles that generate noise during the night and at dawn; - Personnel operating the plant or equipment should use appropriate hearing protectors, which must attenuate the user's exposure to sound pressure levels below 85dB (A). Put up signage to remind personnel to use hearing protection at work areas that emit excessive noise. Choose hearing protectors such as ear plugs (for < 100 dB (A)), earmuffs (for 100 dB (A) to 120 dB (A)), or ear plugs and earmuffs (for > 120dB (A)) according to various noise exposure levels; - Conduct noise awareness briefings regularly and highlight the noise mitigation measures such as positioning machinery, using portable noise barriers, and the dos and don'ts for using machinery at night. - If noise remains an issue even after implementation of recommended mitigation measures such as noise barriers, contractor should consider implementation of proprietary noise barriers of high noise reduction capabilities to further reduce noise to acceptable levels.	- Where controlling noise sources at the source is not feasible, acoustic enclosures or sheds are to be introduced to mitigate noise at the source. Typical acoustic enclosure covers the machine as fully as possible (with or without ventilation where applicable) to provide sound insulation. MITIGATION MEASURES FOR CONSTRUCTION NOISE: - Noise barriers are proposed at the construction boundary fronting noise sensitive receptors; and - The construction of buildings of staggered heights with low-rise, mid-rise, and high-rise buildings should be considered			for establishment of latest baseline. During Construction Phase - Continuous monitoring at the proposed locations for the entire duration of construction. - Records on noise levels from construction sites should be properly kept and produced when requested.			Management Plan; - Monitoring Log. - If the monitored parameters exceed applicable values of EPM regulations. - If complaints are received due to project activities. - If visual non-compliance to any of the minimum control or mitigation measures are observed on-site. - If there are any cracks / leaks present on the noise barrier erected.

9.13.2 Operational Phase

The EMMP for operational phase of the project is described in Table 9-7.

Table 9-7 Proposed environmental management and monitoring plan for the operational phase

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{9,10}
Biodiversity	Minimisation of operational impacts to flora/vegetation/fauna	Not Applicable						
Water Resources (Surface Water Quality and Groundwater Quality)	- Stormwater run-off generation - Improper management of liquid and solid wastes - Accidental spills and leaks - Discharge or leakage of waste and chemicals into the soil	- Ensure adequate drainage, piping, and/or channelling of stormwater runoff is assured through detailed design for capturing and treating before discharge into receiving watercourses. - Establish regular and dedicated procedures for inspecting and maintaining stormwater collection, storage, and treatment infrastructure, such as pipes, oil-water separators, silt screens, etc. - Implement regular and dedicated procedures for managing stormwater collection, settling, testing, and eventually discharging 'clean' water to surface waters, including associated measures to prevent high sediment concentration in stormwater drainage to surface waters. - Ensure no trade effluent other than that of a nature or type approved by NEA Director-General is discharged into any watercourse or land. - Prepare an adequate number of disposal bins around the Project to prevent improper waste disposal. - Conduct regular inspections of the Project's waste storage system. - Regularly monitor proposed watercourses and their surroundings with CCTV surveillance to prevent contamination. - Develop an emergency response plan and provide adequate training to maintenance workers to handle accidental water contamination. - Raise awareness among various stakeholders through community/stakeholder engagement (e.g., signage boards, warning signs, etc.). - Regularly inspect the waste storage system within the Project to prevent system clogging and leachate entering the underlying soil. - Store all toxic waste and hazardous substances/chemicals (if any) in designated sheltered areas equipped with access-controlled entrances and concrete bund walls or in containers with adequate ventilation. Ensure spill trays are provided for all chemical drums and potentially pollutive substances and maintain them regularly to prevent rain from washing out pollutive substances. - Dispose of all toxic waste chemicals to licensed Toxic Industrial waste (TIW) collectors for treatment. - Ensure all hazardous chemicals/substances (if stored on site) are properly labelled, their movements recorded, and returned to designated storage areas when not in use. - Conduct all activities involving hazardous chemicals/substances on appropriately contained areas (e.g., concreted areas with proper containment/sumps). - Provide emergency spill kits on site for immediate response to any chemical spills. Ensure the emergency response team is trained and competent in using these spill kits.	Not Applicable	All parameters identified in Table 9-3	At the main outlets/ drains of the Study Area, in the vicinity of Project.	Monthly inspection for the surface water quality especially during heavy storm event during first three (3) month of operational period.	EHS Officer	Investigation and corrective actions to be taken, when: - If the monitored parameters of all discharge points exceed applicable values of NEA Trade Effluent Discharge Limits at discharge point (refer to Table 6-11); - If complaints are received due to project activities; and - If visual non-compliance to any of the minimum control or mitigation measures are observed on-site.

⁹ Resident Technical Officer (RTO) and Site Officers (SO, WSHO and ECO) check the Study Area for construction progress and implementation of environmental mitigation measures.
¹⁰ If there is trigger then all the mitigation and management measures should be audited in detail for compliance and corrective action must be taken in liaison with the Project Owner.

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{9,10}
Water Resources (Groundwater Level)	More areas with impervious surfaces in the new development leading to decrease in infiltration of surface water/ stormwater into the soil	- Incorporate more pervious surfaces in the development plan - Install recharge wells, if necessary	No additional mitigation measures needed.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Airborne Noise	Noise from conditioning Mechanical Ventilation, Traffic Noise Air- and Land	MINIMUM CONTROLS FOR ACMV NOISE: Minimum Controls below should be applied at the prelim design stage of the development by the appointed M&E consultants. An appointed Noise consultant should validate the noise in accordance with the NEA ACMV Guideline, 2018 [R-37]. In addition, mitigation measures will be provided by the appointed Noise Consultants during the prelim design stage. - Ensure that any exhaust outlet or intake from the mechanical ventilation system is designed to be adequately set back as far as possible from the boundary line of the development; - Acoustic treatment if any to be designed and implemented; - The building design should include provisions to ensure that the condensers of individual air-conditioning systems are positioned away from noise-sensitive areas; and - Acoustic enclosures for outdoor equipment. MINIMUM CONTROLS FOR TRAFFIC NOISE: - Consider road design as part of land use planning to minimise potential impact of land traffic noise on NSRs; - Use of low-noise pavement mix for sections of new road networks near NSRs should be considered; - Consider alternative siting of new road networks away from noise sensitive receptors at pre-design stage; Mitigate traffic noise at drop-off points and parking areas with low-speed postings, speed humps and speed limit signages. The addition of these speed control measures will likely lower noise levels for traffic as the vehicles would be cruising at lower speeds; andDue to the lack of information at this juncture of reporting, assessment, minimum controls, and mitigation will be provided by the appointed Noise Consultant during the prelim design stage and in accordance with the NEA TNIA Guideline, 2016 [R-39]. Note: As current means of noise impact assessment were only performed qualitatively, quantitative noise impact assessment must be conducted by the developer/ developing agent at a later stage to assess noise impacts arising from the operational phase related activities as mandated by law at later stages of the Project.	MITIGATION MEASURES FOR ACMV NOISE: - No further mitigation measures are proposed. MITIGATION MEASURES FOR TRAFFIC NOISE: - No further mitigation measures are proposed for Woodlands Centre Road; - Impacts due to the traffic noise from Marsiling Road are proposed to mitigate by reducing the traffic speed with the installation of low-speed postings, speed humps and speed limit signages	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Vector	Accumulation of stagnant water, poor housekeeping and improper handling/ disposal of solid waste (especially food waste)	- Adhere to Control of Vector and Pesticide Act (CVPA) and ensure good housekeeping on-site/in the development. - Weekly inspections for potential breeding sites should be conducted for areas such as unused containers in open areas and under bushes, open and closed drains, gully traps, tree holes and bifurcations between branches, leaf axils of banana trees, Travellers Palms and other palms, outdoor litter bins etc; - Fortnightly application of sand granular insecticides gully traps, manhole cover handle depressions, lightning conductor pits, stop-cock pits, valve chambers, and sumps; - Immediate application of insecticide should be conducted to destroy breeding habitats identified during inspections and to immediately eliminate the identified potential breeding habitats (i.e. source of stagnant water or waste). Proper recording of these incidents should also be conducted once the breeding habitats or potential breeding grounds have been eliminated; - Thermal Fogging is not recommended, due to its proximity to areas of high ecological value. Instead, preventive methods	No mitigation measures required to be proposed, as minimum controls for vectors should be practised as advised by NEA.	Not applicable	Not applicable	Not applicable	Each household or its housing/ school/ building/ public committee and other relevant party	Not applicable

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{9,10}
		such as inspections and good housekeeping practices should be adhered to instead, in order to ensure no mosquito breeding occurs onsite. Monthly routine pest control checks should be conducted at all locations; Fortnightly application of sand granular insecticide to sources of stagnant water in schools and boarding schools (e.g. toilet bowls, cisterns, and gully traps in toilets), during school vacation.						

10 Conclusion

Woodlands N1 is a proposed development in the northern region of Singapore. The Project site spans across approximately 7.27 ha and is bounded by Admiralty Road in the north, existing urbanised areas in the east, Marsiling Road in the south and low-lying vegetation and Woodlands Centre Road in the West. The site is located in a generally urbanised area, with residential developments dominating the landscape north, east and south of the site, Marsiling Park southwest of the site and Woodlands Checkpoint and Mandai Mangrove and Mudflat northwest of the site. The site is currently mostly vegetated, dominated by secondary forest in central portions, with lower vegetation on its outskirts. Parts of An-Nur Mosque, Marsiling CC (and its accompanying facilities) are located at the northern portions of the site.

Focus of this EIA study was to establish environmental baseline conditions (i.e. biodiversity, hydrology, surface water quality, groundwater level and quality and airborne noise) and assess the potential impacts due to the proposed developments during construction and operational phase on the identified ecological receptors. In addition, impact of surface water quality change on Upper Seletar Reservoir was also included in this Study, as requested by PUB (attached as an Appendix).

As per updated proposed land use plan, the majority of the site will be transformed into public housing developments. In addition, a new road at the eastern portion of the site is planned to be developed, which will connect Admiralty Road and Marsiling Road.

Biodiversity surveys have found that the Study Area is generally dominated by abandoned-land forest which occupies around 38% of the Study Area. In addition, urban vegetation, native-dominated secondary forest and scrubland were also identified as vegetation habitats. In total, ten floral species of conservation significance were identified within the Study Area. Fauna field assessment recorded 95 species, with a total of 3 species of conservation significance identified across 2 taxa (mammal and butterfly).

Hydrological surveys, catchment delineation and analysis of regional catchments show that the water from southern portion of the site eventually gets discharged into the Marsiling Pond (via underground culvert) from there it partially flows towards Mandai Mangrove and Mudflat. Therefore, both Marsiling Pond and the Mandai Mangrove and Mudflat their associated habitats were also taken into consideration for the purposes of this EIA. Surface water quality results did not show exceedances of any parameters, with exception of Aluminium. Measured groundwater depths ranged from 5.26 m bgs to 5.43 m bgs. In addition, none of the tested parameters showed exceedances of their respective DIVs, where applicable.

Taking into consideration the proposed developments and activities during the construction phase, impact significance on existing habitats range from Negligible to Major. Loss of vegetation was assessed to have major impact on abandoned-land forest, moderate on native-dominated secondary forest and scrubland and Minor impact on urban vegetation. Impacts due to habitat degradation and formation of forest edge have been assessed to be Negligible to Minor across all habitats. In terms of impacts on flora, impact significance due to mortality and decline in plant health have been assessed Negligible to Moderate, even after implementation of minimum controls and mitigation measures. Due to the clearance of the majority of the site, loss of or reduction in habitats and food sources has remained the only impact on fauna with Major residual impact significance. Other impacts, such as accidental injury or mortality, human-wildlife conflict as well as human and light disturbances were assessed to be Negligible to Minor during construction phase. During the operational phase, residual impacts from habitat degradation and changes in microclimatic conditions to remaining habitats were assessed to be Negligible to Minor. All the impacts to remaining potential fauna were assessed to be Negligible to Minor.

The impact assessment in this EIA only studied the construction activity of the HDB development. The road widening works along the Marsiling Road in the future which may encroach into the southern part of AHEV may require further assessments in due course.

With regards to the surface water quality, under the assumption that appropriate minimum controls have been successfully implemented, the impact is expected to be Minor. Similarly, during the operational phase the water quality impacts were assessed to be Minor. Given the relatively deep groundwater levels it is unlikely that proposed AHEV will be dependent on this water resources and therefore the impact assessment in terms of groundwater level changes was assessed to be Negligible. Similarly, due to the relatively deep groundwater as well as inferred

groundwater flow (i.e. towards southeast), in the event that any groundwater contamination occurs during construction and operational phase, it is unlikely that it will have any impact on AHEV and Marsiling Pond and therefore the impact significance with this regard was assessed to be Negligible.

Airborne noise impacts on the proposed area to be conserved were assessed to be Moderate to Major during the construction phase. During the operational phase, the airborne noise impacts were assessed to be Negligible to Minor, with the exception of potential land traffic noise associated with Marsiling Road which was assessed to be Moderate.

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Appendix A AECOM Health and Safety Plan

APPENDIX A:

HEALTH AND SAFETY PLAN

Specialist Consultancy Services for Environmental Impact Assessment at Woodlands Neighbourhood 1

Prepared by:

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300 Beach Road, #23-00 The Concourse,
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Project Number: **60705888**

HEALTH AND SAFETY PLAN

APPROVAL PAGE

This project Health and Safety Plan (HASP) was prepared for employees performing a specific, limited scope of work. It was prepared based on the best available information regarding the chemical, physical and biological hazards known or suspected to be present on the projects site. While it is not possible to discover, evaluate, and protect in advance against all possible hazards, which may be encountered during the completion of the projects, adherence to the requirements of the HASP will significantly reduce the potential for occupational injury.

By signing below, I acknowledge that I have reviewed and hereby approve this HASP. This HASP has been written for the exclusive use of AECOM, its employees, and subcontractors. The plan is written for specified site conditions, dates and personnel, and must be amended if these conditions change.

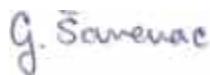
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LIST OF ATTACHMENTS

- Attachment A – HASP Receipt and Acceptance Form
- Attachment B – Emergency Response Information

1.0 Introduction

This Health and Safety Plan (HASP) was developed by AECOM's Environment Business Line (AECOM) for implementing the Specialist Consultancy Services for Environmental Impact Assessment (EIA) at Woodlands Neighbourhood 1. This establishes the health and safety procedures required to minimize potential risk to personnel for the duration of the activity. This is a project and site-specific HASP and should be used concurrently with the AECOM Field Safety, Health and Environment (SH&E) Manual and standard operating procedures (SOPs) and a completed site-specific Emergency Response Information Form (Attachment B).

1.1 Policy

AECOM, as a leading global provider of environmental, health and safety services, is committed in protecting the safety and health of our employees and meeting our obligations with respect to the protection of others affected by the implementation of all our operations. We are also committed to protecting and preserving the natural environment in which we operate. The safety of persons and property is of vital importance to the success of this project and accident prevention measures shall be taken toward the avoidance of needless waste and loss. It shall be the policy of this project that all operations be conducted safely as stated in *AECOM SH&E Policy Statement*.

1.2 Scope and Application

The provisions of this HASP apply to all AECOM project staff who may potentially be exposed to safety and/or health hazards related to activities described in Section 3.0 of this document. Unanticipated site-specific conditions or situations may occur during the implementation of this project. Also, AECOM and/or the contractors may elect to perform certain tasks in a manner that is different from what was originally intended due to a change in field conditions. As such, this HASP must be considered a *working document* that is subject to change to meet the needs of this project.

1.3 Regulatory Compliance

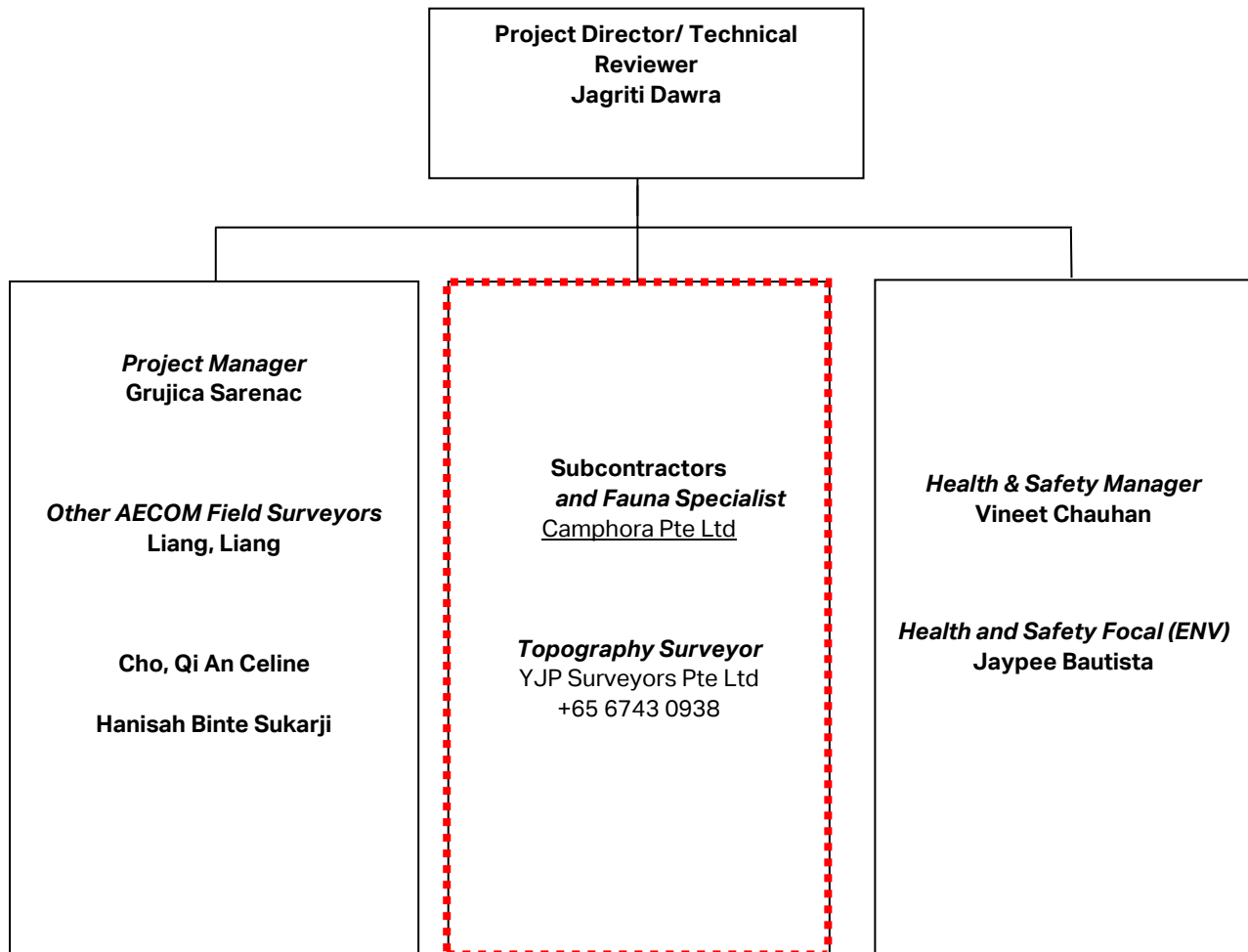
All activities covered by this HASP must be conducted in complete compliance with this HASP and with all applicable environmental, health and safety regulations of Singapore. Additionally, all work will be conducted in accordance with AECOM SH&E Policies and Procedures found in the *AECOM Field SH&E Manual* and Singapore Occupational Safety and Health Administration (OSHA) framework. Personnel covered by this HASP who cannot or will not comply with any of these requirements will be excluded from site activities.

1.4 Management of Change

The procedures in this HASP have been developed based on current knowledge regarding the specific biological and physical hazards, which are known or anticipated for the proposed onsite baseline survey. Site specific requirements and hazards for this project will be taken into consideration and will be included in any update of this HASP. Should additional information become available regarding unique site hazards or operational change, it may be necessary to modify this HASP. All proposed modifications to this HASP must be reviewed and approved by the AECOM Project Manager (PM) and Health, Safety, Security and Environment (HSSE) Focal before such modifications are implemented. The Receipt and Acceptance Sign-off sheet must be submitted to the AECOM PM. The HASP Receipt and Acceptance Sign-off Sheet are included in this HASP as Attachment A.

1.5 Health and Safety Organization

The implementation of health and safety at the site location will be the shared responsibility of the Project Manager (PM), the Project Field Surveyors (FS), the HSSE Focal (HSSEF), and other site-based personnel and contractors implementing the proposed scope of work. The responsibilities of the PM, FS and HSSEF are shown in detail in the *AECOM SH&E Field Manual*. For the implementation of this project, the following Health and Safety Organizational Chart will apply:



1.5.1 Project Director and Project Supervisor

The Project Director is the lead of the entire AECOM working team. Project Supervisor is assisting Project Director in daily business administrative and project execution tasks, also serving as the advisor for the Project Manager in terms of site work arrangement, health and safety and budgetary resources. In this Project, both the Project Director and Project Supervisor are the technical leads in reviewing the Environmental Baseline Studies (EBS) report(s) before external submission to the Client.

1.5.2 Project Manager

The Project Manager (PM) has overall management authority and responsibility for the project, including safety. The PM will provide the FS with work plans, safety personnel, and budgetary resources, which are appropriate to meet the safety needs of the project operations. Helping the PM with the management of the project is the Deputy Project Manager (DPM).

1.5.3 AECOM Field Surveyors

The AECOM Field Surveyor (FS) has the overall responsibility and authority to complete the work according to the provided scope of work. The FS must verify that all tasks are in compliance with the requirements of this HASP and halt any activity that poses a potential hazard to personnel, property, or the environment.

1.5.4 Subcontractors

Subcontractors (in red box) involved in this project should review and understand the contents of this HASP prior to the start of on-site work. However, as part of the contract with the subcontractors, they are expected to follow their internal health and safety protocols. The subcontractor shall be fully responsible and shall indemnify AECOM for any losses, liabilities and claims as stipulated in Clause 9 and Clause 13 of the signed Subconsultant Engagement. Moreover, the subcontractors are expected to maintain proper and adequate insurances to cover health and safety related emergencies.

1.5.5 Other Field Personnel

All other field personnel covered by this HASP are responsible for following the health and safety procedures specified in this HASP and for performing their work in a safe and responsible manner.

1.6 Stop Work Authority

AECOM Stop Work Procedures (S3AS-106-PR) grants all AECOM employees, including employees of any of its subcontractors the right and responsibility to exercise a 'Stop Work Authority' any time that an employee



2.0 Project Background and Scope of Work

2.1 Project Background

AECOM Singapore Pte Ltd was appointed by the Housing Development Board (HDB) of Singapore, through the Authorisation Order dated 17 February 2023, to carry out Environmental Impact Assessment (EIA) at Woodlands Neighbourhood 1 (hereafter collectively referred to as 'Project Site' or "study area"). The study area, bounded by Woodlands Centre Road, Admiralty Road and Marsiling Road, is safeguarded for residential development based on URA's Master Plan 2019. In addition to this, an LTA proposed road network will be developed to increase connectivity within the area and other parts of Singapore.

Woodlands Neighbourhood 1 was formerly a plantation in 1943, with parts of the site being used for rubber plantation in 1966 and was mostly vegetated. In 1980 with a mosque observed within the site. The study area is approximated to be 7.72 hectares (ha). The indicative proposed boundary of the study area is shown below in Figure 1.

As the existing terrain is mostly forested and undulating, the project would require site clearance (removal of existing trees) and earthworks cutting/filling to achieve the platform levels required for the development as well as the construction of roads, drains, sewers, etc., to serve the development. For earthworks filling, good earth material will be used.

Location map of site areas is shown in **Figure 1**.



Figure 1 Project Location

2.2 Scope of Work

To assess the nature and existing baseline of study area, HDB would like to conduct an Environmental Impact Assessment (EIA) at the Project Site. The scope of the field work for the project is composed of the following items:

2.2.1 Biodiversity Study

This study will include biodiversity baseline studies which will consist of habitat, vegetation and tree mapping, list of important flora and fauna species present, with a focus on those that are threatened and/or are of high conservation value, have significant ecological functions, such as keystone species, and/or are of public interest. The EIA will assess the impacts on flora and fauna communities and/or ecological processes due to risk of pollution to aquatic habitats and noise pollution from the construction and operational phase of the project. Area of high conservation value and buffer zones will be identified. Baseline results will inform assessment of impacts, allow appropriate mitigation measures (if warranted) and recommendations for monitoring programme will be proposed.

2.2.2 Hydrology and Water Quality

This study will identify and map out the existing watercourses and investigate the flow conditions (indicative water depth, flow velocity and width during wet and dry weathers) of those watercourses. The dimensions, pattern and profile of each watercourse channel will be identified and documented based on multiple samplings under wet and dry weather conditions. Hydrological analysis will be conducted to identify surface water sources and sub-catchment areas that contribute to the major watercourses in the site. Impacts that are related to the stream watercourses alignment, potential runoff and water pollution will be identified for the construction and operational phase. In addition, baseline surface water quality will be carried out to establish the baseline conditions in the identified watercourses. Potential impacts that are related to possible construction activities will be identified, and contaminant concentrations will be compared to relevant water quality criteria.

2.2.3 Groundwater Level and Quality

A groundwater investigation will be carried out to assess the groundwater levels in the vicinity of the natural watercourses. The groundwater distribution will be established based on multiple environmental boreholes within the Project Site. The groundwater level will be compared to water levels in the nearby waterbody to assess the degree of dependency of watercourse flow from the groundwater. The baseline data will be used for further groundwater impact assessment, together with the use of relevant information generated from hydrological analysis. In addition, groundwater quality will be documented based on in-situ and ex-situ

groundwater sampling and analysis. EIA will assess the impact on groundwater level and quality during both construction and operational phases of the project.

2.2.4 Topography Survey

Topographic survey will be conducted to gather data about the elevation of points within the study area and present them as contour lines on a plot. The purpose of a topographic survey is to collect survey data about the natural and man-made features of the land, as well as its elevations. A survey map of terrain and levels within the study area will be provided.

3.0 Hazard Assessment

3.1 Remote Site Work

Lone work is not permitted in remote areas, minimum two person teams are required. Prior to conducting activities in remote areas, the Project Manager, in consultation with the field staff, must develop a functional communication system consisting of devices and protocols.

For the communication devices, consideration may be given to the type of equipment required and the suitability of the equipment for the proposed works location. Where necessary, external expert advice on communication devices must be sourced. Communication equipment that may be considered for remote work includes wide-ranging network coverage mobile phones, satellite/GPS communication devices, or personal locator beacons.

The Project Manager must ensure a Communication Plan is developed for the remote works. The plan should outline the time and frequency of check-in, contact numbers for field staff and nominated check-in persons, contact numbers for alternative contacts, and escalation procedures for failed or missed check-ins.

The Project Manager must ensure appropriate resourcing, accommodation; equipment and transport are sourced prior to commencement of the works.

Field Staff are required to have an adequately stocked first aid kit with them for the duration of the works.

3.2 Physical Hazards

AECOM recognizes that performing certain tasks related to executing the scope of work for the site would expose workers to a variety of physical hazards. As such, AECOM employees have been trained and mentored to carry out assessment activities following AECOM standard operating procedures (SOPs) making SH&E a priority in their operations.

3.2.1 Falling Objects

Suspended loads or falling objects may be present at the site in the form of tree branches, old logs, collapsing remnants of old structures and other aboveground objects (e.g., suspended loads in a construction site within the site). The field staff must initially assess the site for presence of falling object(s), and the work must be conducted away from locations that may be directly impacted by such. Pathways should be planned and selected such that they are away from potential falling loads and/or suspended objects. For works within construction sites, the field staff must comply to the construction developer's health and safety procedures and as a minimum should wear a hardhat and safety shoes.

3.2.2 Slip, Trip and Fall Hazards

On any work area, it is expected that the ground may be uneven. The ground surface may be unreliable due to settling. The site should be initially assessed for potential slip, trip and fall hazards. Identify excavations, open pits, holes, and trenches then place appropriate markers at locations with these hazards. Establish and follow an unobstructed walking path identified when working due to the irregular terrain.

3.2.3 Pinch Points

The use of hand tools, mechanical equipment can create pinch points within the working area. Pinch points can be recognized when moving objects are present in the workspace in close proximity to employees, and it is

reasonable to assume that a part of the employee's body can be caught between the moving objects. Pinch points will be considered when performing a Job Safety Risk Assessment (JSRA) for the task being performed and recommendations will be made to reduce the potential for body parts to become caught in moving parts, including but not limited to:

- When tools are used as an extension of the body consideration will be given to how the tool may become a hazard if it is caught within moving parts; and
- The use of Personal Protective Equipment (PPE), e.g., gloves, boots, etc., to protect exposed body parts.

3.2.4 Manual Lifting

Most materials associated with construction-related activities are moved by hand. The human body is subject to severe damage in the forms of back injury, muscle strains, and hernia if caution is not observed in the handling process. Whenever possible, use at least two people to lift, or roll/lift with your arms as close to the body as possible. Under no circumstances should any one person lift more than 12 kgs unassisted. Using the proper techniques to lift and move heavy pieces of equipment is important to reduce the potential for back injury. Use mechanical devices to move objects that are too heavy to be moved manually. If mechanical devices are not available, ask another person to assist you. Bend at the knees and not the waist when lifting loads. Let your legs do the lifting and do not twist your body while lifting. Be sure the path you are taking while carrying a heavy object is free of obstructions and slip, trip and fall hazards.

3.2.5 Cuts and Lacerations

Field personnel should always look for sharp surfaces such as glass when handling sampling bottles, soil samples or debris. Always wear cut/puncture resistant gloves when hand-clearing cannot be avoided. Never attempt to remove objects caught in an auger stem with the hand and make sure the equipment is turned off.

3.3 Weather Hazards

3.3.1 Heat Stress

Heat stress related problems include **heat rash, fainting, heat cramps, heat exhaustion and heat stroke**. Increased body temperature and physical discomfort also promote irritability and a decreased attention to the performance of hazardous tasks. The surveyors should establish work-rest cycles (short and frequent are more beneficial than long and seldom) and rest in a shaded, cool area.

Most workers exposed to hot environments drink less fluid than needed because of an insufficient thirst. **DO NOT DEPEND ON THIRST TO SIGNAL WHEN AND HOW MUCH TO DRINK. During field work, drink at least 4 - 6 litres (120 - 200 ounces) of fluids for an 8-hour workday.** Sufficient potable water and approved beverages should be made available each day for the field team. The field surveyors should also identify the most effective technique for heat stress monitoring.

3.3.2 Sun Exposure

Field personnel are encouraged to liberally apply sunscreen, with a minimum sun protection factor (SPF) of 30, when working outdoors to avoid sunburn and potential skin cancer, which is associated with excessive sun exposure to unprotected skin. Additionally, employees should consider wearing safety glasses that offer protection from UVA/UVB rays.

3.3.3 Darkness

AECOM discourages field activities to be done at low light conditions, particularly at night. When working in dark areas, ensure that additional artificial lighting must be present to illuminate the work area to ensure that paths and potential site hazards are clearly visible. The field personnel should also recognize the effect of fatigue on workers not accustomed to working at night or extended periods. If night works is required, approval from the PM/DPM, and URA must be obtained prior to start of any night works. Moreover, a minimum of two personnel should be completing the work. Lone worker at night-time is NOT allowed.

3.3.4 Haze

Haze can occur for some period in Singapore every year and the atmosphere could be filled with dust, some or other dry particulates such as fine suspended particles that obscure the clarity of sky. N95 mask should be worn if the haze will affect the work performance during field survey. If N95 masks are used, note that it will increase

effort of breathing. It may cause discomfort in breathing, tiredness or headache. Instituting regular breaks should be considered and drink more water to ensure enough hydration during field survey.

3.3.5 Inclement Weather and Other Natural Disasters

Severe weather can occur with little warning. Employees will be vigilant for the potential of storms, lightning, high winds, and flash flood events. The field personnel will be attentive to daily weather forecasts for the project area each morning. Predicted weather conditions of potential field impact should be considered when performing the work. No field surveys will be conducted during inclement weather, thunder or lightning in the vicinity of the study area.

Be alert to the signs of changing weather, such as darkening skies, a sudden wind shift or drop in temperature. If you are expected to be onsite, plan your evacuation and safety measures in advance. During thunderstorms, when you first see lightning or hear thunder, activate your emergency plan and go inside to the closest building or vehicle. In the event that the national weather service predicts that one of the areas where AECOM is working is in the direct path of a typhoon or cyclone, the PM will immediately contact the field personnel to determine what, if any, precautions are necessary, including the need for evacuation.

This same protocol will be followed in the event that other natural disasters (e.g., floods, landslides, earthquakes, etc.) could impact field personnel. **DO NOT IGNORE INSTRUCTIONS TO GET TO SAFETY.**

3.4 Biological Hazards

As part of the site consists of a secondary forest, biological hazards are expected to be present. The AECOM project team shall ensure that the potential for exposure to specific biological hazards are assessed prior to the commencement of work and that the procedures specified by this HASP are integrated into the project planning process and conveyed to AECOM employees conducting the field work. This information shall be communicated in the site kick-off meetings. Possible biological hazards that may be encountered at the site include mosquitoes, wild boars, spiders, bees, and snakes. Where detected, assessment of trees will only be carried out at a distance.

The hazard assessments must also consider the additional hazards posed by vegetative clearing such as the increased risk of coming in contact with plants that may cause irritation, cuts and punctures, and hazards associated with the use of tools and equipment to remove vegetation.

3.4.1 Spiders

Spiders can be found in derelict buildings, sheltered areas, basements, storage areas, well heads, and even on open ground. Spiders can be found year-round in sheltered areas and are often present in well heads and valve boxes. Most spider bites produce wounds with localized inflammation and swelling. All spiders are poisonous, but fear of all spiders is unwarranted because most are either too small or possess poison that is too weak to harm humans. Only a few have bites that are dangerous to humans. However, the bite of these few species can cause serious medical problems and possible death under certain circumstances.

3.4.2 Mosquitoes

When a mosquito bites, it injects an enzyme that breaks down blood capillaries and acts as an anticoagulant. The enzymes induce an immune response in the host that results in itching and local inflammation. The tendency to scratch the bite sites can lead to secondary infections. Centers for Disease Control and Prevention (CDC) data indicates that mosquito-borne illnesses, including the strains of dengue, Zika, malaria and encephalitis, are a health risk to employees working in outdoor environments. Mosquitoes breed in stagnant water and typically only travel a quarter mile from their breeding site. Whenever possible, stagnant water should be drained to eliminate breeding areas. Project managers and client should be contacted to determine whether water can be drained and the most appropriate method for draining containers, containment areas, and other objects of standing water. Application of mosquito-repellent lotion is advised especially when working outdoors. Employees also need to consider whether they are sensitive to the use of insect repellents. Priority should be given to elimination of breeding areas.

3.4.3 Bees and Hornets

Bees, hornets and wasps may be found in derelict buildings, sheltered areas, and even on open ground. Avoid reaching into areas where visibility is limited. If stung by a wasp or bee or hornet, notify a co-worker or someone who can help should you have an allergic reaction. Stay calm and treat the area with ice or cold water. Seek

medical attention if you have any reactions to the sting such as developing a rash, excessive swelling or pain at the site of the bite or sting or any swelling or numbness beyond the site of the bite or sting.

Employees with known allergies to insect stings should consult their personal physician for advice on any immediate medications that they should carry with them. AECOM recommends that employees with known allergies inform their co-workers of the allergy and the location of the medications they might carry for the allergy.

3.4.4 Snakes

Most snake bites happen when the snake is trodden on, either in the dark or in undergrowth. If you find a snake while at work, contact local authorities which will arrange for a suitably qualified snake handler to catch and relocate the snake. DO NOT attempt to catch the snake yourself as this may result in serious injury. Simply track the snake's movements and await the arrival of the snake handler. Attention to the following recommendations might reduce the number of accidents.

- Know your local snakes, the sort of places where they like to live and hide, at what times of year, day/night or in what kinds of weather they are most likely to be active.
- Be especially vigilant about snake bites after rains, during flooding, at harvest time and at night.
- Wear proper shoes or boots and long trousers, especially when walking in the dark or in undergrowth.
- Avoid working in areas where snakes are suspected present or there is a history of their presence. Wear snake chaps if it is necessary to work in or near these areas.
- Avoid snakes as far as possible. Never handle, threaten or attack a snake and never intentionally trap or corner a snake in an enclosed space.
- Avoid or take great care handling dead snakes, or snakes that appear to be dead.
- Avoid having rubble, rubbish, termite mounds or domestic animals close to human dwellings, as all of these attract snakes.
- If you suspect that snake is present in close proximity to your work location, back off and request for help.
- Avoid work alone in remote sites – the buddy can serve as additional eyes for hazard identification and aide in times of emergency
- Prepare an emergency vehicle on standby for working in remote sites especially difficult in transportation (e.g. rent a car)

The hazard assessments must also consider the additional hazards posed by vegetative clearing such as the increased risk of coming in contact with plants that may cause irritation, cuts and punctures. Hazards associated with the use of tools and equipment to remove vegetation.

3.4.5 Wild Boars

Wild boars are not expected in the area as it is surrounded by urbanised areas. However, in the event that a wild boar is encountered, the following recommendations are to be followed:

- Be calm and move slowly away from the wild boar.
- Do not approach or attempt to attack the wild boar.
- Keep a safe distance and do not corner or provoke the wild boar.
- If see adults with young piglets, leave them alone to avoid increase the alertness of the adult and they may attempt to defend their young.
- Wear proper shoes or boots and long trousers, especially when walking in the dark or in undergrowth.
- Avoid working in areas where wild boars are suspected present or there is a history of their presence.
- Avoid or take great care handling dead wild boar, or wild boar that appear to be dead.
- If you suspect that wild boar is present in close proximity to your work location, back off and request for help.

3.4.6 Stray Dogs and Other Wild Animals

Stray dogs and other wild animals may be present in the study area. Dogs have the tendency to attack once it demonstrates aggressive behaviour such as growling, crouching and barking. If an aggressive dog approaches. Stand still with arms relaxed at the sides. Do not wave the arms or hands around as this can be seen as aggressive by the dog. Do not stare in the dog's eyes or meet it at eye level.

If employees get bitten or injured such as scratches or scrapes from the dog, proceed to the nearest medical centre (see Emergency Response section). The wounds should be treated and the necessary vaccines must be availed.

4.0 Personal Protective Equipment

4.1 Basic PPE

PPE will be worn during field work activities to meet the facility's basic PPE requirements and to prevent on-site personnel from being injured by the safety hazards posed by the site and/or the activities being performed. The following tables describe the basic PPE requirements for general site activities and for certain specific tasks/areas.

Basic PPE Item	Requirements for Donning Item
Long sleeved work jacket or shirt; 100% cotton	Required at all times. No torn or sleeveless shirts allowed
Long pants; denim or cotton	Required at all times. No short pants allowed.
Closed shoes/knee-high rubber boots/gaiters	Required at all times.
Hard Hat (ANSI Z89.1, Type 1, Class E)	Required when working in areas or activities with overhead hazards
Traffic vests (ANSI 107, Class II)	Required when working in areas with moving vehicles.
Work Gloves	Type required dependent on work performed. Brightly colored gloves are recommended.

4.2 Other Safety Equipment

The following additional safety items should be available at the site:

- Portable, hand-held eyewash bottles;
- Fully-stocked First Aid Kit;
- Hard barricades or traffic cones to designate work area;
- Multipurpose Dry Chemical (Type A-B-C) Fire (when hot works are implemented). The fire extinguisher should be accessible and placed close to the area where the Hot Work activities are occurring;
- Trekking pole/stick; and
- Face shield/mask.

5.0 Personal & Travel Related Safety & Security

5.1 General Information

This project involves travel to an area of Singapore that may or may not pose security threats to the AECOM field team members that will perform the project work. All field personnel will use the buddy system when working within any controlled work area. Under no circumstances will any employee be present alone in a controlled area. To ensure the personal safety of AECOM staff, the following general precautions need to be considered and implemented:

- Obtain travel, health and security advisories applicable prior to mobilization. This includes notice to proceed from NParks, URA, SLA, ISD, MINDEF and SPF.

- Schedule onsite works during daylight hours or until nearby establishments are still open.
- Keep a mobile phone with you onsite. Maintain regular contact with someone in the office.
- To avoid being a target, dress conservatively. Do not wear expensive looking jewellery.
- Always try to travel light. You can move more quickly and with ease and will be more likely to have a free hand.
- If you wear glasses, pack an extra pair and pack medicines you need in your carry-on luggage.
- Notify a representative of the site/facility and your supervisor immediately if you become concerned at any time about your personal safety and security while conducting this work.

5.2 Communications

Throughout field surveys, a minimum of two personnel will work together at all times and carry hand phones to keep in contact with non-field personnel. Local telephone facilities or services may be limited at the site. Field teams must have a portable mobile phone to contact other AECOM Project Managers, and if necessary, local emergency responders.

6.0 Site Control

6.1 Housekeeping

During site activities, work areas will be continuously policed for identification of excess trash and unnecessary debris. Excess debris and trash will be collected and stored in an appropriate container (e.g., plastic trash bags, garbage can, roll-off bin) prior to disposal. At no time will debris or trash be intermingled with waste PPE or contaminated materials.

6.2 Smoking, Eating, or Drinking

Smoking, eating and drinking will not be permitted inside any controlled work area at any time. Field workers will first wash hands and face immediately after leaving controlled work areas (and always prior to eating or drinking). Consumption of alcoholic beverages is prohibited at any AECOM site.

6.3 Personal Hygiene

The following personal hygiene requirements will be observed:

- Water Supply: A water supply meeting the following requirements will be utilized:
 - ❖ Potable Water - An adequate supply of potable water will be available for field personnel consumption. Potable water can be provided in the form of water bottles, canteens, water coolers, or drinking fountains. Where drinking fountains are not available, individual-use cups will be provided as well as adequate disposal containers. Potable water containers will be properly identified in order to distinguish them from non-potable water sources.
 - ❖ Non-Potable Water - Non-potable water may be used for hand washing and cleaning activities. Non-potable water will not be used for drinking purposes. All containers of non-potable water will be marked with a label stating:

***Non-Potable Water
Not Intended for Drinking Water Consumption***

- Toilet Facilities: The FS shall identify the nearest toilet facilities.

7.0 Health and Safety Requirements

7.1 Training Requirements

7.1.1 Site Safety Officer Accreditation

All AECOM personnel performing activities covered by this HASP must have completed the appropriate prescribed internal training requirements.

7.2 SH&E Briefings and Meetings

7.2.1 Field Kick-off Meetings

Prior to the commencement of on-site activities, a field kick-off meeting will be conducted by the FS to review the specific requirements of this HASP. Attendance of the pre-entry meeting is mandatory for all personnel covered by this HASP and must be documented on the HASP Acceptance Form provided in Attachment A. All documentation should be maintained in the project file. The pre-entry briefing must be completed for each new employee before they begin work at the site.

7.3 Medical Surveillance Program

AECOM has a medical surveillance program in place specifically designed to provide pre-placement baseline medical examinations to determine the medical suitability of, and to establish a "medical baseline" for, newly hired employees. The program provides annual examinations to detect medical conditions or changes, which may affect medical suitability for unrestricted work; and also provides interim and post exposure examinations, as necessary, based on types of projects and materials handled.

7.4 Substance Abuse

AECOM understands that the unlawful or improper presence or use of controlled substances or alcohol in the workplace presents a danger to everyone. Employees who refuse to meet the requirements of the AECOM Substance Abuse Policy shall be removed from the project and may be subjected to disciplinary action, up to and including termination.

8.0 Emergency Response

AECOM response actions will be limited to evacuation and medical/first aid as described within this section. As such, this section of the HASP has been written to comply with 29CFR 1910.38 (a). AECOM employees and their subcontractors should be prepared to evacuate the work site in the event of an emergency. When work involves working at a remote location where medical facilities may not exist, it is imperative that the field team understand how to contact transportation companies to assist with transport to the closest medical facility. This information must be determined in advance of mobilizing to a remote location with no medical facilities, reviewed with the field team and verified with the identified transport companies on the day of field mobilization to ensure services are available. AECOM will bring a portable phone to the site to ensure that communications with local emergency responders is maintained, when necessary.

8.1 Emergency Information and References

Prior to working, the field personnel will review with the PM the scope of work and any site-specific information that may be available, including emergency information specific to the site location, emergency contact information and the designated emergency evacuation area. Emergency references of MEDICAL (ambulance), FIRE and POLICE services that can be summoned to the facility during an emergency should be determined as part of the Site Specific Data Form and should be discussed during the daily safety meetings. The field personnel and/or PM must ensure completion of the **Emergency Response Information** form ([Attachment B](#)) prior to mobilization.

8.2 Accident Reporting and Investigation

8.2.1 AECOM Reporting Requirements

All work-related H&S incidents, including injuries and illnesses, first aid cases, accidents, property damage incidents, and near-miss incidents must be reported to the PM as soon as possible. The PM should then notify the HSSE Focal to discuss the incident and to determine whether the incident must be reported to LTA (see below) and whether an accident investigation should be conducted and documented. If any person is injured, his/her supervisor, the PM and HSSE Focal must be notified immediately.

If an investigation will be required, it should be conducted as soon as emergency conditions are under control. The purpose of the investigation is not to attribute blame but to determine the pertinent facts so that repeat or similar occurrences can be avoided. An AECOM Accident Investigation Form in the *AECOM Field SH&E Manual* must be completed as soon as possible and submitted to the PM.

Attachment A

HASP Receipt and Acceptance Form

Health and Safety Plan Receipt and Acceptance Form

for Specialist Consultancy Services for Environmental Impact Assessment (EIA) at Woodlands N1 Project.

I have received a copy of the Health and Safety Plan (HASP) prepared for the above referenced project. I have read and understood its contents and I agree that I will abide by its requirements.

Name	Signature	Company	Date
Jaypee Perez Bautista		AECOM Singapore Pte Ltd	27/04/2023
Jagriti Dawra		AECOM Singapore Pte Ltd	27/04/2023
Grujica Sarenac		AECOM Singapore Pte Ltd	27/04/2023
Cho, Qi An Celine		AECOM Singapore Pte Ltd	27/04/2023
Dr. Liang Liang		AECOM Singapore Pte Ltd	27/04/2023
Hanisah Binte Sukarji		AECOM Singapore Pte Ltd	27/04/2023

Attachment B

Emergency Response Information

Local Police: Bukit Panjang North Neighbourhood Police Post, 27 Marsiling Drive, #01-237 Marsiling Green, Singapore 730027 Tel: +65 1800 368 9999

Local Fire: Woodlands Fire Station, 1 Woodlands industrial Park D St 2 , Singapore 738782 Tel: +65 6884 1350

Closest Hospital/Clinic to Site:

Hospitals and Clinics Near Project Site

Name of Hospital and Clinic	Distance from Project Site (km)	Address	Contact Number/Hotline	Opening Hours	Coordinates
Woodlands Clinic	~476m	01-204, 131 Marsiling Rise, Singapore 730131	+65 6269 6681	Mon, Wed: 6.30am – 10.30pm, Tues, Thurs, Sat: 6.30am – 6pm	1°26'18.33"N, 103°46'42.23"E
DR+ Medical and Paincare Marsiling	~509m	18 Marsiling Lane, #01-269, Singapore 730018	+65 6269 7435	Mon – Fri: 8.30am – 12.30pm, 1.30pm-4.30pm, 7pm-9pm Sat: 8.30am – 12.30pm	1°26'35.82"N, 103°46'40.32"E
OneCare Medical Clinic Woodlands	~860m	4 Woodlands Street 12, #02-57 Marsiling Mall, Singapore 738623	+65 6363 2919	Mon-Fri: 8.30am – 3pm, 6pm – 9pm Sat-Sun: 8.30am - 1pm	1°25'59.74"N, 103°46'47.19"E
Doctors Clinic & surgery	~975m	Woodlands Street 31, #01-91 Block 305, Singapore 730305	+65 6269 1017	Mon-Fri: 8.30am-12pm, 2pm-4.30pm, 6.30pm-9pm Sat-Sun: 8.30am-12pm	1°25'47.93"N, 103°46'25.92"E
T.S Wong Clinic & Surgery	~520m	166 Woodlands Street 13, #02-523, Singapore 730166	+65 6368 8670	Mon-Fri: 9am-12.30pm, 2pm-3.45pm, 7pm-8.45pm, Sat-Sun: 9am-11.45am	1°26'2.79"N, 103°46'32.03"E

Royal Medical Centre	~887m	111 Woodlands Street 13, #01-84, Singapore 730111	+65 6365 6855	Mon-Fri: 8.30am – 1pm, 2pm-4pm, 6.30pm-9pm Sat: 8.30am-12.30pm, Sun: 9am-12.30pm	1°26'15.98"N, 103°46'55.53"E
Raffles Medical Causway Point	~882m	1 Woodlands Square, #5-20, Singapore 738099	+65 6894 0777	Mon-Sun: 8am-1pm, 2pm-5.30pm, 6.30pm-9.30pm	1°26'9.20"N, 103°47'10.98"E
Canary Medical Clinic	~441m	Woodlands Street 13, Marsiling Greenview, #01-04, Singapore 730182	+65 6235 2880	Mon-Thurs: 9am-12pm, Fri-Sat: 9am-12pm, Sun: 6.30pm-9.30pm	1°26'6.17"N, 103°46'33.21"E

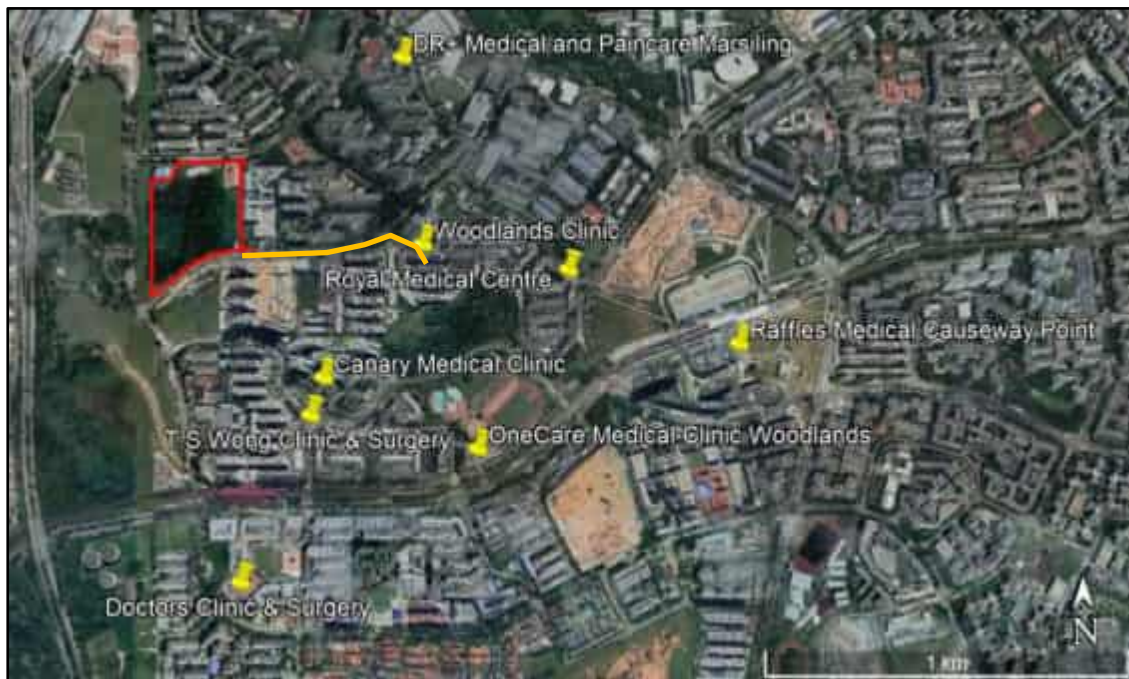
Emergency Alarms, Evacuation Route/s and Procedures:

In the case of an emergency, AECOM will contact appropriate local emergency response agencies.

In the event of an emergency, all personnel should proceed to the designated emergency muster point (unless directed to an alternate muster point by the AECOM emergency coordinator).

Depending upon the type of emergency, AECOM will determine whether the muster point is a safe distance from the emergency location. Employees will be moved further from the site of the emergency if it is determined that the muster point is not at a safe distance.

Location of Nearest Hospital/Clinic:



Appendix B
AECOM Job Safety Risk
Assessment

APPENDIX B:

JOB SAFETY RISK ASSESSMENT

SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT
ASSESSMENT (EIA) AT WOODLANDS NEIGHBOURHOOD 1

Prepared by:

AECOM Singapore Pte Ltd
300 Beach Road, #23-00 The Concourse,
Singapore 199555

Project Number: **60705888**

JOB SAFETY RISK ASSESSMENT

Project:	Woodlands Neighbourhood 1	Location:	Woodlands Neighborhood 1
Work Activity:	Site walkabout/ reconnaissance, water quality sampling, biodiversity surveys, topographic survey, noise monitoring		
Personnel Protective Equipment (PPE):	Long-sleeved shirt, long trousers, raincoat/poncho (as applicable), mosquito head net, trekking pole, face shield/mask, knee-high rubber boots and insect repellent.		
Development Team:	Name/Designation Grujica Sarenac / Consultant	Date 6 March 2023	Reviewed by: Jaypee Bautista / RA Champion 
JSRA Type:	☒ New ☐ Revised	Next Review Date: 6 March 2024	Date 8 March 2023

No	Job Steps	Potential Hazard(s)	Existing Risk Control	Initial Risk Evaluation			Additional Risk Control	Residual Risk Evaluation			Responsible Person	Completed by:
				L	S	R		L	S	R		
1.1	Site walkabout / locating of point counts/transects - Inspecting the area / vicinity walk within the site - Conduct flora and fauna surveys	Slips, trips and fall due to uneven surface, slippery ground, soft soil, obstructions (fence/railing) or wayward objects (FB, FC)	- Use alternative routes, if available, for areas blocked by fences/railings - Assess for slippery, uneven surface or obstructions; remove wayward objects; identify safe routes and pathways; follow designated paths as shown in maps (access maps)	3	2	6	- If climbing over a low fence or railing cannot be avoided, always maintain three-point contact - Use trekking poles or stick to assess the ground and to aid balance when walking around uneven/grassy ground - Remove obstructions - Maintain a slow and steady walking pace while working onsite - Ensure anti-slip threads on safety boots are clean and not worn out	1	2	2	AECOM Personnel	17 September 2023
1.2		Falling object causing injuries to the field staff	- Inspect the site for the presence of potential falling objects such as tree branches, old logs, collapsing remnants of old structures, etc. - Identify alternative routes to avoid the potential area of impact from falling objects - Inform the team of the presence of the falling objects, if any	2	3	6	- Rope off the area, if possible, where fall hazards may exist - Use hard hats in the vicinity of the area where fall hazard may exist - Use alternative routes, if available	1	3	3	AECOM Personnel	17 September 2023

No	Job Steps	Potential Hazard(s)	Existing Risk Control	Initial Risk Evaluation			Additional Risk Control	Residual Risk Evaluation			Responsible Person	Completed by:
				L	S	R		L	S	R		
1.3		Exposure to extreme heat	- Take periodic breaks and keep hydrated – drink water or ionic drinks - Stay under the shade whenever possible	3	2	6	- Apply sunscreen as necessary - Use umbrella as necessary	1	2	2	AECOM Personnel	17 September 2023
1.4		Haze-related hazards - Difficulty in breathing (acute) and respiratory illness (chronic)	- Wear N95 mask when necessary	3	1	3	- Not required	-	-	-	AECOM Personnel	17 September 2023
1.5		Biological hazard - Mosquito bites (and other insect bites – bees, hornets, ants)	- Read AECOM Safety for Life Safety Alert regarding mosquitoes and malaria - Be on an active lookout for beehives and hornet nests	3	2	6	- Use insect repellent (spray or patch) - Wear light coloured clothing with long sleeves and long pants - Be aware of peak mosquito hours – avoid works during dusk and dawn - Wear mosquito head nets - Use a poncho/raincoat, if necessary, to cover body parts	1	2	2	AECOM Personnel	17 September 2023
1.6		Biological hazard - Snake bites (CB) / animal bites (wild animals like wild boars)	- Read AECOM Safety for Life Safety Alert regarding safety measures during snake season - Do not approach or provoke wild animals - Leave the area cautiously and slowly	2	3	6	- Avoid walking through dense vegetation / tall grass. Use known tracks or cleared routes (i.e., with no or little vegetation). - If there is a person who is familiar with the site, seek advice on safer or alternative routes. - Always carry a stick or trekking pole which you can use as protection - Use knee-high rubber boots or gaiters, especially when walking on grassy and waterlogged areas - Avoid walking alone in remote sites	1	3	3	AECOM Personnel	17 September 2023

No	Job Steps	Potential Hazard(s)	Existing Risk Control	Initial Risk Evaluation			Additional Risk Control	Residual Risk Evaluation			Responsible Person	Completed by:
				L	S	R		L	S	R		
1.7		Intermittent weather	- Stop work during heavy rain or thunderstorm	2	4	8	- Seek shelter; do not hide under trees in case of thunderstorms - Resume work only 30 minutes after a thunderstorm	1	3	3	AECOM Personnel	17 September 2023
2.1	Water Quality Sampling • Grab sampling of water sample using sample container	Contact with preservatives in sampling bottles (CW)	Wear appropriate PPE, such as nitrile gloves, long sleeve shirts and safety glasses	2	1	2	- Not required	-	-	-	AECOM Personnel	17 September 2023
2.2	• Use of water quality kit to measure water parameters	Ergonomic hazards – repetitive movements, overreaching, bending, twisting, slouching (O)	- Observe good ergonomic practices such as minimizing twisting, bending and slouching, avoiding overreaching and awkward positions - Sit on a stool, if possible	3	2	6	- Sit on a stool, if possible - Use a trolley to carry buckets to designated waste disposal/storage location or - Avoid overfilling the buckets (at most, half-filled) if a trolley is not available or usable	1	2	2	AECOM Personnel	17 September 2023
2.3		Falling object causing injuries to the field staff	- Inspect the site for the presence of potential falling objects such as tree branches, old logs, collapsing remnants of old structures, etc. - Identify alternative routes to avoid the potential area of impact from falling objects - Inform the team of the presence of the falling objects, if any	2	3	6	- Rope off the area, if possible, where fall hazards may exist - Use hard hats in the vicinity of the area where fall hazard may exist - Use alternative routes, if available	1	3	2	AECOM Personnel	17 September 2023
2.4		Slip, trip, fall due soft grounds or slippery surface/uneven grounds while climbing the fence; Getting stuck/trapped in subsiding/very soft ground (FS, FB) Slip, trip and fall into waterbody (FB)	- Observe good housekeeping practices – clean up spills - Maintain slow and steady walking pace while walking on site - Conduct surface water sampling with a buddy as a watchman	2	3	6	- Remove obstructions if observed - Use a trekking pole for additional support - Wear rubber boots / high boots with high traction - Ensure three-point contact while climbing the fence	1	3	3	AECOM Personnel	17 September 2023

No	Job Steps	Potential Hazard(s)	Existing Risk Control	Initial Risk Evaluation			Additional Risk Control	Residual Risk Evaluation			Responsible Person	Completed by:
				L	S	R		L	S	R		
5.1	Elevation/Topo Survey (subcon YJP Surveyor) - Locate monitoring wells/survey points - Open the well cover and well cap and set up survey equipment - Read elevation data and coordinates/north ing-easting - Moving from each location	Struck by moving vehicles (SB)	Wear high visibility clothing when moving around areas near the road	2	3	6	- Assign traffic watch/spotter - Utilize cones, signs, flags and/or other traffic control, if necessary	1	3	3	AECOM Personnel & YJP Surveyor	17 September 2023
5.2		Slip, trips and falls due to slippery and uneven surface and/or due to obstructions (FS, SA)	- Identify safe routes and pathways; - Assess for slippery, uneven surface or obstructions				- Remove obstructions - Maintain a slow and steady walking pace while working onsite. Ensure anti-slip threads on safety boots are clean and not worn out	1	2	2	AECOM Personnel & YJP Surveyor	17 September 2023
5.3		Falling object causing injuries to the field staff	- Inspect the site for the presence of potential falling objects such as tree branches, old logs, collapsing remnants of old structures, etc. - Identify alternative routes to avoid the potential area of impact from falling objects - Inform the team of the presence of the falling objects, if any	2	3	6	- Rope off the area, if possible, where fall hazards may exist - Use hard hats in the vicinity of the area where fall hazard may exist - Use alternative routes, if available	1	3	3	AECOM Personnel & YJP Surveyor	17 September 2023
5.4		Hand injury, pinch points (CBT)	- Be aware of possible pinch points or sharp edges when opening well covers/caps - Use mechanical means (e.g. hooks) when opening well covers/caps - Wear appropriate working gloves	2	1	2	Not required	-	-	-	AECOM Personnel & YJP Surveyor	17 September 2023
5.5		Biological hazard - Snake bites (CB) / animal bites (wild animals, stray dogs)	- Do not approach or provoke wild animals - Leave the area cautiously	2	3	6	- Always carry a stick or trekking pole which you can use as protection - Wear knee-length rubber boots or gaiters	1	3	3	AECOM Personnel & YJP Surveyor	17 September 2023
6.1	Biodiversity survey	Refer to the General Safety Plan provided in Appendix C and developed by Camphora Pte Ltd for this project									Camphora Personnel	17 September 2023

My signature below indicates that all requirements and conditions listed above have been verified, met, and reviewed will all affected personnel prior to start of work.

Supervisor's Signature:

G. Sarenac

Grujica Sarenac

Date/Time: 6 March 2023

I have read this JSRA, and I understand the hazards and safe work practices associated with the task.			
Signature: _____ Jagriti Dawra	Date/Time: 6 March 2023	Signature:	Date/Time:
Signature: _____ Cho, Qi An Celine	Date/Time: 6 March 2023	Signature:	Date/Time:
Signature: <u>Liang</u> Dr Liang Liang	Date/Time: 6 March 2023	Signature:	Date/Time:
Signature: _____ Hanisah Binte Sukarji	Date/Time: 6 March 2023	Signature:	Date/Time:
Signature:	Date/Time:	Signature:	Date/Time:
Signature:		Signature:	Date/Time:

RISK ASSESSMENT GUIDE

Assessment of Severity:

LEVEL	SEVERITY	DESCRIPTION
1	Negligible	Not likely to cause injury or ill-health.
2	Minor	Injury or ill-health requiring first-aid only (includes minor cuts and bruises, irritation, ill-health with temporary discomfort).
3	Moderate	Injury requiring medical treatment or ill-health leading to disability (includes lacerations, burns, sprains, minor fractures, dermatitis, deafness and work-related upper limb disorders).
4	Major	Serious injuries or life-threatening occupational disease (includes amputations, major fractures, multiple injuries, occupational cancer, acute poisoning).
5	Catastrophic	Fatality, fatal diseases or multiple major injuries.

Assessment of Likelihood:

LEVEL	LIKELIHOOD	DESCRIPTION
1	Rare	Not expected to occur but still possible
2	Remote	Not likely to occur under normal circumstances
3	Occasional	Possible or known to occur
4	Frequent	Common occurrence
5	Almost Certain	Continual or repeating experience

Risk Evaluation:

Likelihood(L) Severity (S)	Rare (1)	Remote (2)	Occasional (3)	Frequent (4)	Almost Certain (5)
Catastrophic (5)	5	10	15	20	25
Major (4)	4	8	12	16	20
Moderate (3)	3	6	9	12	15
Minor (2)	2	4	6	8	10
Negligible (1)	1	2	3	4	5

Acceptability of Risk and Recommended Actions:

RISK LEVEL	ACCEPTABILITY OF RISK	RECOMMENDED ACTIONS
Low Risk (1-3)	Acceptable	- No additional risk control measures may be needed. - However, frequent review and monitoring of hazards are required to ensure that the risk level assigned is accurate and does not increase over time.
Medium Risk (4-12)	Moderately acceptable	- A careful evaluation of the hazards should be carried out to ensure that the risk level is reduced to as low as reasonably practicable (ALARP) within a defined time period. - Interim risk control measures, such as administrative controls or PPE, may be implemented while longer term measures are being established. - Management attention is required.
High Risk (15-25)	Not acceptable	- High Risk level must be reduced to at least Medium Risk before work commences. - There should not be any interim risk control measures and risk control measures should not be overly dependent on personal protective equipment or appliances. - If practicable, the hazard should be eliminated before work commences. - Immediate management review/ intervention is required before work commences.

Code for Potential Hazards:

Caught Between (CBT)	Contacted By (CB)	Fall to Below (FB)	Overexertion (O)	Struck Against (SA)
Caught In (CI)	Contact With (CW)	Fall – Same Level (FS)	Release To (R)	Struck By (SB)

Appendix C Camphora Safety Plan



RISK ASSESSMENT FORM

Company :		Camphora Pte Ltd		Conducted by:		Derek Yap			Reference
Process :		Conducting surveys of flora and fauna		Names, designations		Lead Arborist			Cam-EIA
Location :		Forested sites		Date :		Apr-23			
First Assessment Date:		Jul-21		Project Name :		Woodlands N1			
Last Review Date:		Apr-23							
1. Hazard Identification				2. Risk Evaluation				3. Risk Control	
1a.	1b.	1c.	1d.	2a.	2b.	2c.	2d.	3a.	3b.
No.	Work Activity	Hazard	Possible Accident / Ill Health & Persons-at-Risk	Existing Risk Control	S	L	Risk Level	Additional Risk Control	Action Officer, Designation
				(if any)					(Follow-up date)
1	Mobilisation of project team	Unaware of site conditions and site-specific safety rules and regulations	Entering into prohibited areas, injury to persons	Ensure approval has been granted by clients/authority; carry approval letter if available; seek advice from clients regarding site access/conditions.	2	1	2 (L)	Study topography plans prior to entry.	Designated team leader for the project
2	Working within natural/forested areas during the day	Falling branches, dangerous fauna, thorns, plants with sap that cause irritations, unobvious obstacles, uneven ground	Stings/bites/scratches, trips/slips/falls, head injury, feet injury, getting lost	Work in a group of at least 2 people; visually assess the surroundings for hornets/bees/snakes/dead branches/roots/protruding vegetation while walking; stamp feet and make loud noises when walking through thick vegetation; wear long sleeves and pants; wear appropriate close-toed footwear; use clear paths where possible; ensure experienced field personnel are present at all times;	3	1	3 (L)	Exit forested site during inclement weather; use GPS to track location; bring spare batteries for GPS; remain contactable by mobile phone.	Designated team leader for the project

3	Night works	Dangerous fauna, getting lost	Stings/bites/scratches, trips/slips/falls, head injury, feet injury, getting lost	Work in a group of at least 3 people; visually assess the surroundings for hornets/bees/snakes/dead branches/roots/protruding vegetation while walking; stamp feet and make loud noises when walking through thick vegetation; wear long sleeves and pants; wear appropriate close-toed footwear; use clear paths where possible; ensure experienced field personnel are present at all times; bring first aid kit; avoid areas where crocodiles have been	2	1	2 (L)	Use GPS to track location; bring spare batteries for GPS; remain contactable by mobile phone; bring spare batteries for torches/headlamps	Designated team leader for the project
4	Working at water edges	Falling into water	To trips/slips/falls, drowning	Work in a group of at least 2 people; wear appropriate close-toed footwear; avoid working near the edge of deep water; wear life vest if working near the edge of deep water is necessary.	4	1	4 (L)	Conduct works during low tide.	Designated team leader for the project
5	Working near steep slopes	Falling from slope	Injury from trips/slips/falls	Avoid steep slopes.	2	1	2 (L)	Avoid works during inclement weather.	Designated team leader for the project
6	Working outdoors	Lightning	Lightning strike	Stop all work activity and seek shelter when there is lightning.	5	1	5 (M)	Continue work at least 30 minutes after the last lightning strike; monitor NEA app for lightning activity.	Designated team leader for the project
7	Working outdoors	Heat	Heat sickness, heat stroke	Bring plenty of water; take regular breaks	2	1	2 (L)	Wear light-coloured clothings.	Designated team leader for the project
8	Collection of plant specimens	Use of secateurs	Cuts and injuries by improper use of secateurs	Be aware of cutting points; do not deviate attention when making cuts.	2	1	2 (L)	Wear gloves.	Designated team leader for the project

9	Bat trapping and handling of live bats	Sustaining accidental bat bites	Potential spread of unknown diseases	Put on full PPE (bite-resistant leather gloves, face masks) and receive pre-exposure rabies vaccination. Work in teams with at least three trained bat handlers. Minimise bat handling time. Avoid handling bats if there are open wounds on handler.	2	3	6 (M)	Bring field first aid kit (with iodine solution for immediate disinfection in the case of an accidental bite). Prepare emergency exit route to TTSH (hospital with post-exposure rabies vaccination). Prepare oral hydration salts and small syringes to feed and calm fruit bats down if they get overly stressed during handling and disentanglement.	Designated team leader for the project

CAMPHORA PTE LTD RISK ASSESSMENT

Severity	(1)	(2)	(3)	(4)	(5)
Catastrophic (5)	5 (M)	10 (M)	15 (H)	20 (H)	25 (H)
Major (4)	4 (M)	8 (M)	12 (M)	16 (H)	20 (H)
Moderate (3)	3 (L)	6 (M)	9 (M)	12 (M)	15 (H)
Minor (2)	2 (L)	4 (M)	6 (M)	8 (M)	10 (M)
Negligible (1)	1 (L)	2 (L)	3 (L)	4 (M)	5 (M)

H= High Risk, M = Medium risk, L = Low Risk

Likelihood	Description
Almost Certain 5	Continual or repeating experience.
Frequent 4	4 Common occurrences.
Occasional 3	Possible or known to occur.
Remote 2	Not likely to occur under normal circumstances.
Rare 1	Not expected to occur but still possible.

Severity	Description
Catastrophic 5	Fatality, fatal diseases or multiple major injuries.
Major 4	Serious injuries or life-threatening occupational disease (includes amputations, major fractures, multiple injuries, occupational cancer, acute poisoning).
Moderate 3	Injury requiring medical treatment or ill-health leading to disability (includes lacerations, burns, sprains, minor fractures, dermatitis, deafness, work-related upper limb disorders).
Minor 2	Injury or ill-health requiring first-aid only (includes minor cuts and bruises, irritation, ill-health with temporary discomfort).
Negligible 1	Not likely to cause injury or ill-health

Risk level	Risk Acceptability	Recommended actions
High Risk	Not acceptable	- High Risk level must be reduced to at least Medium Risk before work commences. - There should not be any interim risk control measures. Risk control measures should not be overly dependent on PPE or appliances. - If practicable, the hazard should be eliminated before work commences. - Management review is required before work commences.
Medium Risk	Tolerable	- A careful evaluation of the hazards should be carried out to ensure that the risk level is reduced to as low as reasonably practicable (ALARP) within a defined time period. - Interim risk control measures, such as administrative controls or PPE, may be implemented while longer term measures are being established. - Management attention is required.
Low Risk	Acceptable	- No additional risk control measures may be needed. - Frequent review and monitoring of hazards are required to ensure that the risk level assigned is accurate and does not increase overtime.

Contact Information			Remarks
Contact List Emergency Contacts Ambulance 995 Fire 995 Police 999 MINDEF TRMC Ops Room 6410 5333			
Team Contacts SN Role Name			
	Personnel title	Name	Contact no.
1	Project manager (OIC)	Ting Ying Ying	91907557
2	Project coordinator (2IC)	Shirlene Chiam	97733068
3	Project coordinator (2IC)	Sheryl Seet	96976288
4	Lead arborist	Derek Yap	9838 1751
5	Senior flora specialist	Boo Chih Min	9783 4814

Appendix D Flora Species List

Species	Family	Origin	Status	Habit
<i>Abelmoschus esculentus</i>	Malvaceae	Exotic	Cultivated Only	Shrub
<i>Acacia auriculiformis</i>	Fabaceae	Exotic	Naturalised	Tree
<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree
<i>Adinandra dumosa</i>	Pentaphylacaceae	Native	Common	Tree
<i>Alocasia macrorrhizos</i>	Araceae	Exotic	Naturalised	Herb
<i>Alpinia purpurata</i>	Zingiberaceae	Exotic	Cultivated Only	Herb
<i>Alsophila latebrosa</i>	Cyatheaceae	Native	Common	Tree
<i>Alternanthera sessilis</i>	Amaranthaceae	Cryptogenic	-	Herb
<i>Amaranthus blitum</i> ssp. <i>oleraceus</i>	Amaranthaceae	Exotic	Naturalised	Herb
<i>Amblovenatum opulentum</i>	Thelypteridaceae	Native	Common	Climber
<i>Ananas comosus</i>	Bromeliaceae	Exotic	Casual	Herb
<i>Andira inermis</i>	Fabaceae	Exotic	Casual	Tree
<i>Annona muricata</i>	Annonaceae	Exotic	Cultivated Only	Shrub
<i>Antidesma bunius</i>	Phyllanthaceae	Exotic	Casual	Tree
<i>Aphanamixis polystachya</i>	Meliaceae	Native	Common	Tree
<i>Aporosa falcifera</i>	Phyllanthaceae	Native	Critically Endangered	Tree
<i>Aporosa frutescens</i>	Phyllanthaceae	Native	Common	Tree
<i>Ardisia elliptica</i>	Primulaceae	Native	Common	Tree
<i>Aristolochia acuminata</i>	Aristolochiaceae	Exotic	Casual	Climber
<i>Arthrophyllum jackianum</i>	Araliaceae	Native	Common	Tree
<i>Artocarpus altilis</i>	Moraceae	Exotic	Casual	Tree
<i>Artocarpus heterophyllus</i>	Moraceae	Exotic	Casual	Tree
<i>Asplenium longissimum</i>	Aspleniaceae	Native	Common	Epiphyte
<i>Asplenium nidus</i>	Aspleniaceae	Native	Common	Epiphyte
<i>Asystasia gangetica</i> ssp. <i>micrantha</i>	Acanthaceae	Exotic	Naturalised	Herb
<i>Averrhoa carambola</i>	Oxalidaceae	Exotic	Casual	Tree
<i>Axonopus compressus</i>	Poaceae	Exotic	Naturalised	Herb
<i>Azadirachta indica</i>	Meliaceae	Exotic	Casual	Tree
<i>Baccaurea motleyana</i>	Phyllanthaceae	Native	Critically Endangered	Tree
<i>Baccaurea polyneura</i>	Phyllanthaceae	Native	Vulnerable	Tree
<i>Bambusa vulgaris</i>	Poaceae	Exotic	Casual	Shrub
<i>Bouea oppositifolia</i>	Anacardiaceae	Native	Critically Endangered	Tree
<i>Bromheadia finlaysoniana</i>	Orchidaceae	Native	Common	Herb
<i>Caladium bicolor</i>	Araceae	Exotic	Cultivated Only	Herb
<i>Calophyllum soulattri</i>	Calophyllaceae	Exotic	Not assessed	Tree
<i>Campnosperma auriculatum</i>	Anacardiaceae	Native	Common	Tree
<i>Capsicum annuum</i>	Caricaceae	Exotic	Cultivated Only	Shrub
<i>Carica papaya</i>	Caricaceae	Exotic	Casual	Tree
<i>Caryota mitis</i>	Arecaceae	Native	Common	Tree
<i>Cayratia mollissima</i>	Vitaceae	Native	Endangered	Climber
<i>Cecropia pachystachya</i>	Urticaceae	Exotic	Naturalised	Tree
<i>Celosia argentea</i>	Amaranthaceae	Exotic	Casual	Herb
<i>Cenchrus purpureus</i>	Poaceae	Exotic	Naturalised	Herb
<i>Centotheca lappacea</i>	Poaceae	Native	Common	Herb
<i>Champereia manillana</i>	Opiliaceae	Native	Common	Tree
<i>Christella dentata</i>	Thelypteridaceae	Native	Common	Herb
<i>Christella subpubescens</i>	Thelypteridaceae	Native	Common	Herb
<i>Cinnamomum iners</i>	Lauraceae	Native	Common	Tree
<i>Cissus hastata</i>	Vitaceae	Native	Common	Climber

Species	Family	Origin	Status	Habit
<i>Citrus maxima</i>	Rutaceae	Exotic	Cultivated Only	Tree
<i>Citrus x aurantiifolia</i>	Rutaceae	Exotic	Cultivated Only	Tree
<i>Claoxylon indicum</i>	Euphorbiaceae	Native	Common	Tree
<i>Clausena excavata</i>	Rutaceae	Native	Common	Shrub
<i>Clerodendrum villosum</i>	Lamiaceae	Native	Common	Shrub
<i>Clinacanthus nutans</i>	Acanthaceae	Exotic	Cultivated Only	Herb
<i>Codiaeum variegatum</i>	Euphorbiaceae	Exotic	Casual	Shrub
<i>Coleus monostachyus</i>	Lamiaceae	Exotic	Naturalised	Herb
<i>Colocasia esculenta</i>	Araceae	Exotic	Casual	Herb
<i>Crinum asiaticum</i>	Amaryllidaceae	Native	Critically Endangered	Herb
<i>Crotalaria retusa</i>	Fabaceae	Cryptogenic	-	Shrub
<i>Cucuma cultivar</i>	Zingiberaceae	Exotic	Cultivated Only	Herb
<i>Curculigo latifolia</i>	Hypoxidaceae	Native	Vulnerable	Herb
<i>Cymbopogon citratus</i>	Poaceae	Exotic	Cultivated Only	Herb
<i>Cyperus mindorensis</i>	Cyperaceae	Cryptogenic	-	Herb
<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree
<i>Davallia denticulata</i>	Davalliaceae	Native	Common	Epiphyte
<i>Dendrobium crumenatum</i>	Orchidaceae	Native	Common	Epiphyte
<i>Dieffenbachia seguine</i> var. <i>seguine</i>	Araceae	Exotic	Casual	Herb
<i>Dillenia suffruticosa</i>	Dilleniaceae	Native	Common	Shrub
<i>Dimocarpus lichi</i>	Sapindaceae	Native	Data Deficient	Tree
<i>Dioscorea hispida</i>	Dioscoreaceae	Native	Critically Endangered	Climber
<i>Diospyros blancoi</i>	Ebenaceae	Exotic	Cultivated Only	Tree
<i>Dracaena braunii</i>	Ruscaceae	Exotic	Cultivated Only	Shrub
<i>Dracaena fragrans</i>	Ruscaceae	Exotic	Casual	Shrub
<i>Dracaena reflexa</i>	Ruscaceae	Exotic	Cultivated Only	Shrub
<i>Drynaria quercifolia</i>	Polypodiaceae	Native	Common	Epiphyte
<i>Durio zibethinus</i>	Malvaceae	Exotic	Casual	Tree
<i>Elaeis guineensis</i>	Arecaceae	Exotic	Casual	Tree
<i>Elaeocarpus mastersii</i>	Elaeocarpaceae	Native	Common	Tree
<i>Elaeocarpus petiolatus</i>	Elaeocarpaceae	Native	Common	Tree
<i>Epipremnum aureum</i>	Araceae	Exotic	Casual	Climber
<i>Epipremnum pinnatum</i>	Araceae	Exotic	Naturalised	Climber
<i>Falcataria falcata</i>	Fabaceae	Exotic	Naturalised	Tree
<i>Ficus aurata</i>	Moraceae	Native	Common	Tree
<i>Ficus benamina</i>	Moraceae	Cryptogenic	-	Strangler
<i>Ficus fistulosa</i>	Moraceae	Native	Common	Tree
<i>Ficus grossularioides</i> var. <i>grossularioides</i>	Moraceae	Native	Common	Tree
<i>Ficus heteropleura</i>	Moraceae	Native	Common	Climber
<i>Ficus microcarpa</i>	Moraceae	Native	Common	Strangler
<i>Ficus punctata</i>	Moraceae	Native	Common	Climber
<i>Ficus variegata</i>	Moraceae	Native	Common	Tree
<i>Flagellaria indica</i>	Flagellariaceae	Native	Common	Climber
<i>Garcinia mangostana</i> var. <i>mangostana</i>	Clusiaceae	Exotic	Casual	Tree
<i>Gironniera nervosa</i>	Cannabaceae	Native	Common	Tree
<i>Gnetum gnemon</i> var. <i>gnemon</i>	Gnetaceae	Native	Critically Endangered	Tree
<i>Guioa pleuropteris</i>	Sapindaceae	Native	Common	Tree
<i>Gymnacranthera farquhariana</i> var. <i>farquhariana</i>	Myristicaceae	Native	Endangered	Tree
<i>Haplopteris ensiformis</i>	Vittariaceae	Native	Common	Epiphyte

Species	Family	Origin	Status	Habit
<i>Hedyotis diffusa</i>	Rubiaceae	Native	Common	Herb
<i>Heliconia psittacorum</i>	Heliconiaceae	Exotic	Casual	Herb
<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree
<i>Hibiscus rosa-sinensis</i>	Malvaceae	Exotic	Casual	Shrub
<i>Impatiens balsamina</i>	Balsaminaceae	Exotic	Cultivated Only	Herb
<i>Indorouchea griffithiana</i>	Linaceae	Native	Common	Climber
<i>Lansium domesticum</i>	Meliaceae	Exotic	Casual	Tree
<i>Leea indica</i>	Vitaceae	Native	Common	Tree
<i>Lepisanthes alata</i>	Sapindaceae	Exotic	Cultivated Only	Tree
<i>Licuala spinosa</i>	Arecaceae	Native	Common	Shrub
<i>Lindera lucida</i>	Lauraceae	Native	Vulnerable	Tree
<i>Lindernia diffusa</i>	Linderniaceae	Exotic	Not assessed	Herb
<i>Litsea elliptica</i>	Lauraceae	Native	Common	Tree
<i>Litsea umbellata</i>	Lauraceae	Native	Vulnerable	Tree
<i>Luffa cylindrica</i>	Cucurbitaceae	Exotic	Cultivated Only	Climber
<i>Lygodium flexuosum</i>	Schizaeaceae	Native	Common	Climber
<i>Macaranga bancana</i>	Euphorbiaceae	Native	Common	Tree
<i>Macaranga conifera</i>	Euphorbiaceae	Native	Common	Tree
<i>Macaranga gigantea</i>	Euphorbiaceae	Native	Common	Tree
<i>Macaranga heynei</i>	Euphorbiaceae	Native	Common	Tree
<i>Mallotus paniculatus</i>	Euphorbiaceae	Native	Common	Tree
<i>Mangifera × odorata</i>	Anacardiaceae	Exotic	Casual	Tree
<i>Mangifera indica</i>	Anacardiaceae	Exotic	Casual	Tree
<i>Manihot carthagenensis ssp. glaziovii</i>	Euphorbiaceae	Exotic	Naturalised	Tree
<i>Manilkara zapota</i>	Sapotaceae	Exotic	Cultivated Only	Tree
<i>Megathyrsus maximus</i>	Poaceae	Exotic	Naturalised	Herb
<i>Melastoma malabathricum</i>	Melastomataceae	Native	Common	Tree
<i>Miconia crenata</i>	Melastomataceae	Exotic	Naturalised	Shrub
<i>Microlepis speluncae</i>	Dennstaedtiaceae	Native	Vulnerable	Herb
<i>Mimusops elengi</i>	Sapotaceae	Exotic	Casual	Tree
<i>Morinda citrifolia</i>	Rubiaceae	Native	Common	Tree
<i>Moringa oleifera</i>	Moringaceae	Exotic	Cultivated Only	Tree
<i>Morus alba</i>	Moraceae	Exotic	Cultivated Only	Tree
<i>Musa cultivar</i>	Musaceae	Exotic	Not assessed	Herb
<i>Myristica fragrans</i>	Myristicaceae	Exotic	Cultivated Only	Tree
<i>Neolitsea cassia</i>	Lauraceae	Native	Common	Tree
<i>Nephelium lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree
<i>Nephrolepis biserrata</i>	Oleandraceae	Native	Common	Herb
<i>Ochna kirkii</i>	Ochnaceae	Exotic	Naturalised	Shrub
<i>Ocimum tenuiflorum</i>	Lamiaceae	Cryptogenic	-	Herb
<i>Ottochloa nodosa</i>	Poaceae	Native	Common	Herb
<i>Oxyceros longiflorus</i>	Rubiaceae	Native	Common	Climber
<i>Pandanus amaryllifolius</i>	Pandanaceae	Exotic	Casual	Shrub
<i>Passiflora foetida</i>	Passifloraceae	Exotic	Naturalised	Climber
<i>Passiflora laurifolia</i>	Passifloraceae	Exotic	Naturalised	Climber
<i>Peperomia pellucida</i>	Piperaceae	Exotic	Naturalised	Herb
<i>Philodendron erubescens</i>	Araceae	Exotic	Cultivated Only	Climber
<i>Piper betle</i>	Piperaceae	Exotic	Casual	Climber
<i>Piper crassipes</i>	Piperaceae	Native	Common	Climber

Species	Family	Origin	Status	Habit
<i>Piper sarmentosum</i>	Piperaceae	Native	Common	Climber
<i>Pipturus argenteus</i>	Urticaceae	Cryptogenic	-	Shrub
<i>Planchonella obovata</i>	Sapotaceae	Native	Common	Tree
<i>Podocarpus rumphii</i>	Podocarpaceae	Exotic	Cultivated Only	Tree
<i>Pseuderanthemum atropurpureum</i>	Acanthaceae	Exotic	Cultivated Only	Shrub
<i>Pseuderanthemum reticulatum</i>	Acanthaceae	Exotic	Cultivated Only	Shrub
<i>Psychotria polycarpa</i>	Rubiaceae	Native	Critically Endangered	Climber
<i>Ptychosperma macarthurii</i>	Arecaceae	Exotic	Naturalised	Tree
<i>Punica granatum</i>	Lythraceae	Exotic	Cultivated Only	Shrub
<i>Pyrrosia piloselloides</i>	Polypodiaceae	Native	Common	Epiphyte
<i>Saccharum officinarum</i>	Poaceae	Exotic	Casual	Herb
<i>Samanea saman</i>	Fabaceae	Exotic	Casual	Tree
<i>Sanchezia speciosa</i>	Acanthaceae	Exotic	Cultivated Only	Shrub
<i>Saribus rotundifolius</i>	Arecaceae	Exotic	Casual	Tree
<i>Scleria ciliaris</i>	Cyperaceae	Native	Common	Herb
<i>Scoparia dulcis</i>	Scrophulariaceae	Exotic	Naturalised	Herb
<i>Solanum melongena</i>	Solanaceae	Exotic	Cultivated Only	Herb
<i>Solanum torvum</i>	Solanaceae	Exotic	Naturalised	Shrub
<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree
<i>Sphaerostephanos heterocarpus</i>	Thelypteridaceae	Native	Common	Herb
<i>Stenochlaena palustris</i>	Blechnaceae	Native	Common	Climber
<i>Sterculia cordata</i>	Malvaceae	Native	Critically Endangered	Tree
<i>Sterculia parviflora</i>	Malvaceae	Native	Critically Endangered	Tree
<i>Strobilanthes reptans</i>	Acanthaceae	Exotic	Naturalised	Shrub
<i>Syngonium angustatum</i>	Araceae	Exotic	Naturalised	Climber
<i>Syzygium aqueum</i>	Myrtaceae	Exotic	Cultivated Only	Tree
<i>Syzygium borneense</i>	Myrtaceae	Native	Common	Tree
<i>Syzygium cerasiforme</i>	Myrtaceae	Native	Common	Tree
<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree
<i>Syzygium jambos</i>	Myrtaceae	Exotic	Casual	Tree
<i>Syzygium malaccense</i>	Myrtaceae	Exotic	Casual	Tree
<i>Syzygium myrtifolium</i>	Myrtaceae	Native	Critically Endangered	Tree
<i>Syzygium polyanthum</i>	Myrtaceae	Native	Common	Tree
<i>Tabebuia rosea</i>	Bignoniaceae	Exotic	Casual	Tree
<i>Tagetes erecta</i>	Asteraceae	Exotic	Casual	Herb
<i>Tamarindus indica</i>	Fabaceae	Exotic	Casual	Tree
<i>Terminalia catappa</i>	Combretaceae	Native	Common	Tree
<i>Theobroma cacao</i>	Malvaceae	Exotic	Cultivated Only	Tree
<i>Thyrsostachys siamensis</i>	Poaceae	Exotic	Casual	Shrub
<i>Timonius wallichianus</i>	Rubiaceae	Native	Common	Tree
<i>Tinospora crispa</i>	Menispermaceae	Exotic	Casual	Climber
<i>Triadica cochinchinensis</i>	Euphorbiaceae	Native	Common	Tree
<i>Vigna unguiculata</i>	Fabaceae	Exotic	Casual	Herb
<i>Vitex pinnata</i>	Lamiaceae	Native	Common	Tree
<i>Vitis vinifera</i>	Vitaceae	Exotic	Cultivated Only	Climber
<i>Xanthosoma sagittifolium</i>	Araceae	Exotic	Cultivated Only	Herb
<i>Youngia japonica</i>	Asteraceae	Exotic	Naturalised	Herb
<i>Zingiber officinale</i>	Zingiberaceae	Exotic	Cultivated Only	Herb

Appendix E

List and Location of Plant Species of Conservation Significance

Species	Family	Origin	Status	Habit	Northing	Easting	Girth/ spread (m)	Height (m)
Aporosa falcifera	Phyllanthaceae	Native	Critically Endangered	Tree	46648.59755	21167.94648	0.05	2.5
Baccaurea polyneura	Phyllanthaceae	Native	Vulnerable	Tree	46847.07801	21232.94205	< 0.05	0.3
Baccaurea polyneura	Phyllanthaceae	Native	Vulnerable	Tree	46840.266	21230.456	1.1	16
Bouea oppositifolia	Anacardiaceae	Native	Critically Endangered	Tree	46778.52	21282.462	0.2	4
Curculigo latifolia	Hypoxidaceae	Native	Vulnerable	Herb	46864.9913	21228.046	-	-
Dioscorea hispida	Dioscoreaceae	Native	Critically Endangered	Climber	46807.38391	21145.8051	-	-
Dioscorea hispida	Dioscoreaceae	Native	Critically Endangered	Climber	46772.88227	21228.59997	-	-
Dioscorea hispida	Dioscoreaceae	Native	Critically Endangered	Climber	46805.8341	21157.71252	-	-
<i>Gymnacranthera farquhariana</i> var. <i>farquhariana</i>	Myristicaceae	Native	Endangered	Tree	46755.51995	21305.6085	0.1-0.15	2.5-5
<i>Gymnacranthera farquhariana</i> var. <i>farquhariana</i>	Myristicaceae	Native	Endangered	Tree	46807.38	21292.03314	0.2	4
<i>Gymnacranthera farquhariana</i> var. <i>farquhariana</i>	Myristicaceae	Native	Endangered	Tree	46776.97197	21288.02609	0.1	4
<i>Gymnacranthera farquhariana</i> var. <i>farquhariana</i>	Myristicaceae	Native	Endangered	Tree	46806.93755	21297.81993	0.1	4
<i>Gymnacranthera farquhariana</i> var. <i>farquhariana</i>	Myristicaceae	Native	Endangered	Tree	46778.741	21285.244	0.4	8
Lindera lucida	Lauraceae	Native	Vulnerable	Tree	46714.05768	21178.85414	0.1	2
Lindera lucida	Lauraceae	Native	Vulnerable	Tree	46764.03845	21147.4732	0.1	2
Lindera lucida	Lauraceae	Native	Vulnerable	Tree	46724.56238	21176.18359	0.2	3
Lindera lucida	Lauraceae	Native	Vulnerable	Tree	46681.32716	21190.53815	<0.05	1
Lindera lucida	Lauraceae	Native	Vulnerable	Tree	46717.59613	21177.07368	0.1	3
Lindera lucida	Lauraceae	Native	Vulnerable	Tree	46769.67708	21173.18011	0.05	1.8
Lindera lucida	Lauraceae	Native	Vulnerable	Tree	46688.17	21172.13	0.5	10
Lindera lucida	Lauraceae	Native	Vulnerable	Tree	46692.82	21196.66	0.8	10
Lindera lucida	Lauraceae	Native	Vulnerable	Tree	46674.57	21216.19	0.6	8
Lindera lucida	Lauraceae	Native	Vulnerable	Tree	46900.41	21282.06	0.7	16
Lindera lucida	Lauraceae	Native	Vulnerable	Tree	46786.06	21187.49	1.1	18
Lindera lucida	Lauraceae	Native	Vulnerable	Tree	46781.06661	21162.16324	0.3	5
Lindera lucida	Lauraceae	Native	Vulnerable	Tree	46731.66	21161.8	0.8	16
Lindera lucida	Lauraceae	Native	Vulnerable	Tree	46834.25004	21180.97178	0.4	10
Litsea umbellata	Lauraceae	Native	Vulnerable	Tree	46781.066	21166.503	0.05	1
Litsea umbellata	Lauraceae	Native	Vulnerable	Tree	46687.851	21183.973	0.05	2
Litsea umbellata	Lauraceae	Native	Vulnerable	Tree	46647.712	21191.316	0.2	1.5
Litsea umbellata	Lauraceae	Native	Vulnerable	Tree	46722.24	21175.182	< 0.05	0.5
Litsea umbellata	Lauraceae	Native	Vulnerable	Tree	46783.942	21143.579	0.05	2
Microlepidia speluncae	Dennstaedtiaceae	Native	Vulnerable	Herb	46774.652	21225.039	-	-
Microlepidia speluncae	Dennstaedtiaceae	Native	Vulnerable	Herb	46776.863	21212.575	-	-
Microlepidia speluncae	Dennstaedtiaceae	Native	Vulnerable	Herb	46811.142	21200.669	-	-
Microlepidia speluncae	Dennstaedtiaceae	Native	Vulnerable	Herb	46822.31	21198.554	-	-
Microlepidia speluncae	Dennstaedtiaceae	Native	Vulnerable	Herb	46834.363	21193.658	-	-
Microlepidia speluncae	Dennstaedtiaceae	Native	Vulnerable	Herb	46852.275	21225.709	-	-
Microlepidia speluncae	Dennstaedtiaceae	Native	Vulnerable	Herb	46832.15	21241.622	-	-
Microlepidia speluncae	Dennstaedtiaceae	Native	Vulnerable	Herb	46848.072	21261.097	-	-
Microlepidia speluncae	Dennstaedtiaceae	Native	Vulnerable	Herb	46793.226	21295.037	-	-
Psychotria polycarpa	Rubiaceae	Native	Critically Endangered	Climber	46707.53405	21168.05935	-	-
Psychotria polycarpa	Rubiaceae	Native	Critically Endangered	Climber	46710.18745	21182.86028	-	-
Psychotria polycarpa	Rubiaceae	Native	Critically Endangered	Climber	46692.38588	21145.13429	-	-
Psychotria polycarpa	Rubiaceae	Native	Critically Endangered	Climber	46698.02536	21139.79278	-	-
Psychotria polycarpa	Rubiaceae	Native	Critically Endangered	Climber	46702.55876	21146.24741	-	-
Psychotria polycarpa	Rubiaceae	Native	Critically Endangered	Climber	46714.72119	21176.73975	-	-
Psychotria polycarpa	Rubiaceae	Native	Critically Endangered	Climber	46724.56238	21176.18359	-	-
Psychotria polycarpa	Rubiaceae	Native	Critically Endangered	Climber	46681.32716	21190.53815	-	-
Psychotria polycarpa	Rubiaceae	Native	Critically Endangered	Climber	46717.59613	21177.07368	-	-
Psychotria polycarpa	Rubiaceae	Native	Critically Endangered	Climber	46736.505	21169.284	-	-

Appendix F List and Location of Large Plant Specimens

Tree ID	Species	Family	Origin	Status	Habit	Northing	Easting	Girth/ spread (m)	Height (m)	Remarks
WC097	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46650.3	21176.59	3	20	
WC077	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46665.06	21173.02	3	20	
WC087	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46707.75	21186.73	3.4	25	
WC098	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46642.91	21189.33	3	22	
WC086	<i>Ficus microcarpa</i>	Moraceae	Native	Common	Strangler	46698.34	21184.85	6	25	
WC146	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46720.02	21302.8	3.2	20	
WC305	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46716.23	21313.99	3	18	
WC309	<i>Ficus benjamina</i>	Moraceae	Cryptogenic	-	Strangler	46758.9	21288.92	15	20	
WC319	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46728.4	21345.74	3	18	
WC327	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46732.07	21342.59	3	18	
WC336	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46751.23	21348.4	3	18	
WC301A	<i>Samanea saman</i>	Fabaceae	Exotic	Casual	Tree	46734.12	21392.54	3.4	16	
WC323	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46731.38	21349.43	3	20	
WC301B	<i>Tabebuia rosea</i>	Bignoniaceae	Exotic	Casual	Tree	46748.62	21395.79	3.2	15	
WC187	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46840.44	21360.73	4	20	
WC185	<i>Mangifera indica</i>	Anacardiaceae	Exotic	Casual	Tree	46826.68	21357.13	3.2	16	
WC167	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46833.72	21294.88	4	20	
WC193	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46867.7	21337.39	3.5	18	
WC214	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46878.27	21307.69	3	18	
WC206	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46856.11	21296.32	3	20	
WC212	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46879.62	21305.54	4	18	
WC175	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46833.39	21291.13	3.4	20	
WC367	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46793.75	21270.64	3	20	
WC437A	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46758.89	21137.16	3.5	18	
WC451	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46716.97	21142.45	3	15	
WC431	<i>Ficus microcarpa</i>	Moraceae	Native	Common	Strangler	46787.05	21134.1	3	18	
WC465	<i>Falcataria falcata</i>	Fabaceae	Exotic	Naturalised	Tree	46814.28	21132.19	3	30	
WC482	<i>Ficus microcarpa</i>	Moraceae	Native	Common	Strangler	46857.14	21157.01	15	20	

Appendix G

List and Location of Other Specimens of Value

Species	Family	Origin	Status	Habit	Northing	Easting	Girth/ spread (m)	Height (m)	Remarks
<i>Bambusa vulgaris</i>	Poaceae	Exotic	Casual	Shrub	46878.483	21170.512	0.4	4	
<i>Thyrsostachys siamensis</i>	Poaceae	Exotic	Casual	Shrub	46875.498	21168.286	0.4	5	

Appendix H

List of Mapped Trees Specimens in the Study Area

Tree ID	Species	Family	Origin	Status	Habit	Northing	Easting	Girth/ spread (m)	Height (m)	Remarks
CE1477	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46632.4538	21159.2658	1	16	
CE1478	<i>Vitex pinnata</i>	Lamiaceae	Native	Common	Tree	46636.5458	21133.4479	1	14	
CE1479	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46679.7807	21133.0039	1	14	
CE1480	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46681.7702	21164.1637	1	18	
CE1481	<i>Macaranga gigantea</i>	Euphorbiaceae	Native	Common	Tree	46664.4086	21211.4592	1	12	
CE1482	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46656.7789	21214.0186	1.1	16	
CE1483	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46647.7123	21191.3162	1	16	
WC038	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46650.31	21129.65	2.8	14	
WC039	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46627.12	21172.71	1.3	16	
WC040	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46627.91	21166.18	1.8	15	
WC041	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46629.36	21171.11	1.2	16	
WC042	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46627.36	21160.37	1.6	18	
WC043	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46629.44	21151.16	1.6	16	
WC044	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46629.51	21146.49	1.3	15	
WC044A	<i>Elaeis guineensis</i>	Arecaceae	Exotic	Casual	Tree	46627.66	21145.33	2.5	10	
WC044B	<i>Elaeis guineensis</i>	Arecaceae	Exotic	Casual	Tree	46634.3	21147.38	2.5	10	
WC044C	<i>Elaeis guineensis</i>	Arecaceae	Exotic	Casual	Tree	46630.65	21140.9	2.5	10	
WC045	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46634.04	21132.97	2	17	
WC045A	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46627.37	21144.13	2.4	18	
WC046	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46650.48	21141.76	2	18	
WC046A	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46661.08	21140.05	1.8	16	
WC047	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46652.79	21140.35	1.6	19	
WC048	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46655.23	21135.79	1.1	20	
WC049	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46666.74	21150.08	2.2	20	
WC050	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46664.9	21139.99	1.3	18	
WC051	<i>Vitex pinnata</i>	Lamiaceae	Native	Common	Tree	46671.85	21139.31	1.5	18	
WC051A	<i>Macaranga gigantea</i>	Euphorbiaceae	Native	Common	Tree	46685.3	21134.29	1.4	12	
WC052	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46689.61	21139.64	1.8	20	
WC053	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46689.72	21138.86	1.1	20	
WC054	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46690.72	21140.75	2.5	25	
WC055	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46698.24	21143.42	2.6	25	
WC057	<i>Adinandra dumosa</i>	Pentaphylacaceae	Native	Common	Tree	46675.9	21145.65	1.8	17	
WC058	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46676.23	21147.65	1.4	20	
WC059	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46677.23	21150.88	1.2	18	
WC060	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46674.68	21153.99	2	20	
WC061	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46671.48	21143.75	2.2	20	
WC062	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46651.35	21147.43	1.6	20	
WC063	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46649.8	21148.09	1.1	20	
WC064	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46649.92	21148.43	1.2	20	
WC065	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46649.14	21149.98	1.2	20	
WC066	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46650.36	21150.21	1.2	18	
WC067	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46645.82	21152.54	1.5	20	
WC068	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46638.08	21162.11	1.3	18	
WC069	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46642.73	21166.23	1.2	17	
WC070	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46645.6	21166.01	1.3	20	
WC071	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46654.45	21168.12	1.3	20	
WC072	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46654.34	21168.46	1.1	20	
WC073	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46654.56	21163.45	1.3	20	
WC076	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46665.73	21170.02	1.2	20	
WC077	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46665.06	21173.02	3	20	
WC078	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46682.76	21172.13	1.6	20	
WC079	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46682.53	21173.24	1.4	16	
WC080	<i>Lindera lucida</i>	Lauraceae	Native	Vulnerable	Tree	46688.17	21172.13	0.5	10	
WC081	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46690.05	21170.13	1.3	20	
WC082	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46695.86	21159.03	1.3	20	
WC083	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46692.94	21159.18	1	18	
WC084	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46696.61	21151.89	1.2	25	
WC085	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46696.44	21170.58	1	25	
WC086	<i>Ficus microcarpa</i>	Moraceae	Native	Common	Strangler	46698.34	21184.85	6	25	
WC087	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46707.75	21186.73	3.4	25	
WC088	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46695.6	21184.44	1.8	20	
WC089	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46694.87	21183.87	2	25	
WC090	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46697.85	21182.45	1.5	20	
WC091	<i>Lindera lucida</i>	Lauraceae	Native	Vulnerable	Tree	46692.82	21196.66	0.8	10	
WC092	<i>Macaranga gigantea</i>	Euphorbiaceae	Native	Common	Tree	46695.04	21190.62	1.3	18	
WC093	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46677.26	21195.09	1.8	20	
WC094	<i>Campnosperma auriculatum</i>	Anacardiaceae	Native	Common	Tree	46669.99	21187.35	1.3	25	
WC095	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46655.37	21181.19	1.8	20	
WC096	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46649.43	21182.13	1.3	20	
WC097	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46650.3	21176.59	3	20	
WC098	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46642.91	21189.33	3	22	
WC099	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46650.38	21195.89	1.3	20	
WC100	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46657.13	21196.29	1.3	20	
WC101	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46650.35	21192.73	1.3	18	
WC102	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46649.75	21197.9	1.3	18	
WC103	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46654.61	21191.45	1.5	20	
WC104	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46654.04	21195.27	1.4	20	
WC105	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46676.16	21194.41	1.8	22	
WC106	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46675.54	21199.5	1.6	22	
WC107	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46666.39	21198.38	1.8	25	

Tree ID	Species	Family	Origin	Status	Habit	Northing	Easting	Girth/ spread (m)	Height (m)	Remarks
WC108	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46661.08	21211.32	1.3	18	
WC109	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46667.54	21207.62	1.3	18	
WC110	<i>Lindera lucida</i>	Lauraceae	Native	Vulnerable	Tree	46674.57	21216.19	0.6	8	
WC111	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46672.47	21218.52	2.4	20	
WC421	<i>Vitex pinnata</i>	Lamiaceae	Native	Common	Tree	46711.72	21180.65	1	18	
WC457	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46705.96	21159.25	1.1	18	
SN1409	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46675.2444	21231.7133	1	16	
SN1410	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46679.4464	21228.4862	1	7	
SN1412	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46735.7278	21274.7821	1	12	
SN1413	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46735.8383	21277.3417	1	12	
SN1416	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46723.8955	21303.6045	1.2	16	
SN1417	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46714.6078	21282.6828	1	15	
WC112	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46675.46	21226.86	1.1	16	
WC113	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46677.95	21234.33	1.4	14	
WC114	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46678.72	21235.68	1.8	16	
WC115	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46687.57	21239.23	1.8	18	
WC116	<i>Macaranga gigantea</i>	Euphorbiaceae	Native	Common	Tree	46683.44	21234.34	1.8	12	
WC117	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46697.53	21209.27	1.6	20	
WC118	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46715.53	21204.75	2.2	20	
WC119	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46709.11	21207.91	2	18	
WC119A	<i>Elais guineensis</i>	Arecaceae	Exotic	Casual	Tree	46727.82	21205.07	2.5	10	
WC120	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46728.92	21202.35	2	18	
WC122	<i>Andira inermis</i>	Fabaceae	Exotic	Casual	Tree	46712.83	21213.11	1.3	18	
WC123	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46708.15	21228.32	1.6	18	
WC123A	<i>Elais guineensis</i>	Arecaceae	Exotic	Casual	Tree	46692.48	21247.15	2.5	9	
WC125	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46704.81	21254.17	2.2	16	
WC127	<i>Ficus microcarpa</i>	Moraceae	Native	Common	Strangler	46718.49	21252.6	1.2	16	
WC128	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46715.21	21248.26	1.8	18	
WC129	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46726.41	21239.83	2	20	
WC131	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46707.69	21263.98	2.1	18	
WC132	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46723.06	21276.75	2.2	16	
WC133	<i>Baccaurea motleyana</i>	Phyllanthaceae	Native	Critically End	Tree	46719.34	21274.24	1.8	16	
WC134	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46720.23	21283.63	1.6	15	
WC135	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46719.06	21279.3	2	18	
WC136	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46721.71	21281.27	2.4	18	
WC137	<i>Durio zibethinus</i>	Malvaceae	Exotic	Casual	Tree	46733.31	21278.97	2.2	18	
WC138	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46735.68	21278.08	1	18	
WC139	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46739.38	21259.81	1	15	
WC141	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46741.5	21283.86	1.4	14	
WC142	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46751.58	21284.55	1.4	20	
WC143	<i>Cinnamomum iners</i>	Lauraceae	Native	Common	Tree	46748.98	21280.87	1.1	15	
WC144	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46754.94	21276.75	1.3	15	
WC145	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46723.96	21289.18	1.3	18	
WC146	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46720.02	21302.8	3.2	20	
WC147	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46717.82	21300.64	1.6	20	
WC148	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46713.73	21302.27	1.4	20	
WC149	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46714.65	21295.9	1.1	15	
WC301	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46724.24	21308.27	1.2	16	
WC302	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46720.72	21302.24	1.4	18	
WC303	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46718.71	21304.84	1.3	18	
WC304	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46713.54	21321.01	1.3	18	
WC305	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46716.23	21313.99	3	18	
WC306	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46719.17	21312.41	1.3	18	
WC307	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46729.41	21305.6	2	18	
WC308	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46740.18	21303.63	1.8	18	
WC309	<i>Ficus benjamina</i>	Moraceae	Cryptogenic	-	Strangler	46758.9	21288.92	15	20	
WC310	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46748.27	21311.47	1.3	18	
WC407	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46747.73	21252.46	1.1	12	
WC408A	<i>Elais guineensis</i>	Arecaceae	Exotic	Casual	Tree	46724.54	21214.71	1.5	12	
HE4853	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46777.1912	21359.2483	1	12	
HE4854	<i>Claoxylon indicum</i>	Euphorbiaceae	Native	Common	Tree	46783.716	21334.766	1.2	12	
HE4855	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46762.7069	21322.524	1	15	
HE4856	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46752.4226	21353.906	1.4	16	
WC150	<i>Andira inermis</i>	Fabaceae	Exotic	Casual	Tree	46803.09	21343.97	1.8	12	
WC151	<i>Andira inermis</i>	Fabaceae	Exotic	Casual	Tree	46806.45	21357.38	1	5	
WC152	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46806.89	21357.69	1.7	16	
WC301A	<i>Samanea saman</i>	Fabaceae	Exotic	Casual	Tree	46734.12	21392.54	3.4	16	
WC301B	<i>Tabebuia rosea</i>	Bignoniaceae	Exotic	Casual	Tree	46748.62	21395.79	3.2	15	
WC301C	<i>Tabebuia rosea</i>	Bignoniaceae	Exotic	Casual	Tree	46762.14	21412.34	2.2	15	
WC301D	<i>Tabebuia rosea</i>	Bignoniaceae	Exotic	Casual	Tree	46762.43	21413.14	2.2	15	
WC301E	<i>Tabebuia rosea</i>	Bignoniaceae	Exotic	Casual	Tree	46766.99	21412.64	2.4	15	
WC301F	<i>Tabebuia rosea</i>	Bignoniaceae	Exotic	Casual	Tree	46777.09	21413.38	2.2	15	
WC311	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46748.7	21321.85	1	18	
WC312	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46734.81	21322.29	1.1	16	
WC313	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46728.49	21321.6	1.1	18	
WC314	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46716.95	21330.38	2	18	
WC316	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46720.02	21335.74	1.4	15	
WC317	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46725.84	21334.64	2.5	16	
WC317A	<i>Elais guineensis</i>	Arecaceae	Exotic	Casual	Tree	46721.22	21343.02	1	16	
WC318	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46718.14	21338.73	1.2	18	

Tree ID	Species	Family	Origin	Status	Habit	Northing	Easting	Girth/ spread (m)	Height (m)	Remarks
WC318A	<i>Elaeis guineensis</i>	Arecaceae	Exotic	Casual	Tree	46720.5	21355.61	1.6	16	
WC319	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46728.4	21345.74	3	18	
WC320	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46729.97	21349.03	1	8	
WC321	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46729.36	21352.67	1.8	18	
WC322	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46731.38	21346.24	1.3	18	
WC323	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46731.38	21349.43	3	20	
WC324	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46732.62	21350.26	1.1	15	
WC325	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46732.41	21351.5	1.6	18	
WC326	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46740.8	21337.11	2	18	
WC327	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46732.07	21342.59	3	18	
WC328	<i>Mangifera indica</i>	Anacardiaceae	Exotic	Casual	Tree	46749.19	21347.4	1.1	12	
WC329	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46737.63	21355.63	2	18	
WC330	<i>Durio zibethinus</i>	Malvaceae	Exotic	Casual	Tree	46752.25	21356.57	2.2	18	
WC331	<i>Durio zibethinus</i>	Malvaceae	Exotic	Casual	Tree	46750.12	21358.53	1.8	18	
WC332	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46750.15	21365.99	1.2	18	
WC334	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46759.96	21359.72	2.4	16	
WC335	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46750.59	21349.46	1.7	18	
WC336	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46751.23	21348.4	3	18	
WC337	<i>Tamarindus indica</i>	Fabaceae	Exotic	Casual	Tree	46768.87	21322.86	2.5	18	
WC338	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46765.85	21321.31	2.6	18	
WC339	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46769.06	21318.62	1.3	16	
WC340	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46767.46	21320.5	1.2	16	
WC341	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46770.94	21326.01	2	16	
WC342	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46772.06	21329.87	1.2	18	
WC343	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46774.42	21342.36	1.3	16	
WC344	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46777.77	21342.77	1.3	16	
WC345	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46782.97	21344.48	1	16	
WC346	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46777.67	21350.06	1.1	14	
WC347	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46781.38	21344.12	1.3	18	
WC348	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46770.22	21351.03	1	12	
WC349	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46785.9	21347.12	1.2	16	
WC350	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46789.73	21349.56	1.8	14	
WC351	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46788.2	21353.72	1.7	14	
WC352	<i>Claoxylon indicum</i>	Euphorbiaceae	Native	Common	Tree	46789.7	21350.61	1.3	10	
WC353	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46788.18	21352.4	1.1	18	
WC354	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46797.28	21352.33	1	18	
WC355	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46797.15	21356.36	1.6	18	
WC356	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46794.49	21352.77	1	12	
WC357	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46795.75	21332.99	2.5	18	
CE1587	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46835.4655	21312.2877	1.2	12	
CE1588	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46869.0795	21342.6693	1.3	10	
CE1589	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46882.9021	21317.9645	1.1	11	
CE1590	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46882.7917	21310.8422	1.1	6	
WC153	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46813.13	21352.97	1.2	16	
WC154	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46813.22	21353.93	2	16	
WC155	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46812.47	21341.84	1.3	20	
WC156	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46815.52	21331.3	1.1	20	
WC157	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46819.73	21330.77	1.6	20	
WC158	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46820.37	21327.81	2.4	20	
WC159	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46815.91	21322.14	1.1	16	
WC160	<i>Andira inermis</i>	Fabaceae	Exotic	Casual	Tree	46812.38	21320.33	1.3	20	
WC161	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46802.6	21318.63	1.4	18	
WC162	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46806.94	21312.23	1.8	10	
WC163	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46813.4	21311.71	2	20	
WC164	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46824.53	21317.33	1.3	20	
WC165	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46822.21	21316.5	2.8	20	
WC166	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46827.12	21313.02	1	20	
WC167	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46833.72	21294.88	4	20	
WC170	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46816.8	21294.05	1.6	20	
WC176	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46833.89	21302.51	2	18	
WC177	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46837.49	21306.98	1.1	16	
WC178	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46835.01	21305.87	2	20	
WC179	<i>Macaranga gigantea</i>	Euphorbiaceae	Native	Common	Tree	46836.59	21308.12	1.8	20	
WC180	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46829.78	21316.05	2.2	20	
WC181	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46825.04	21327.45	2	18	
WC182	<i>Mangifera indica</i>	Anacardiaceae	Exotic	Casual	Tree	46819.57	21337.23	2	20	
WC183	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46826.82	21338.54	2	18	
WC184	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46819.57	21346.05	1	16	
WC185	<i>Mangifera indica</i>	Anacardiaceae	Exotic	Casual	Tree	46826.68	21357.13	3.2	16	
WC186	<i>Andira inermis</i>	Fabaceae	Exotic	Casual	Tree	46843.29	21358.18	1.4	20	
WC187	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46840.44	21360.73	4	20	
WC188	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46845.99	21353.79	2.5	20	
WC189	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46845.7	21347.1	1.2	20	
WC190	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46849.58	21346.7	1.8	18	
WC191	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46853.5	21341.5	1.7	18	
WC193	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46867.7	21337.39	3.5	18	
WC194	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46847.48	21333.13	1.4	20	
WC195	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46836.78	21345.41	1.6	20	
WC197	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46844.25	21330.38	2.8	20	
WC198	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46857.67	21334.91	1.3	16	

Tree ID	Species	Family	Origin	Status	Habit	Northing	Easting	Girth/ spread (m)	Height (m)	Remarks
WC199	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46857.83	21329.32	1.4	20	
WC200	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46854.07	21342.78	1	20	
WC201	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46859.85	21322.85	1	20	
WC202	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46863.54	21317.41	1.3	18	
WC203	<i>Macaranga gigantea</i>	Euphorbiaceae	Native	Common	Tree	46843.08	21301.09	2.6	20	
WC204	<i>Macaranga gigantea</i>	Euphorbiaceae	Native	Common	Tree	46838.11	21307.06	1.2	16	
WC205	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46841.22	21301.68	2.6	20	
WC207	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46848.57	21301.1	1.1	16	
WC208	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46848.84	21312.68	1.6	20	
WC209	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46854.5	21300.66	1.2	20	
WC211	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46871.73	21306.48	1.6	20	
WC213	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46867.32	21305.36	1	18	
WC214	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46878.27	21307.69	3	18	
WC215	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46875.85	21312.6	1	8	
WC216	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46875.73	21308.14	1.2	16	
CCK419	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46854.4898	21263.3229	1.2	14	
CCK421	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46886.1135	21254.421	1.2	16	
CCK422	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46871.8496	21253.9755	1.2	14	
CCK423	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46887.8839	21248.4117	1.2	10	
CCK424	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46893.4077	21251.3052	1	14	
CCK425	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46881.682	21300.0476	1	14	
CCK426	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46877.1496	21308.5051	1	16	
CCK427	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46873.943	21297.8217	1.2	14	
CCK428	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46863.9981	21298.3779	1	14	
WC206	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46856.11	21296.32	3	20	
WC210	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46862.74	21292.24	1.4	22	
WC212	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46879.62	21305.54	4	18	
WC217	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46886.34	21303.185	1.1	14	
WC218	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46885.179	21301.384	2.5	15	
WC219	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46904.086	21307.895	2	16	
WC220	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46906.13	21295.182	1.6	15	
WC221	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46911.942	21294.185	1.2	20	
WC222	<i>Andira inermis</i>	Fabaceae	Exotic	Casual	Tree	46914.934	21289.843	1.4	13	
WC224	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46911.067	21284.633	2.4	18	
WC225	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46908.108	21286.816	1.4	18	
WC226	<i>Lindera lucida</i>	Lauraceae	Native	Vulnerable	Tree	46900.41	21282.06	0.7	16	
WC227	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46895.73	21292.173	1.3	15	
WC228	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46896.547	21294.824	1	12	
WC229	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46907.415	21270.982	2.7	18	
WC230	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46886.1	21277.595	1.4	17	
WC231	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46883.919	21282.503	2.9	18	
WC232	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46880.291	21282.753	1	17	
WC233	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46883.209	21268.527	1.3	16	
WC234	<i>Mangifera</i> × <i>odorata</i>	Anacardiaceae	Exotic	Casual	Tree	46883.812	21262.143	1.5	14	
WC235	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46886.036	21260.786	1.3	14	
WC236	<i>Dimocarpus lichi</i>	Sapindaceae	Native	Data Deficient	Tree	46889.345	21259.446	1.3	12	
WC237	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46896.568	21264.302	1.5	16	
WC238	<i>Cecropia pachystachya</i>	Urticaceae	Exotic	Naturalised	Tree	46907.394	21256.761	1	11	
WC239	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46904.226	21243.937	1.4	13	
WC240	<i>Artocarpus heterophyllus</i>	Moraceae	Exotic	Casual	Tree	46907.232	21231.122	1.1	10	
WC241	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46884.909	21231.153	1.3	12	
WC242	<i>Claoxylon indicum</i>	Euphorbiaceae	Native	Common	Tree	46888.442	21239.116	1	11	
WC243	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46888.432	21222.58	2.8	14	
WC244	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46893.891	21225.245	2.3	15	
WC261	<i>Vitex pinnata</i>	Lamiaceae	Native	Common	Tree	46846.809	21222.811	1.1	18	
WC262	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46849.565	21222.926	1.6	18	
WC263	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46849.354	21225.386	1.2	17	
WC264	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46855.985	21224.852	1.2	9	
WC267	<i>Baccaurea motleyana</i>	Phyllanthaceae	Native	Critically End.	Tree	46873.235	21223.531	1	10	
WC268	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46868.877	21232.01	1.3	18	
WC270	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46876.347	21236.715	1.6	14	
WC271	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46846.794	21231.699	1.5	20	
WC272	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46844.45	21240.288	1.3	20	
WC273	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46843.555	21246.186	1	17	
WC274	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46845.635	21243.121	1.3	12	
WC275	<i>Camposperma auriculatum</i>	Anacardiaceae	Native	Common	Tree	46866.237	21264.549	2	20	
WC276	<i>Planchonella obovata</i>	Sapotaceae	Native	Vulnerable	Tree	46865.723	21263.968	0.4	6	
WC277	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46860.281	21263.666	1.4	19	
WC278	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46854.221	21265.006	2.5	22	
WC279	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46850.241	21260.03	1.2	17	
WC280	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46848.509	21275.905	1.8	22	
WC281	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46853.21	21284.249	1.3	18	
WC282	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46841.255	21269.049	1.3	17	
WC283	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46843.111	21259.309	1	18	
WC284	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46837.43	21246.018	1	20	
WC285	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46835.573	21246.511	1.5	20	
WC286	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46835.887	21252.157	1.3	17	
WC287	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46836.08	21256.621	1.4	19	
WC288	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46827.248	21266.285	1.5	20	
WC299	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46827.753	21230.567	1	18	

Tree ID	Species	Family	Origin	Status	Habit	Northing	Easting	Girth/ spread (m)	Height (m)	Remarks
WC300	<i>Baccaurea polyneura</i>	Phyllanthaceae	Native	Endangered	Tree	46840.266	21230.456	1.1	16	
CE1494	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46754.0836	21262.5413	1	14	
CE1497	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46773.876	21284.354	1	12	
CE1498	<i>Gymnacranthera farquhariana</i> var. <i>farquhariana</i>	Myristicaceae	Native	Endangered	Tree	46778.741	21285.244	0.4	8	
WC168	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46832.19	21289.17	1.2	20	
WC169	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46829.54	21284.5	2	18	
WC171	<i>Tamarindus indica</i>	Fabaceae	Exotic	Casual	Tree	46815.4	21282.41	2	20	
WC172	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46800.54	21291.43	1.1	20	
WC173	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46807.06	21289.7	2.4	20	
WC175	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46833.39	21291.13	3.4	20	
WC289	<i>Syzygium aqueum</i>	Myrtaceae	Exotic	Cultivated Or	Tree	46820.153	21258.279	1	10	
WC290	<i>Syzygium polyanthum</i>	Myrtaceae	Native	Common	Tree	46819.367	21251.595	2	22	
WC292	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46796.48	21258.865	1.6	20	
WC293	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46804.295	21249.839	1.6	18	
WC294	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46805.161	21247.188	1.6	20	
WC295	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46805.016	21245.583	1.2	15	
WC296	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46817.679	21240.837	2.2	20	
WC298	<i>Campnosperma auriculatum</i>	Anacardiaceae	Native	Common	Tree	46822.103	21237.359	1.6	19	
WC359	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46787.84	21300.45	1.8	16	
WC360	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46790.67	21299.81	1.2	14	
WC361	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46821.39	21278.31	2.3	20	
WC362	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46824.92	21274.42	1.8	18	
WC363	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46823.57	21278.71	1.4	18	
WC364	<i>Artocarpus heterophyllus</i>	Moraceae	Exotic	Casual	Tree	46812.16	21271.24	1.2	16	
WC365	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46799.13	21282.72	2.4	18	
WC366	<i>Diospyros blancoi</i>	Ebenaceae	Exotic	Cultivated Or	Tree	46794.37	21270.43	1.4	18	
WC367	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46793.75	21270.64	3	20	
WC368	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46778.88	21276.05	1	14	
WC369	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46780.2	21273.87	2.3	20	
WC371	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46763.81	21252.11	1.4	15	
WC372	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46765.03	21251.64	1.2	18	
WC373	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46788.63	21262.12	1.1	18	
WC374	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46769.7	21239.81	2.2	20	
WC375	<i>Andira inermis</i>	Fabaceae	Exotic	Casual	Tree	46772.3	21230.35	1	15	
WC376	<i>Campnosperma auriculatum</i>	Anacardiaceae	Native	Common	Tree	46770.08	21233.08	1.3	30	
WC377	<i>Campnosperma auriculatum</i>	Anacardiaceae	Native	Common	Tree	46775.59	21231.29	2.4	30	
WC378	<i>Campnosperma auriculatum</i>	Anacardiaceae	Native	Common	Tree	46779.17	21237.95	2.1	25	
WC379	<i>Macaranga gigantea</i>	Euphorbiaceae	Native	Common	Tree	46773.38	21239.07	1.2	11	
WC380	<i>Cecropia pachystachya</i>	Urticaceae	Exotic	Naturalised	Tree	46777.92	21210.48	1	12	
WC380A	<i>Elaeis guineensis</i>	Arecaceae	Exotic	Casual	Tree	46779.44	21218.65	2.5	16	
WC381	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46782.33	21198.82	2.3	25	
WC382	<i>Syzygium polyanthum</i>	Myrtaceae	Native	Common	Tree	46783.42	21191.06	1.2	18	
WC383	<i>Lindera lucida</i>	Lauraceae	Native	Vulnerable	Tree	46786.06	21187.49	1	14	
WC384	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46798.56	21190.92	1.2	20	
WC385	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46791.3	21189.95	1.2	25	
WC387	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46791.16	21200.43	1.3	25	
WC388	<i>Durio zibethinus</i>	Malvaceae	Exotic	Casual	Tree	46789.74	21204.69	1.3	25	
WC389	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46795.64	21195.47	1.2	25	
WC390	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46800.08	21205.85	1	20	
WC391	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46805.05	21194.71	1.3	12	
WC392	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46808.37	21194.9	1.5	25	
WC398	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46812.37	21212.1	1.1	25	
WC399	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46820.36	21215.99	2.2	25	
WC400	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46815.28	21213.66	1	18	
WC401	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46823.54	21224.41	1.1	20	
WC402	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46811.51	21220.71	1.3	25	
WC403	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46822.32	21229.11	1.6	20	
WC404	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46812.91	21221.97	1.1	20	
WC408	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46752.67	21245.81	1.1	15	
WC411	<i>Mangifera indica</i>	Anacardiaceae	Exotic	Casual	Tree	46767.92	21201.53	1.1	9	
CE1484	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46750.88	21149.1421	1.2	14	
CE1485	<i>Macaranga confiera</i>	Euphorbiaceae	Native	Common	Tree	46763.8178	21130.5579	1	10	
CE1486	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46787.4799	21163.0537	1	14	
CE1487	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46783.9413	21171.6225	1	12	
CE1488	<i>Lindera lucida</i>	Lauraceae	Native	Vulnerable	Tree	46781.0666	21162.1632	0.3	5	
CE1489	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46762.0473	21176.5184	1	18	
CE1490	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46754.3067	21191.2078	1	14	
WC121	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46735.55	21207.79	1.5	20	
WC121A	<i>Elaeis guineensis</i>	Arecaceae	Exotic	Casual	Tree	46748.05	21209.19	1.5	15	
WC386	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46792.57	21179.2	1.2	15	
WC409	<i>Syzygium polyanthum</i>	Myrtaceae	Native	Common	Tree	46749.94	21237.51	2.2	18	
WC410	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46746.08	21191.94	1	14	
WC412	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46761.17	21207.64	1.6	10	
WC413	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46749.97	21192.23	1.4	15	
WC415	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46760.86	21177.3	1.4	15	
WC416	<i>Macaranga gigantea</i>	Euphorbiaceae	Native	Common	Tree	46767.43	21165.39	1	9	
WC417	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46788.53	21157.25	1.8	18	
WC418	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46786.31	21166.3	1.4	15	
WC419	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46791.64	21162.08	1.1	18	
WC420	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46747.04	21190.21	1.6	18	

Tree ID	Species	Family	Origin	Status	Habit	Northing	Easting	Girth/ spread (m)	Height (m)	Remarks
WC422	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46734.6	21163.47	1.4	18	
WC423	<i>Lindera lucida</i>	Lauraceae	Native	Vulnerable	Tree	46731.66	21161.8	0.8	16	
WC424	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46743.48	21164.87	1.1	8	
WC425	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46739.07	21161.24	1.1	18	
WC426	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46750.95	21154.97	1.1	10	
WC427	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46784.45	21158.4	1	20	
WC428	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46785.71	21159.17	1	20	
WC429	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46781.66	21157.65	1.1	20	
WC430	<i>Artocarpus heterophyllus</i>	Moraceae	Exotic	Casual	Tree	46787.27	21127.95	1.1	10	
WC431	<i>Ficus microcarpa</i>	Moraceae	Native	Common	Strangler	46787.05	21134.1	3	18	
WC432	<i>Campnosperma auriculatum</i>	Anacardiaceae	Native	Common	Tree	46774.2	21140.49	1.6	15	
WC434	<i>Campnosperma auriculatum</i>	Anacardiaceae	Native	Common	Tree	46768.76	21148.17	2.2	18	
WC435	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46768.96	21137.33	1.2	15	
WC436	<i>Vitex pinnata</i>	Lamiaceae	Native	Common	Tree	46767.78	21130.85	1.2	15	
WC437	<i>Cinnamomum iners</i>	Lauraceae	Native	Common	Tree	46759.82	21141.98	1.1	10	
WC437A	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46758.89	21137.16	3.5	18	
WC438	<i>Acacia auriculiformis</i>	Fabaceae	Exotic	Naturalised	Tree	46748.69	21135.82	2.3	20	
WC438A	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46749.89	21132.04	2.5	15	
WC438B	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46739.63	21134.46	1.2	10	
WC439	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46740.99	21141.66	1.3	15	
WC440	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46739.73	21145.14	1.6	18	
WC442	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46729.47	21130.87	2.8	15	
WC443	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46732.61	21138.37	1.6	15	
WC444	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46732.1	21140.29	1.5	15	
WC446	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46731.07	21145.12	2.2	18	
WC447	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46728.6	21151.92	2.1	15	
WC448	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46729.7	21148.24	1.2	15	
WC449	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46734	21140.56	1.1	12	
WC450	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46722.01	21145.95	1.3	12	
WC450A	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46725.81	21133.6	1.4	12	
WC450B	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46717.58	21134.16	1.4	12	
WC451	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46716.97	21142.45	3	15	
WC452	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46713.78	21145.75	1.8	18	
WC453	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46718.09	21144.57	1.6	18	
WC454	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46711.91	21158.99	1	15	
WC455	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46712.26	21161.93	1.3	18	
WC456	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46714.69	21157.35	1.6	18	
WC458	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46709.3	21134.94	1.2	15	
WC459	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46705.76	21139.58	1.1	15	
WC460	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46700.27	21133.5	1.5	12	
WC469	<i>Cinnamomum iners</i>	Lauraceae	Native	Common	Tree	46790.15	21172.5	1	13	
WC470	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46796.47	21172.85	1.2	15	
WC394	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46836.2	21194.33	1.4	6	
WC395	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46826.64	21200.13	2	20	
WC396	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46814.87	21199.38	2.2	25	
WC397	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46821.94	21200.37	1.4	20	
WC461	<i>Falcataria falcata</i>	Fabaceae	Exotic	Naturalised	Tree	46805.67	21130.53	2.4	20	
WC463	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46830.81	21132.72	1.3	20	
WC463A	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46827.75	21142.49	1.6	20	
WC463B	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46819.73	21126.67	1.5	20	
WC464	<i>Adenanthera pavonina</i>	Fabaceae	Exotic	Naturalised	Tree	46823.14	21128.32	2.4	20	
WC465	<i>Falcataria falcata</i>	Fabaceae	Exotic	Naturalised	Tree	46814.28	21132.19	3	30	
WC466	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46810.37	21144.94	2.2	20	
WC467	<i>Cyrtophyllum fragrans</i>	Gentianaceae	Native	Common	Tree	46815.15	21143.67	1.4	10	
WC468	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46801.25	21159.76	1.4	18	
WC473	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46830.42	21187.41	1.2	15	
WC474	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46838.91	21196.06	1	14	
WC479	<i>Macaranga gigantea</i>	Euphorbiaceae	Native	Common	Tree	46859.12	21162.71	1.1	14	
WC481	<i>Falcataria falcata</i>	Fabaceae	Exotic	Naturalised	Tree	46854.85	21162.05	2.3	30	
WC482	<i>Ficus microcarpa</i>	Moraceae	Native	Common	Strangler	46857.14	21157.01	15	20	
WC483	<i>Syzygium grande</i>	Myrtaceae	Native	Common	Tree	46820.09	21137.91	2.4	25	
WC484	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46827.32	21146.99	1.1	18	
WC485	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46824.52	21155.24	1.3	15	
WC486	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46826.89	21153.68	1.2	15	
WC487	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46823.64	21157.31	1.5	18	
WC488	<i>Durio zibethinus</i>	Malvaceae	Exotic	Casual	Tree	46825.24	21166.22	1.8	30	
WC489	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46816.04	21169.37	1.1	22	
WC491	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46823.39	21184.49	1.2	25	
WC493	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46848.36	21165.32	1.2	20	
WC494	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46849.07	21165.02	1.1	20	
WC495	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46847.03	21162.65	1	20	
WC496	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46840.19	21167.04	1.1	20	
CE1575	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46845.8629	21197.3309	1	16	
CE1576	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46844.7601	21187.4266	1.1	16	
CE1577	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46855.2614	21177.0774	1	10	
CE1578	<i>Syzygium polyanthum</i>	Myrtaceae	Native	Common	Tree	46825.187	21132.4514	1	16	
CE1579	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46830.2736	21196.329	1	16	
CE1580	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46851.9426	21204.1195	1	18	
CE1581	<i>Andira inermis</i>	Fabaceae	Exotic	Casual	Tree	46849.5138	21222.5926	1	16	
CE1582	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46834.5826	21223.0374	1	18	

Tree ID	Species	Family	Origin	Status	Habit	Northing	Easting	Girth/ spread (m)	Height (m)	Remarks
CE1583	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46841.1076	21216.8056	1.4	20	
CE1584	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46839.782	21224.8181	1.3	20	
CE1585	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46910.7667	21270.6692	1	14	
CE1586	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46884.2336	21191.879	1	16	
CE1574	<i>Lindera lucida</i>	Lauraceae	Native	Vulnerable	Tree	46834.25	21180.9718	0.4	10	
WC245	<i>Cecropia pachystachya</i>	Urticaceae	Exotic	Naturalised	Tree	46897.111	21215.907	1.3	14	
WC246	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46885.131	21211.582	2.1	18	
WC247	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46881.517	21208.559	1.1	13	
WC248	<i>Cecropia pachystachya</i>	Urticaceae	Exotic	Naturalised	Tree	46883.32	21207.464	1.3	11	
WC249	<i>Cecropia pachystachya</i>	Urticaceae	Exotic	Naturalised	Tree	46893.058	21205.775	1.2	13	
WC250	<i>Cecropia pachystachya</i>	Urticaceae	Exotic	Naturalised	Tree	46894.455	21207.623	1.3	13	
WC251	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46884.938	21198.478	1.3	19	
WC252	<i>Cecropia pachystachya</i>	Urticaceae	Exotic	Naturalised	Tree	46885.868	21191.926	1.1	10	
WC253	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46875.094	21196.599	1.3	17	
WC255	<i>Ficus variegata</i>	Moraceae	Native	Common	Tree	46868.399	21180.772	1.2	18	
WC256	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46872.229	21199.766	1.2	18	
WC257	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46872.831	21199.195	1.3	18	
WC258	<i>Mangifera indica</i>	Anacardiaceae	Exotic	Casual	Tree	46865.393	21195.473	2	17	
WC259	<i>Nephelium lappaceum</i> var. <i>lappaceum</i>	Sapindaceae	Cryptogenic	-	Tree	46858.285	21198.072	1.6	16	
WC260	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46859.446	21214.262	1	18	
WC265	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46865.661	21216.415	1.1	17	
WC266	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46869.291	21214.05	1	16	
WC475	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46856.9	21185.8	1.5	15	
WC476	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46851.02	21183.56	1.7	18	
WC477	<i>Spathodea campanulata</i>	Bignoniaceae	Exotic	Naturalised	Tree	46854.76	21188.22	1.2	15	
WC478	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46866.92	21165.28	1	15	
WC480	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46853.89	21172.51	1	14	
WC497	<i>Hevea brasiliensis</i>	Euphorbiaceae	Exotic	Naturalised	Tree	46850.08	21178.53	2.4	25	

Appendix I

List of Probable and Recorded Faunal Species

Faunal Group	No. of Recorded Species		Total No. of Probable CS Species
	All Species	CS Species	
Odonates	6	0	0
Dragonflies	6	0	0
Damselflies	0	0	0
Butterflies	29	2	8
Herpetofauna	10	0	2
Amphibians	4	0	0
Reptiles	6	0	2
Birds	37	1	12
Mammals	13	1	4
Non-volant mammals	7	0	2
Bats	6	1	2
Total	95	4	26

Appendix J Faunal Survey Data

Export Supply Data

Date	Cycle	Survey type	Waypoint	Latitude	Longitude	Time (24h)	Scientific name	Common name	Taxon	Global status	National status	Quantity	Observation type (seen/heard/cough/scar/ot her sign)	Survey method (targeted/incidental/post)
5/27/2023	2	AM OB	LT53	143928702	103.773804	11:40	<i>Apellis lyrida vaava</i>	Chocolate albino	Butterfly	Not Listed	Data Deficient	1	Seen	Targeted
5/27/2023	2	AM OB	LT53	143928702	103.773804	11:10	<i>Phalaeta phalaeta phalaeta</i>	Leopard	Butterfly	Not Listed	Least Concern	2	Seen	Targeted
5/27/2023	2	AM OB	LT53	143928702	103.773804	11:10	<i>Colotis poma poma</i>	Lenon emigrant	Butterfly	Not Listed	Least Concern	1	Seen	Targeted
5/27/2023	2	AM OB	LT53	143928702	103.773804	11:10	<i>Junonia hedonia id</i>	Chocolate pansy	Butterfly	Not Listed	Least Concern	1	Seen	Targeted
5/27/2023	2	AM OB	LT53	143928702	103.773804	11:11	<i>Junonia hedonia id</i>	Chocolate pansy	Butterfly	Not Listed	Least Concern	1	Seen	Targeted
5/27/2023	2	AM OB	LT54	143910063	103.771885	11:11	<i>Acraea terpsicore</i>	Acraea terpsicore	Butterfly	Not Listed	Least Concern	1	Seen	Targeted
5/27/2023	2	AM OB	LT55	143899018	103.774447	11:12	<i>Acraea terpsicore</i>	Tawny coster	Butterfly	Not Listed	Least Concern	1	Seen	Targeted
6/7/2023	2	AM BM	RP2483	143906618	103.773152	7:40	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	4	Seen	Targeted
6/7/2023	2	AM BM	RP2484	143944039	103.778118	7:38	<i>Callosaurus platensis</i>	Paratan squirrel	Mammal	Least Concern	Least Concern	1	Heard	Targeted
6/7/2023	2	AM BM	RP2485	143944039	103.778118	7:40	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Heard	Targeted
6/7/2023	2	AM BM	RP2486	143944039	103.778118	7:42	<i>Callosaurus platensis</i>	Paratan squirrel	Mammal	Least Concern	Least Concern	1	Heard	Targeted
6/7/2023	2	AM BM	RP2487	143971797	103.772228	7:50	<i>Paradissurus musangus</i>	Sumatran palm civet	Mammal	Least Concern	Least Concern	1 cluster	Scat	Targeted
6/7/2023	2	AM BM	RP2487	143971797	103.772228	7:50	<i>Callosaurus platensis</i>	Paratan squirrel	Mammal	Least Concern	Least Concern	1	Heard	Targeted
6/7/2023	2	AM BM	RP2488	143920037	103.771871	7:56	<i>Callosaurus platensis</i>	Paratan squirrel	Mammal	Least Concern	Least Concern	1	Heard	Targeted
6/7/2023	2	AM BM	RP2488	143920037	103.771871	7:56	<i>Subdolophus bowringi</i>	Bowring's agile skink	Reptile	Least Concern	Least Concern	1	Heard	Targeted
6/7/2023	2	AM BM	RP2490	143824966	103.771145	8:01	<i>Callosaurus platensis</i>	Paratan squirrel	Mammal	Least Concern	Least Concern	1	Seen	Targeted
6/7/2023	2	AM BM	RP2491	143840492	103.771175	8:07	<i>Callosaurus platensis</i>	Paratan squirrel	Mammal	Least Concern	Least Concern	1	Heard	Targeted
8/18/2023	2	AM B	MW620	143972081	103.773985	7:53	<i>Callosaurus platensis</i>	Paratan squirrel	Mammal	Least Concern	Least Concern	5	Seen	Targeted
8/18/2023	2	AM B	MW652	143953027	103.773199	7:29	<i>Dicaeum cruentatum</i>	Scarlet-backed flowerpecker	Bird	Least Concern	Least Concern	1	Heard	Targeted
8/18/2023	2	AM B	MW653	143993028	103.773274	7:30	<i>Diolais chinensis</i>	Pink-necked green pigeon	Bird	Least Concern	Least Concern	7	Seen	Targeted
8/18/2023	2	AM B	MW654	143934027	103.773197	7:31	<i>Diolais chinensis</i>	Black-rumped oriole	Bird	Least Concern	Least Concern	1	Seen	Targeted
8/18/2023	2	AM B	MW655	143943999	103.773205	7:32	<i>Garrulus leucophrys</i>	White-crowned laughingthrush	Bird	Least Concern	NA	3	Heard	Targeted
8/18/2023	2	AM B	MW656	143944703	103.773152	7:32	<i>Aplops parvulus</i>	Asian glossy starling	Bird	Least Concern	Least Concern	20	Seen	Targeted
8/18/2023	2	AM B	MW656	143944703	103.773152	7:32	<i>Cinnyris jugularis</i>	Olive-backed sunbird	Bird	Least Concern	Least Concern	1	Heard	Targeted
8/18/2023	2	AM B	MW656	143944703	103.773152	7:32	<i>Picus viridis</i>	Laced woodpecker	Bird	Least Concern	Least Concern	1	Heard	Targeted
8/18/2023	2	AM B	MW657	143948024	103.773018	7:35	<i>Picus viridis</i>	Laced woodpecker	Bird	Least Concern	Least Concern	1	Heard	Targeted
8/18/2023	2	AM B	MW658	143943011	103.773017	7:37	<i>Miomis gilvus</i>	Pink-striped tit-babbler	Bird	Least Concern	Least Concern	3	Heard	Targeted
8/18/2023	2	AM B	MW659	143943011	103.773017	7:39	<i>Diolais chinensis</i>	Black-rumped oriole	Bird	Least Concern	Least Concern	1	Heard	Targeted
8/18/2023	2	AM B	MW660	143972029	103.772252	7:42	<i>Dicaeum cruentatum</i>	Scarlet-backed flowerpecker	Bird	Least Concern	Least Concern	1	Heard	Targeted
8/18/2023	2	AM B	MW661	143949492	103.773809	7:46	<i>Miomis gilvus</i>	Pink-striped tit-babbler	Bird	Least Concern	Least Concern	2	Heard	Targeted
8/18/2023	2	AM B	MW662	143813193	103.772342	7:52	<i>Carpornis maculosa</i>	Large-tailed nightjar	Bird	Least Concern	Least Concern	1	Seen	Targeted
8/18/2023	2	AM B	MW663	143940016	103.772554	7:53	<i>Paradissurus musangus</i>	Sumatran palm civet	Mammal	Least Concern	Least Concern	1 cluster	Scat	Targeted
8/18/2023	2	AM B	MW664	143942423	103.774042	7:53	<i>Acridotheres javanicus</i>	Javan myna	Bird	Vulnerable	NA	3	Seen	Targeted
8/18/2023	2	PM BM	RP2755	143962012	103.772991	20:21	<i>Rallia fasciata</i>	Red-legged cuckoo	Bird	Least Concern	Near Threatened	1	Seen	Targeted
8/18/2023	2	PM BM	RP2756	143967299	103.772768	20:27	<i>Brachycolaptes caeruleus</i>	Green-crowned lizard	Reptile	Least Concern	Least Concern	1	Seen	Targeted
8/18/2023	2	PM BM	RP2757	143967299	103.772768	20:30	<i>Subdolophus bowringi</i>	Painted bronzeback	Reptile	Least Concern	Least Concern	1	Seen	Targeted
8/18/2023	2	PM BM	RP2758	143962012	103.772167	20:30	<i>Polypedates leucomystax</i>	Four-lined tree frog	Amphibian	Least Concern	Least Concern	2	Heard	Targeted
8/18/2023	2	PM BM	RP2759	143940031	103.772904	20:35	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Seen	Targeted
8/18/2023	2	PM BM	RP2760	143813194	103.773186	20:44	<i>Diolais chinensis</i>	Painted bronzeback	Reptile	Least Concern	Least Concern	1	Seen	Targeted
8/18/2023	2	PM BM	RP2761	143813186	103.772126	20:53	<i>Dendrobates tinianus</i>	Painted bronzeback	Reptile	Least Concern	Least Concern	1	Seen	Targeted
8/18/2023	2	PM BM	RP2762	143813186	103.772126	20:58	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Seen	Targeted
8/18/2023	2	PM BM	RP2763	143813186	103.772126	21:05	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Seen	Targeted
8/18/2023	2	PM BM	RP2765	143813186	103.772126	21:10	<i>Calotes versicolor</i>	Changeable lizard	Reptile	Least Concern	NA	4	Seen	Targeted
8/18/2023	2	PM BM	RP2766	143813186	103.772126	21:10	<i>Diolais chinensis</i>	Painted bronzeback	Reptile	Least Concern	Least Concern	1	Seen	Targeted
21/08/2023	1	PM BM	MW665	143891181	103.774116	20:12	<i>Dutphydus bengalensis</i>	Bengal toad	Amphibian	Not Listed	NA	1	Seen	Targeted
21/08/2023	1	PM BM	MW666	143913396	103.773744	20:03	<i>Polypedates leucomystax</i>	Four-lined tree frog	Amphibian	Least Concern	Least Concern	1	Heard	Targeted
21/08/2023	1	PM BM	MW667	143813193	103.773182	20:12	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Heard	Targeted
21/08/2023	1	PM BM	MW668	143813396	103.773182	20:20	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Heard	Targeted
21/08/2023	1	PM BM	MW669	143813396	103.773182	20:23	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Heard	Targeted
21/08/2023	1	PM BM	MW670	143813396	103.773182	20:31	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Seen	Targeted
21/08/2023	1	PM BM	MW671	143912903	103.771854	20:35	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	2	Seen	Targeted
21/08/2023	1	PM BM	MW672	143813193	103.773182	20:37	<i>Dendrobates tinianus</i>	Painted bronzeback	Reptile	Least Concern	Least Concern	1	Seen	Targeted
21/08/2023	1	PM BM	MW673	143950101	103.772042	20:40	<i>Unidentified muridae</i>	NA	Mammal	NA	NA	1	Seen	Targeted
21/08/2023	1	PM BM	MW674	143950101	103.772042	20:40	<i>Polypedates leucomystax</i>	Four-lined tree frog	Amphibian	Least Concern	Least Concern	1	Heard	Targeted
21/08/2023	1	PM BM	MW675	143973978	103.772318	20:43	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Heard	Targeted
21/08/2023	1	PM BM	MW676	143966996	103.772762	20:51	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Seen	Targeted
21/08/2023	1	PM BM	MW677	143966996	103.772762	20:51	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Seen	Targeted
21/08/2023	1	PM BM	MW678	143966996	103.772762	20:51	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Seen	Targeted
21/08/2023	1	PM BM	MW679	143966996	103.772762	20:51	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Seen	Targeted
21/08/2023	1	PM BM	MW680	143917402	103.773074	20:58	<i>Polypedates leucomystax</i>	Four-lined tree frog	Amphibian	Least Concern	Least Concern	1	Heard	Targeted
21/08/2023	1	PM BM	MW681	143972007	103.773008	20:58	<i>Polypedates leucomystax</i>	Four-lined tree frog	Amphibian	Least Concern	Least Concern	1	Heard	Targeted
21/08/2023	1	PM BM	MW682	143917099	103.773016	21:00	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Heard	Targeted
21/08/2023	1	PM BM	MW683	143917099	103.773016	21:00	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Heard	Targeted
21/08/2023	1	PM BM	MW684	143915108	103.773125	21:03	<i>Polypedates leucomystax</i>	Four-lined tree frog	Amphibian	Least Concern	Least Concern	1	Heard	Targeted
21/08/2023	1	PM BM	MW685	143970137	103.772246	21:04	<i>Euphydryas phalaenoides</i>	Greenhouse frog	Amphibian	Least Concern	NA	1	Seen	Targeted
21/08/2023	1	PM BM	MW686	143915108	103.773125	21:10	<i>Acridotheres javanicus</i>	Javan myna	Bird	Vulnerable	NA	4	Seen	Targeted
4/9/2023	1	AM migratory birds	S348	143874404	103.774225	7:16:31	<i>Acridotheres javanicus</i>	Javan myna	Bird	Vulnerable	NA	4	Seen	Targeted
4/9/2023	1	AM migratory birds	S348	143874404	103.774225	7:16:31	<i>Aplops parvulus</i>	Asian glossy starling	Bird	Least Concern	Least Concern	10	Seen	Targeted
4/9/2023	1	AM migratory birds	S348	143874404	103.774225	7:16:31	<i>Acridotheres javanicus</i>	Javan myna	Bird	Vulnerable	NA	4	Seen	Targeted
4/9/2023	1	AM migratory birds	S349	143905509	103.773899	7:19:23	<i>Pycnonotus goiavier</i>	Yellow-fronted bulbul	Bird	Least Concern	Least Concern	1	Heard	Targeted
4/9/2023	1	AM migratory birds	S349	143905509	103.773899	7:19:23	<i>Diolais chinensis</i>	Black-rumped oriole	Bird	Least Concern	Least Concern	1	Heard	Targeted
4/9/2023	1	AM migratory birds	S349	143905509	103.773899	7:19:23	<i>Aplops parvulus</i>	Asian glossy starling	Bird	Least Concern	Least Concern	6	Seen	Targeted
4/9/2023	1	AM migratory birds	S349	143905509	103.773899	7:19:23	<i>Cinnyris jugularis</i>	Olive-backed sunbird	Bird	Least Concern	Least Concern	1	Heard	Targeted
4/9/2023	1	AM migratory birds	S350	143917099	103.773016	7:21:39	<i>Diolais chinensis</i>	Black-rumped oriole	Bird	Least Concern	Least Concern	1	Heard	Targeted
4/9/2023	1	AM migratory birds	S351	143890367	103.773274	7:24:25	<i>Aplops parvulus</i>	Asian glossy starling	Bird	Least Concern	Least Concern	10	Seen	Targeted
4/9/2023	1	AM migratory birds	S351	143890367	103.773274	7:24:25	<i>Picus viridis</i>	Laced woodpecker	Bird	Least Concern	Least Concern	1	Heard	Targeted
4/9/2023	1	AM migratory birds	S351	143890367	103.773274	7:24:25	<i>Mergus philippinus</i>	Blue-throated bee-eater	Bird	Least Concern	Least Concern	1	Heard	Targeted
4/9/2023	1	AM migratory birds	S351	143890367	103.773274	7:24:25	<i>Dicaeum cruentatum</i>	Scarlet-backed flowerpecker	Bird	Least Concern	Least Concern	1	Heard	Targeted
4/9/2023	1	AM migratory birds	S351	143890367	103.773274	7:24:25	<i>Pycnonotus goiavier</i>	Yellow-fronted bulbul	Bird	Least Concern	Least Concern	1	Heard	Targeted
4/9/2023	1	AM migratory birds	S351	143890367	103.773274	7:24:25	<i>Dinopium chinensis</i>	Common flameback	Bird	Least Concern	Least Concern	1	Heard	Targeted
4/9/2023	1	AM migratory birds	S351	143890367	103.773274	7:24:25	<i>Diolais chinensis</i>	Black-rumped oriole	Bird	Least Concern	Least Concern	2	Heard	Targeted
4/9/2023	1	AM migratory birds	S352	143866005	103.773977	7:29:04	<i>Orthotomus sordidus</i>	Dark-necked tailorbird	Bird	Least Concern	Least Concern	1	Heard	Targeted
4/9/2023	1	AM migratory birds	S353	143888971	103.772797	7:31:00	<i>Miomis gilvus</i>	Pink-striped tit-babbler	Bird	Least Concern	Least Concern	3		

Appendix K Camera Trap Data

Station	Latitude	Longitude	Sampling Date	File Modify Date	Date	Time	FileName	Scientific Name	Quantity
WN1.1	1.43917	103.77339	20230717	7/7/2023 18:24	7/7/2023	18:24:22	IMG_0034.AVI	Tupaia glis	1
WN1.1	1.43917	103.77339	20230717	7/15/2023 14:51	7/15/2023	14:51:26	IMG_0038.AVI	Tupaia glis	1
WN1.1	1.43917	103.77339	20230717	7/15/2023 15:00	7/15/2023	15:00:10	IMG_0039.AVI	Tupaia glis	1
WN1.1	1.43917	103.77339	20230717	7/15/2023 16:16	7/15/2023	16:16:04	IMG_0040.AVI	Tupaia glis	1
WN1.1	1.43917	103.77339	20230717	7/16/2023 9:38	7/16/2023	9:38:42	IMG_0042.AVI	Tupaia glis	1
WN1.1	1.43917	103.77339	20230818	7/28/2023 12:59	7/28/2023	12:59:44	IMG_0006.AVI	Cinnyris jugularis	1
WN1.1	1.43917	103.77339	20230818	8/1/2023 18:06	8/1/2023	18:06:36	IMG_0008.AVI	Tupaia glis	1
WN1.1	1.43917	103.77339	20230818	8/13/2023 11:42	8/13/2023	11:42:50	IMG_0011.AVI	Garrulax leucolophus	2
WN1.1	1.43917	103.77339	20230818	8/13/2023 11:44	8/13/2023	11:44:34	IMG_0012.AVI	Garrulax leucolophus	2
WN1.1	1.43917	103.77339	20230818	8/13/2023 11:48	8/13/2023	11:48:04	IMG_0013.AVI	Tupaia glis	1
WN1.1	1.43917	103.77339	20230818	8/14/2023 12:50	8/14/2023	12:50:14	IMG_0014.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230717	7/12/2023 3:21	7/12/2023	3:21:04	IMG_0019.AVI	Rattus tanezumi	1
WN1.2	1.439234968	103.772839	20230717	7/12/2023 5:25	7/12/2023	5:25:40	IMG_0021.AVI	Suncus murinus	1
WN1.2	1.439234968	103.772839	20230818	7/19/2023 3:38	7/19/2023	3:38:08	IMG_0020.AVI	Rattus tanezumi	1
WN1.2	1.439234968	103.772839	20230818	7/19/2023 18:22	7/19/2023	18:22:42	IMG_0023.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	7/19/2023 18:50	7/19/2023	18:50:54	IMG_0025.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	7/22/2023 16:55	7/22/2023	16:55:34	IMG_0032.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	7/22/2023 23:12	7/22/2023	23:12:08	IMG_0033.AVI	Rattus tanezumi	1
WN1.2	1.439234968	103.772839	20230818	7/23/2023 8:33	7/23/2023	8:33:20	IMG_0034.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230818	7/23/2023 14:25	7/23/2023	14:25:26	IMG_0035.AVI	Picus vittatus	1
WN1.2	1.439234968	103.772839	20230818	7/23/2023 23:16	7/23/2023	23:16:04	IMG_0038.AVI	Rattus tiomanicus	1
WN1.2	1.439234968	103.772839	20230818	7/24/2023 7:52	7/24/2023	7:52:20	IMG_0040.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	7/25/2023 17:42	7/25/2023	17:42:20	IMG_0046.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230818	7/25/2023 17:42	7/25/2023	17:42:20	IMG_0046.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	7/26/2023 18:33	7/26/2023	18:33:58	IMG_0050.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	7/26/2023 18:34	7/26/2023	18:34:46	IMG_0051.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	7/26/2023 18:35	7/26/2023	18:35:12	IMG_0052.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	7/26/2023 18:35	7/26/2023	18:35:34	IMG_0053.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	7/26/2023 18:35	7/26/2023	18:35:54	IMG_0054.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230818	7/26/2023 18:36	7/26/2023	18:36:16	IMG_0055.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230818	7/26/2023 18:36	7/26/2023	18:36:44	IMG_0056.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	7/26/2023 18:37	7/26/2023	18:37:12	IMG_0057.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230818	7/26/2023 18:37	7/26/2023	18:37:34	IMG_0058.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230818	7/26/2023 18:40	7/26/2023	18:40:08	IMG_0059.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230818	7/26/2023 18:40	7/26/2023	18:40:28	IMG_0060.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	7/26/2023 18:40	7/26/2023	18:40:56	IMG_0061.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	7/26/2023 18:41	7/26/2023	18:41:34	IMG_0062.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	7/27/2023 9:10	7/27/2023	9:10:44	IMG_0063.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	7/27/2023 13:29	7/27/2023	13:29:44	IMG_0065.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	7/31/2023 18:43	7/31/2023	18:43:14	IMG_0069.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230818	7/31/2023 18:43	7/31/2023	18:43:58	IMG_0070.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	8/1/2023 7:09	8/1/2023	7:09:36	IMG_0071.AVI	Rallina fasciata	1
WN1.2	1.439234968	103.772839	20230818	8/2/2023 18:01	8/2/2023	18:01:28	IMG_0073.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	8/3/2023 8:41	8/3/2023	8:41:56	IMG_0074.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	8/3/2023 18:46	8/3/2023	18:46:26	IMG_0078.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	8/4/2023 18:01	8/4/2023	18:01:20	IMG_0080.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230818	8/4/2023 18:20	8/4/2023	18:20:40	IMG_0081.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	8/4/2023 19:03	8/4/2023	19:03:08	IMG_0082.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	8/5/2023 18:50	8/5/2023	18:50:02	IMG_0086.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230818	8/6/2023 16:11	8/6/2023	16:11:26	IMG_0087.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230818	8/6/2023 17:58	8/6/2023	17:58:10	IMG_0088.AVI	Callosciurus notatus	2
WN1.2	1.439234968	103.772839	20230818	8/6/2023 17:58	8/6/2023	17:58:10	IMG_0088.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230818	8/6/2023 18:29	8/6/2023	18:29:14	IMG_0089.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230818	8/6/2023 18:57	8/6/2023	18:57:08	IMG_0090.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	8/6/2023 18:59	8/6/2023	18:59:30	IMG_0091.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230818	8/6/2023 18:59	8/6/2023	18:59:30	IMG_0091.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230818	8/7/2023 15:18	8/7/2023	15:18:48	IMG_0093.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230818	8/7/2023 18:03	8/7/2023	18:03:14	IMG_0095.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230818	8/7/2023 20:47	8/7/2023	20:47:22	IMG_0097.AVI	Rattus tanezumi	1
WN1.2	1.439234968	103.772839	20230818	8/9/2023 7:35	8/9/2023	7:35:38	IMG_0099.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	8/9/2023 11:21	8/9/2023	11:21:54	IMG_0100.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230818	8/9/2023 11:37	8/9/2023	11:37:34	IMG_0101.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	8/9/2023 18:46	8/9/2023	18:46:36	IMG_0103.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	8/9/2023 18:46	8/9/2023	18:46:58	IMG_0104.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	8/9/2023 18:47	8/9/2023	18:47:24	IMG_0105.AVI	Garrulax leucolophus	3
WN1.2	1.439234968	103.772839	20230818	8/9/2023 18:47	8/9/2023	18:47:46	IMG_0106.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230818	8/9/2023 18:48	8/9/2023	18:48:06	IMG_0107.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230818	8/9/2023 18:48	8/9/2023	18:48:28	IMG_0108.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230818	8/9/2023 18:48	8/9/2023	18:48:50	IMG_0109.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230818	8/9/2023 18:49	8/9/2023	18:49:34	IMG_0110.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230818	8/9/2023 18:53	8/9/2023	18:53:26	IMG_0111.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	8/9/2023 18:53	8/9/2023	18:53:52	IMG_0112.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230818	8/10/2023 7:27	8/10/2023	7:27:08	IMG_0113.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	8/10/2023 9:44	8/10/2023	9:44:40	IMG_0114.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	8/10/2023 9:46	8/10/2023	9:46:52	IMG_0115.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	8/10/2023 18:36	8/10/2023	18:36:10	IMG_0116.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	8/13/2023 8:58	8/13/2023	8:58:26	IMG_0118.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230818	8/17/2023 14:18	8/17/2023	14:18:08	IMG_0121.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	8/17/2023 14:32	8/17/2023	14:32:12	IMG_0122.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	8/17/2023 14:33	8/17/2023	14:33:34	IMG_0123.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230818	8/17/2023 14:34	8/17/2023	14:34:14	IMG_0124.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	8/17/2023 18:21	8/17/2023	18:21:20	IMG_0125.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	8/17/2023 18:21	8/17/2023	18:21:48	IMG_0126.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230818	8/17/2023 18:27	8/17/2023	18:27:56	IMG_0127.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/18/2023 10:55	8/18/2023	10:55:34	IMG_0009.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/19/2023 17:34	8/19/2023	17:34:42	IMG_0011.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/19/2023 18:40	8/19/2023	18:40:54	IMG_0012.AVI	Tupaia glis	2
WN1.2	1.439234968	103.772839	20230911	8/19/2023 18:46	8/19/2023	18:46:56	IMG_0013.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/19/2023 18:52	8/19/2023	18:52:54	IMG_0014.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/19/2023 18:53	8/19/2023	18:53:24	IMG_0015.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/19/2023 18:53	8/19/2023	18:53:44	IMG_0016.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/19/2023 18:54	8/19/2023				

WN1.2	1.439234968	103.772839	20230911	8/20/2023 1:06	8/20/2023	1:06:22	IMG_0021.AVI	Rattus tanezumi	1
WN1.2	1.439234968	103.772839	20230911	8/20/2023 15:24	8/20/2023	15:24:14	IMG_0022.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230911	8/20/2023 18:47	8/20/2023	18:47:24	IMG_0023.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/20/2023 19:13	8/20/2023	19:13:22	IMG_0024.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/21/2023 14:46	8/21/2023	14:46:04	IMG_0025.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/22/2023 8:13	8/22/2023	8:13:26	IMG_0026.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/22/2023 18:53	8/22/2023	18:53:52	IMG_0027.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/22/2023 18:54	8/22/2023	18:54:16	IMG_0028.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/23/2023 18:58	8/23/2023	18:58:54	IMG_0029.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/26/2023 18:25	8/26/2023	18:25:46	IMG_0033.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/26/2023 18:36	8/26/2023	18:36:00	IMG_0034.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/28/2023 13:16	8/28/2023	13:16:26	IMG_0035.AVI	Canis lupus familiaris	1
WN1.2	1.439234968	103.772839	20230911	8/28/2023 13:16	8/28/2023	13:16:48	IMG_0036.AVI	Canis lupus familiaris	1
WN1.2	1.439234968	103.772839	20230911	8/29/2023 16:29	8/29/2023	16:29:58	IMG_0037.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230911	8/29/2023 16:30	8/29/2023	16:30:56	IMG_0038.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230911	8/29/2023 16:30	8/29/2023	16:30:56	IMG_0038.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/29/2023 16:32	8/29/2023	16:32:30	IMG_0039.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230911	8/29/2023 16:32	8/29/2023	16:32:30	IMG_0039.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	8/29/2023 16:33	8/29/2023	16:33:20	IMG_0040.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230911	8/29/2023 16:33	8/29/2023	16:33:20	IMG_0040.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230911	8/29/2023 16:33	8/29/2023	16:33:46	IMG_0041.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230911	8/29/2023 16:33	8/29/2023	16:33:46	IMG_0041.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230911	8/29/2023 16:34	8/29/2023	16:34:48	IMG_0042.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230911	8/29/2023 16:34	8/29/2023	16:34:48	IMG_0042.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230911	8/30/2023 14:01	8/30/2023	14:01:24	IMG_0043.AVI	Garrulax leucolophus	1
WN1.2	1.439234968	103.772839	20230911	8/30/2023 14:01	8/30/2023	14:01:44	IMG_0044.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230911	8/30/2023 17:22	8/30/2023	17:22:32	IMG_0046.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230911	8/30/2023 17:23	8/30/2023	17:23:06	IMG_0047.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230911	9/1/2023 19:06	9/1/2023	19:06:40	IMG_0051.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	9/1/2023 19:07	9/1/2023	19:07:02	IMG_0052.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	9/1/2023 19:08	9/1/2023	19:08:22	IMG_0053.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	9/1/2023 19:09	9/1/2023	19:09:12	IMG_0054.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	9/3/2023 7:02	9/3/2023	7:02:38	IMG_0056.AVI	Tupaia glis	2
WN1.2	1.439234968	103.772839	20230911	9/7/2023 8:26	9/7/2023	8:26:46	IMG_0059.AVI	Garrulax leucolophus	2
WN1.2	1.439234968	103.772839	20230911	9/7/2023 10:21	9/7/2023	10:21:56	IMG_0060.AVI	Callosciurus notatus	1
WN1.2	1.439234968	103.772839	20230911	9/7/2023 18:54	9/7/2023	18:54:40	IMG_0062.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	9/8/2023 1:46	9/8/2023	1:46:14	IMG_0063.AVI	Rattus tanezumi	1
WN1.2	1.439234968	103.772839	20230911	9/9/2023 15:09	9/9/2023	15:09:14	IMG_0064.AVI	Tupaia glis	1
WN1.2	1.439234968	103.772839	20230911	9/10/2023 19:03	9/10/2023	19:03:46	IMG_0066.AVI	Tupaia glis	1
WN1.3	1.43916	103.77227	20230818	7/18/2020 17:43	7/18/2020	17:43:08	IMG_0179.AVI	Garrulax leucolophus	1
WN1.3	1.43916	103.77227	20230818	7/18/2020 17:51	7/18/2020	17:51:26	IMG_0181.AVI	Garrulax leucolophus	1
WN1.3	1.43916	103.77227	20230818	7/18/2020 17:55	7/18/2020	17:55:46	IMG_0182.AVI	Callosciurus notatus	1
WN1.3	1.43916	103.77227	20230904	8/28/2023 13:30	8/28/2023	13:30:54	IMG_0162.AVI	Canis lupus familiaris	1
WN1.3	1.43916	103.77227	20230904	8/28/2023 13:32	8/28/2023	13:32:44	IMG_0163.AVI	Canis lupus familiaris	1
WN1.3	1.43916	103.77227	20230904	8/28/2023 14:06	8/28/2023	14:06:26	IMG_0164.AVI	Canis lupus familiaris	1
WN1.3	1.43916	103.77227	20230904	8/30/2023 15:14	8/30/2023	15:14:46	IMG_0262.AVI	Chalcophaps indica	1
WN1.3	1.43916	103.77227	20230904	8/30/2023 15:14	8/30/2023	15:14:46	IMG_0262.AVI	Garrulax leucolophus	1
WN1.3	1.43916	103.77227	20230904	9/1/2023 0:05	9/1/2023	0:05:16	IMG_0298.AVI	Rattus tanezumi	1
WN1.3	1.43916	103.77227	20230904	9/1/2023 0:06	9/1/2023	0:06:46	IMG_0299.AVI	Rattus tanezumi	1
WN1.3	1.43916	103.77227	20230904	9/1/2023 18:48	9/1/2023	18:48:52	IMG_0304.AVI	Garrulax leucolophus	2
WN1.3	1.43916	103.77227	20230911	9/4/2023 20:45	9/4/2023	20:45:28	IMG_0008.AVI	Rattus tanezumi	1
WN1.3	1.43916	103.77227	20230911	9/5/2023 14:11	9/5/2023	14:11:42	IMG_0009.AVI	Canis lupus familiaris	2
WN1.3	1.43916	103.77227	20230911	9/6/2023 7:40	9/6/2023	7:40:16	IMG_0011.AVI	Canis lupus familiaris	2
WN1.3	1.43916	103.77227	20230911	9/6/2023 8:01	9/6/2023	8:01:50	IMG_0012.AVI	Canis lupus familiaris	1
WN1.3	1.43916	103.77227	20230919	9/12/2023 22:24	9/12/2023	22:24:10	IMG_0051.AVI	Rattus tanezumi	1
WN1.3	1.43916	103.77227	20230919	9/12/2023 22:25	9/12/2023	22:25:32	IMG_0052.AVI	Rattus tanezumi	1
WN1.3	1.43916	103.77227	20230919	9/14/2023 4:51	9/14/2023	4:51:34	IMG_0059.AVI	Rattus tanezumi	1
WN1.3	1.43916	103.77227	20230919	9/19/2023 0:02	9/19/2023	0:02:24	IMG_0083.AVI	Rattus tanezumi	1
WN1.3	1.43916	103.77227	20231004	9/24/2023 1:10	9/24/2023	1:10:58	IMG_0103.AVI	Rattus tanezumi	1
WN1.3	1.43916	103.77227	20231004	9/29/2023 10:23	9/29/2023	10:23:44	IMG_0217.AVI	Gallus gallus	1
WN1.3	1.43916	103.77227	20231004	10/4/2023 3:08	10/4/2023	3:08:46	IMG_0355.AVI	Rattus tanezumi	1
WN1.3	1.43916	103.77227	20231023	10/8/2023 22:31	10/8/2023	22:31:56	IMG_0007.AVI	Canis lupus familiaris	2
WN1.3	1.43916	103.77227	20231023	10/10/2023 14:29	10/10/2023	14:29:36	IMG_0012.AVI	Canis lupus familiaris	1
WN1.3	1.43916	103.77227	20231023	10/12/2023 13:59	10/12/2023	13:59:40	IMG_0031.AVI	Garrulax leucolophus	4
WN1.3	1.43916	103.77227	20231023	10/16/2023 17:56	10/16/2023	17:56:58	IMG_0038.AVI	Dinopium javanese	1
WN1.3	1.43916	103.77227	20231023	10/18/2023 4:27	10/18/2023	4:27:04	IMG_0039.AVI	Rattus tanezumi	1
WN1.3	1.43916	103.77227	20231023	10/20/2023 11:49	10/20/2023	11:49:24	IMG_0043.AVI	Gallus gallus	1
WN1.3	1.43916	103.77227	20231023	10/20/2023 11:49	10/20/2023	11:49:24	IMG_0043.AVI	Garrulax leucolophus	2
WN1.3	1.43916	103.77227	20231023	10/20/2023 11:49	10/20/2023	11:49:56	IMG_0044.AVI	Gallus gallus	1
WN1.3	1.43916	103.77227	20231023	10/20/2023 11:55	10/20/2023	11:55:04	IMG_0045.AVI	Gallus gallus	1
WN1.4	1.438299967	103.771689	20230717	7/7/2023 17:46	7/7/2023	17:46:36	IMG_0009.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230717	7/7/2023 18:51	7/7/2023	18:51:56	IMG_0010.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230717	7/9/2023 8:42	7/9/2023	8:42:58	IMG_0011.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230717	7/9/2023 15:23	7/9/2023	15:23:42	IMG_0012.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230717	7/10/2023 8:56	7/10/2023	8:56:14	IMG_0013.AVI	Garrulax leucolophus	3
WN1.4	1.438299967	103.771689	20230717	7/10/2023 8:57	7/10/2023	8:57:10	IMG_0014.AVI	Garrulax leucolophus	2
WN1.4	1.438299967	103.771689	20230717	7/10/2023 8:57	7/10/2023	8:57:32	IMG_0015.AVI	Garrulax leucolophus	1
WN1.4	1.438299967	103.771689	20230717	7/10/2023 10:05	7/10/2023	10:05:58	IMG_0016.AVI	Garrulax leucolophus	3
WN1.4	1.438299967	103.771689	20230717	7/10/2023 10:06	7/10/2023	10:06:30	IMG_0017.AVI	Garrulax leucolophus	1
WN1.4	1.438299967	103.771689	20230717	7/10/2023 20:13	7/10/2023	20:13:52	IMG_0018.AVI	Rattus tanezumi	1
WN1.4	1.438299967	103.771689	20230717	7/11/2023 9:47	7/11/2023	9:47:38	IMG_0020.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230717	7/11/2023 10:21	7/11/2023	10:21:32	IMG_0021.AVI	Garrulax leucolophus	2
WN1.4	1.438299967	103.771689	20230717	7/11/2023 13:20	7/11/2023	13:20:34	IMG_0022.AVI	Garrulax leucolophus	2
WN1.4	1.438299967	103.771689	20230717	7/11/2023 13:20	7/11/2023	13:20:34	IMG_0022.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230717	7/11/2023 13:21	7/11/2023	13:21:04	IMG_0023.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230717	7/11/2023 13:22	7/11/2023	13:22:06	IMG_0024.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230717	7/13/2023 10:20	7/13/2023	10:20:26	IMG_0028.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230717	7/13/2023 16:42	7/13/2023	16:42:36	IMG_0029.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230717	7/13/2023 16:43	7/13/2023	16:43:16	IMG_0030.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230717	7/14/2023 9:02	7/14/2023	9:02:38	IMG_0031.AVI	Garrulax leucolophus	2
WN1.4	1.438299967	103.771689	20230717	7/14/2023 9:03	7/14/2023	9:03:38	IMG_0032.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230717	7/14/2023 9:04	7/14/2023	9:04:48	IMG_0033.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230717	7/14/2023 9:10	7/14/2023	9:10:12	IMG_0034.AVI	Tupaia	

WN1.4	1.438299967	103.771689	20230717	7/15/2023 9:20	7/15/2023	9:20:14	IMG_0038.AVI	Garrulax leucolophus	1
WN1.4	1.438299967	103.771689	20230717	7/15/2023 9:21	7/15/2023	9:21:46	IMG_0039.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230717	7/15/2023 9:23	7/15/2023	9:23:36	IMG_0040.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230717	7/15/2023 9:27	7/15/2023	9:27:18	IMG_0041.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230717	7/15/2023 13:48	7/15/2023	13:48:30	IMG_0042.AVI	Garrulax leucolophus	4
WN1.4	1.438299967	103.771689	20230717	7/16/2023 18:32	7/16/2023	18:32:14	IMG_0045.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230717	7/16/2023 18:32	7/16/2023	18:32:42	IMG_0046.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230717	7/17/2023 6:21	7/17/2023	6:21:56	IMG_0047.AVI	Rattus tanezumi	1
WN1.4	1.438299967	103.771689	20230717	7/17/2023 12:23	7/17/2023	12:23:14	IMG_0048.AVI	Garrulax leucolophus	2
WN1.4	1.438299967	103.771689	20230717	7/17/2023 12:23	7/17/2023	12:23:38	IMG_0049.AVI	Garrulax leucolophus	2
WN1.4	1.438299967	103.771689	20230717	7/17/2023 12:24	7/17/2023	12:24:40	IMG_0050.AVI	Garrulax leucolophus	1
WN1.4	1.438299967	103.771689	20230717	7/17/2023 12:25	7/17/2023	12:25:26	IMG_0051.AVI	Garrulax leucolophus	1
WN1.4	1.438299967	103.771689	20230717	7/17/2023 12:25	7/17/2023	12:25:48	IMG_0052.AVI	Garrulax leucolophus	1
WN1.4	1.438299967	103.771689	20230818	7/17/2023 16:35	7/17/2023	16:35:46	IMG_0006.AVI	Garrulax leucolophus	3
WN1.4	1.438299967	103.771689	20230818	7/17/2023 16:36	7/17/2023	16:36:28	IMG_0007.AVI	Garrulax leucolophus	3
WN1.4	1.438299967	103.771689	20230818	7/17/2023 16:37	7/17/2023	16:37:06	IMG_0008.AVI	Garrulax leucolophus	3
WN1.4	1.438299967	103.771689	20230818	7/17/2023 16:38	7/17/2023	16:38:14	IMG_0009.AVI	Garrulax leucolophus	4
WN1.4	1.438299967	103.771689	20230818	7/19/2023 9:57	7/19/2023	9:57:08	IMG_0014.AVI	Amuornis phoenicurus	1
WN1.4	1.438299967	103.771689	20230818	7/19/2023 20:32	7/19/2023	20:32:30	IMG_0016.AVI	Rattus tanezumi	1
WN1.4	1.438299967	103.771689	20230818	7/20/2023 10:38	7/20/2023	10:38:20	IMG_0018.AVI	Garrulax leucolophus	1
WN1.4	1.438299967	103.771689	20230818	7/22/2023 9:57	7/22/2023	9:57:20	IMG_0020.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230818	7/22/2023 9:57	7/22/2023	9:57:40	IMG_0021.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230818	7/23/2023 10:32	7/23/2023	10:32:20	IMG_0025.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230818	7/23/2023 10:33	7/23/2023	10:33:40	IMG_0026.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230818	7/23/2023 10:33	7/23/2023	10:33:40	IMG_0026.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230818	7/23/2023 10:41	7/23/2023	10:41:02	IMG_0028.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230818	7/24/2023 4:40	7/24/2023	4:40:32	IMG_0029.AVI	Paradoxurus musangus	1
WN1.4	1.438299967	103.771689	20230818	7/24/2023 4:40	7/24/2023	4:40:54	IMG_0030.AVI	Paradoxurus musangus	1
WN1.4	1.438299967	103.771689	20230818	7/24/2023 9:09	7/24/2023	9:09:24	IMG_0031.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230818	7/25/2023 17:49	7/25/2023	17:49:30	IMG_0032.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230818	7/26/2023 2:39	7/26/2023	2:39:28	IMG_0035.AVI	Rattus tanezumi	1
WN1.4	1.438299967	103.771689	20230818	7/26/2023 18:43	7/26/2023	18:43:48	IMG_0037.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230818	7/26/2023 18:44	7/26/2023	18:44:16	IMG_0038.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230818	8/1/2023 18:46	8/1/2023	18:46:44	IMG_0054.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230818	8/1/2023 18:50	8/1/2023	18:50:22	IMG_0055.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230818	8/4/2023 1:36	8/4/2023	1:36:02	IMG_0057.AVI	Paradoxurus musangus	1
WN1.4	1.438299967	103.771689	20230818	8/4/2023 1:36	8/4/2023	1:36:22	IMG_0058.AVI	Paradoxurus musangus	1
WN1.4	1.438299967	103.771689	20230818	8/10/2023 11:22	8/10/2023	11:22:28	IMG_0065.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230818	8/11/2023 6:50	8/11/2023	6:50:26	IMG_0066.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230818	8/11/2023 13:59	8/11/2023	13:59:28	IMG_0067.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230818	8/11/2023 14:30	8/11/2023	14:30:48	IMG_0068.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230818	8/16/2023 6:52	8/16/2023	6:52:30	IMG_0071.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230818	8/17/2023 8:38	8/17/2023	8:38:48	IMG_0072.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230911	8/18/2023 12:31	8/18/2023	12:31:54	IMG_0011.AVI	Garrulax leucolophus	4
WN1.4	1.438299967	103.771689	20230911	8/19/2023 22:36	8/19/2023	22:36:18	IMG_0013.AVI	Paradoxurus musangus	1
WN1.4	1.438299967	103.771689	20230911	8/24/2023 7:49	8/24/2023	7:49:44	IMG_0016.AVI	Callosciurus notatus	1
WN1.4	1.438299967	103.771689	20230911	8/28/2023 18:40	8/28/2023	18:40:28	IMG_0017.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230911	8/29/2023 18:55	8/29/2023	18:55:30	IMG_0019.AVI	Tupaia glis	1
WN1.4	1.438299967	103.771689	20230911	8/31/2023 17:05	8/31/2023	17:05:42	IMG_0021.AVI	Callosciurus notatus	2
WN1.5	1.439869981	103.772092	20230717	7/7/2023 16:15	7/7/2023	16:15:56	IMG_0003.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230717	7/8/2023 9:33	7/8/2023	9:33:26	IMG_0009.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230717	7/8/2023 12:03	7/8/2023	12:03:34	IMG_0011.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230717	7/10/2023 5:18	7/10/2023	5:18:12	IMG_0014.AVI	Rattus tanezumi	1
WN1.5	1.439869981	103.772092	20230717	7/10/2023 15:28	7/10/2023	15:28:14	IMG_0015.AVI	Callosciurus notatus	1
WN1.5	1.439869981	103.772092	20230717	7/11/2023 8:31	7/11/2023	8:31:24	IMG_0017.AVI	Amuornis phoenicurus	1
WN1.5	1.439869981	103.772092	20230717	7/13/2023 10:15	7/13/2023	10:15:40	IMG_0020.AVI	Garrulax leucolophus	1
WN1.5	1.439869981	103.772092	20230717	7/13/2023 10:16	7/13/2023	10:16:02	IMG_0021.AVI	Garrulax leucolophus	1
WN1.5	1.439869981	103.772092	20230717	7/13/2023 10:20	7/13/2023	10:20:20	IMG_0022.AVI	Garrulax leucolophus	1
WN1.5	1.439869981	103.772092	20230717	7/15/2023 17:10	7/15/2023	17:10:18	IMG_0023.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230717	7/15/2023 18:27	7/15/2023	18:27:02	IMG_0024.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230717	7/16/2023 7:50	7/16/2023	7:50:02	IMG_0025.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230717	7/16/2023 8:12	7/16/2023	8:12:38	IMG_0026.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230717	7/16/2023 10:06	7/16/2023	10:06:28	IMG_0028.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230717	7/16/2023 11:26	7/16/2023	11:26:28	IMG_0029.AVI	Amuornis phoenicurus	1
WN1.5	1.439869981	103.772092	20230717	7/16/2023 14:08	7/16/2023	14:08:32	IMG_0030.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230717	7/16/2023 18:21	7/16/2023	18:21:32	IMG_0031.AVI	Callosciurus notatus	1
WN1.5	1.439869981	103.772092	20230717	7/17/2023 8:51	7/17/2023	8:51:32	IMG_0033.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/17/2023 18:49	7/17/2023	18:49:22	IMG_0005.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/19/2023 8:08	7/19/2023	8:08:44	IMG_0007.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/20/2023 7:40	7/20/2023	7:40:06	IMG_0011.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/22/2023 15:22	7/22/2023	15:22:52	IMG_0013.AVI	Garrulax leucolophus	1
WN1.5	1.439869981	103.772092	20230818	7/22/2023 15:23	7/22/2023	15:23:20	IMG_0014.AVI	Garrulax leucolophus	2
WN1.5	1.439869981	103.772092	20230818	7/22/2023 16:12	7/22/2023	16:12:48	IMG_0017.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/22/2023 16:20	7/22/2023	16:20:38	IMG_0018.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/23/2023 10:29	7/23/2023	10:29:42	IMG_0019.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/23/2023 10:34	7/23/2023	10:34:58	IMG_0020.AVI	Garrulax leucolophus	2
WN1.5	1.439869981	103.772092	20230818	7/23/2023 10:35	7/23/2023	10:35:46	IMG_0021.AVI	Garrulax leucolophus	4
WN1.5	1.439869981	103.772092	20230818	7/23/2023 10:43	7/23/2023	10:43:44	IMG_0022.AVI	Garrulax leucolophus	3
WN1.5	1.439869981	103.772092	20230818	7/23/2023 10:44	7/23/2023	10:44:10	IMG_0023.AVI	Garrulax leucolophus	3
WN1.5	1.439869981	103.772092	20230818	7/23/2023 10:45	7/23/2023	10:45:20	IMG_0024.AVI	Garrulax leucolophus	4
WN1.5	1.439869981	103.772092	20230818	7/23/2023 10:46	7/23/2023	10:46:24	IMG_0025.AVI	Garrulax leucolophus	4
WN1.5	1.439869981	103.772092	20230818	7/23/2023 10:47	7/23/2023	10:47:12	IMG_0026.AVI	Garrulax leucolophus	2
WN1.5	1.439869981	103.772092	20230818	7/23/2023 15:54	7/23/2023	15:54:42	IMG_0027.AVI	Amuornis phoenicurus	1
WN1.5	1.439869981	103.772092	20230818	7/24/2023 14:26	7/24/2023	14:26:40	IMG_0031.AVI	Amuornis phoenicurus	1
WN1.5	1.439869981	103.772092	20230818	7/24/2023 14:40	7/24/2023	14:40:16	IMG_0032.AVI	Garrulax leucolophus	2
WN1.5	1.439869981	103.772092	20230818	7/24/2023 14:43	7/24/2023	14:43:02	IMG_0034.AVI	Garrulax leucolophus	2
WN1.5	1.439869981	103.772092	20230818	7/24/2023 14:43	7/24/2023	14:43:02	IMG_0034.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/24/2023 14:43	7/24/2023	14:43:34	IMG_0035.AVI	Garrulax leucolophus	2
WN1.5	1.439869981	103.772092	20230818	7/24/2023 14:43	7/24/2023	14:43:34	IMG_0035.AVI	Tupaia glis	2
WN1.5	1.439869981	103.772092	20230818	7/24/2023 14:43	7/24/2023	14:43:58	IMG_0036.AVI	Garrulax leucolophus	2
WN1.5	1.439869981	103.772092	20230818	7/24/2023 14:43	7/24/2023	14:43:58	IMG_0036.AVI	Tupaia glis	2
WN1.5	1.439869981	103.772092	20230818						

WN1.5	1.439869981	103.772092	20230818	7/24/2023 15:07	7/24/2023	15:07:18	IMG_0042.AVI	Callosciurus notatus	1
WN1.5	1.439869981	103.772092	20230818	7/24/2023 15:09	7/24/2023	15:09:56	IMG_0043.AVI	Callosciurus notatus	1
WN1.5	1.439869981	103.772092	20230818	7/24/2023 15:25	7/24/2023	15:25:14	IMG_0044.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/25/2023 5:25	7/25/2023	5:25:50	IMG_0045.AVI	Paradoxurus musangus	1
WN1.5	1.439869981	103.772092	20230818	7/25/2023 5:26	7/25/2023	5:26:12	IMG_0046.AVI	Paradoxurus musangus	1
WN1.5	1.439869981	103.772092	20230818	7/25/2023 7:42	7/25/2023	7:42:06	IMG_0047.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/25/2023 13:08	7/25/2023	13:08:52	IMG_0048.AVI	Garrulax leucolophus	3
WN1.5	1.439869981	103.772092	20230818	7/25/2023 13:09	7/25/2023	13:09:58	IMG_0049.AVI	Garrulax leucolophus	1
WN1.5	1.439869981	103.772092	20230818	7/25/2023 13:10	7/25/2023	13:10:42	IMG_0050.AVI	Callosciurus notatus	1
WN1.5	1.439869981	103.772092	20230818	7/25/2023 13:10	7/25/2023	13:10:42	IMG_0050.AVI	Garrulax leucolophus	2
WN1.5	1.439869981	103.772092	20230818	7/25/2023 13:58	7/25/2023	13:58:48	IMG_0051.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/25/2023 14:40	7/25/2023	14:40:50	IMG_0052.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/26/2023 7:05	7/26/2023	7:05:30	IMG_0053.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/26/2023 15:30	7/26/2023	15:30:26	IMG_0055.AVI	Garrulax leucolophus	1
WN1.5	1.439869981	103.772092	20230818	7/26/2023 17:45	7/26/2023	17:45:34	IMG_0056.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/28/2023 7:45	7/28/2023	7:45:18	IMG_0057.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/28/2023 8:53	7/28/2023	8:53:36	IMG_0058.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/28/2023 12:30	7/28/2023	12:30:42	IMG_0059.AVI	Garrulax leucolophus	1
WN1.5	1.439869981	103.772092	20230818	7/28/2023 12:38	7/28/2023	12:38:18	IMG_0060.AVI	Garrulax leucolophus	3
WN1.5	1.439869981	103.772092	20230818	7/28/2023 12:39	7/28/2023	12:39:10	IMG_0061.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/28/2023 12:47	7/28/2023	12:47:34	IMG_0062.AVI	Garrulax leucolophus	1
WN1.5	1.439869981	103.772092	20230818	7/29/2023 10:44	7/29/2023	10:44:24	IMG_0063.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/30/2023 19:03	7/30/2023	19:03:10	IMG_0064.AVI	Callosciurus notatus	1
WN1.5	1.439869981	103.772092	20230818	7/31/2023 11:25	7/31/2023	11:25:14	IMG_0065.AVI	Garrulax leucolophus	1
WN1.5	1.439869981	103.772092	20230818	7/31/2023 12:09	7/31/2023	12:09:52	IMG_0066.AVI	Garrulax leucolophus	3
WN1.5	1.439869981	103.772092	20230818	7/31/2023 12:14	7/31/2023	12:14:38	IMG_0067.AVI	Garrulax leucolophus	2
WN1.5	1.439869981	103.772092	20230818	7/31/2023 12:14	7/31/2023	12:14:38	IMG_0067.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/31/2023 12:15	7/31/2023	12:15:56	IMG_0068.AVI	Garrulax leucolophus	2
WN1.5	1.439869981	103.772092	20230818	7/31/2023 12:56	7/31/2023	12:56:00	IMG_0069.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	7/31/2023 12:57	7/31/2023	12:57:10	IMG_0070.AVI	Callosciurus notatus	1
WN1.5	1.439869981	103.772092	20230818	7/31/2023 13:36	7/31/2023	13:36:36	IMG_0071.AVI	Callosciurus notatus	1
WN1.5	1.439869981	103.772092	20230818	7/31/2023 13:55	7/31/2023	13:55:18	IMG_0072.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	8/4/2023 7:06	8/4/2023	7:06:48	IMG_0075.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	8/4/2023 7:56	8/4/2023	7:56:04	IMG_0076.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	8/5/2023 17:46	8/5/2023	17:46:20	IMG_0077.AVI	Callosciurus notatus	1
WN1.5	1.439869981	103.772092	20230818	8/7/2023 7:01	8/7/2023	7:01:38	IMG_0078.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	8/7/2023 7:13	8/7/2023	7:13:04	IMG_0079.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	8/7/2023 11:05	8/7/2023	11:05:28	IMG_0080.AVI	Garrulax leucolophus	3
WN1.5	1.439869981	103.772092	20230818	8/7/2023 18:29	8/7/2023	18:29:58	IMG_0081.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	8/7/2023 18:30	8/7/2023	18:30:38	IMG_0082.AVI	Callosciurus notatus	1
WN1.5	1.439869981	103.772092	20230818	8/9/2023 8:52	8/9/2023	8:52:44	IMG_0085.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	8/10/2023 7:10	8/10/2023	7:10:22	IMG_0087.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	8/12/2023 9:39	8/12/2023	9:39:28	IMG_0091.AVI	Garrulax leucolophus	1
WN1.5	1.439869981	103.772092	20230818	8/12/2023 9:40	8/12/2023	9:40:56	IMG_0092.AVI	Garrulax leucolophus	1
WN1.5	1.439869981	103.772092	20230818	8/12/2023 9:43	8/12/2023	9:43:58	IMG_0093.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	8/12/2023 10:59	8/12/2023	10:59:00	IMG_0094.AVI	Garrulax leucolophus	2
WN1.5	1.439869981	103.772092	20230818	8/12/2023 11:00	8/12/2023	11:00:10	IMG_0096.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	8/12/2023 11:01	8/12/2023	11:01:10	IMG_0097.AVI	Garrulax leucolophus	1
WN1.5	1.439869981	103.772092	20230818	8/12/2023 12:13	8/12/2023	12:13:56	IMG_0098.AVI	Callosciurus notatus	1
WN1.5	1.439869981	103.772092	20230818	8/12/2023 16:50	8/12/2023	16:50:30	IMG_0099.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	8/12/2023 18:39	8/12/2023	18:39:30	IMG_0100.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	8/13/2023 14:51	8/13/2023	14:51:36	IMG_0101.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	8/17/2023 18:08	8/17/2023	18:08:30	IMG_0102.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230818	8/17/2023 18:13	8/17/2023	18:13:28	IMG_0103.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230911	8/18/2023 17:18	8/18/2023	17:18:52	IMG_0004.AVI	Callosciurus notatus	1
WN1.5	1.439869981	103.772092	20230911	8/18/2023 17:19	8/18/2023	17:19:40	IMG_0005.AVI	Callosciurus notatus	1
WN1.5	1.439869981	103.772092	20230911	8/18/2023 18:07	8/18/2023	18:07:02	IMG_0006.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230911	8/19/2023 9:32	8/19/2023	9:32:06	IMG_0007.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230911	8/19/2023 16:00	8/19/2023	16:00:46	IMG_0008.AVI	Amaurornis phoenicurus	1
WN1.5	1.439869981	103.772092	20230911	8/19/2023 18:44	8/19/2023	18:44:24	IMG_0009.AVI	Amaurornis phoenicurus	1
WN1.5	1.439869981	103.772092	20230911	8/20/2023 9:05	8/20/2023	9:05:10	IMG_0010.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230911	8/20/2023 11:08	8/20/2023	11:08:22	IMG_0011.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230911	8/20/2023 11:13	8/20/2023	11:13:40	IMG_0012.AVI	Garrulax leucolophus	1
WN1.5	1.439869981	103.772092	20230911	8/21/2023 8:30	8/21/2023	8:30:14	IMG_0014.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230911	8/22/2023 9:23	8/22/2023	9:23:50	IMG_0015.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230911	8/25/2023 7:00	8/25/2023	7:00:28	IMG_0017.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230911	8/25/2023 7:03	8/25/2023	7:03:28	IMG_0018.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230911	8/26/2023 10:50	8/26/2023	10:50:42	IMG_0020.AVI	Amaurornis phoenicurus	1
WN1.5	1.439869981	103.772092	20230911	8/26/2023 18:48	8/26/2023	18:48:18	IMG_0021.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230911	8/28/2023 10:31	8/28/2023	10:31:20	IMG_0023.AVI	Garrulax leucolophus	2
WN1.5	1.439869981	103.772092	20230911	8/28/2023 12:51	8/28/2023	12:51:44	IMG_0024.AVI	Canis lupus familiaris	2
WN1.5	1.439869981	103.772092	20230911	8/28/2023 12:53	8/28/2023	12:53:46	IMG_0025.AVI	Canis lupus familiaris	1
WN1.5	1.439869981	103.772092	20230911	8/28/2023 17:50	8/28/2023	17:50:06	IMG_0026.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230911	8/29/2023 18:52	8/29/2023	18:52:12	IMG_0027.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230911	8/30/2023 19:11	8/30/2023	19:11:44	IMG_0030.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230911	9/1/2023 7:51	9/1/2023	7:51:54	IMG_0031.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230911	9/2/2023 9:36	9/2/2023	9:36:02	IMG_0032.AVI	Amaurornis phoenicurus	1
WN1.5	1.439869981	103.772092	20230911	9/2/2023 9:37	9/2/2023	9:37:02	IMG_0033.AVI	Callosciurus notatus	1
WN1.5	1.439869981	103.772092	20230911	9/3/2023 7:03	9/3/2023	7:03:44	IMG_0034.AVI	Tupaia glis	1
WN1.5	1.439869981	103.772092	20230911	9/6/2023 7:22	9/6/2023	7:22:34	IMG_0035.AVI	Canis lupus familiaris	2
WN1.6	1.44009	103.77246	20230717	7/12/2023 22:59	7/12/2023	22:59:38	IMG_0101.AVI	Malayopython reticulatus	1
WN1.6	1.44009	103.77246	20230717	7/13/2023 20:29	7/13/2023	20:29:28	IMG_0225.AVI	Rattus tanezumi	1
WN1.6	1.44009	103.77246	20230818	7/18/2023 19:14	7/18/2023	19:14:24	IMG_0118.AVI	Tupaia glis	1
WN1.6	1.44009	103.77246	20230904	8/26/2023 17:13	8/26/2023	17:13:04	IMG_0239.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20230911	9/7/2023 11:40	9/7/2023	11:40:36	IMG_0098.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20230911	9/9/2023 18:28	9/9/2023	18:28:52	IMG_0200.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20230911	9/10/2023 9:35	9/10/2023	9:35:18	IMG_0249.AVI	Tupaia glis	1
WN1.6	1.44009	103.77246	20230919	9/11/2023 10:30	9/11/2023	10:30:02	IMG_0008.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20231004	9/24/2023 14:49	9/24/2023	14:49:40	IMG_0024.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20231004	9/27/2023 12:53	9/27/2023	12:53:10	IMG_0043.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20231004	9/29/2023 9:43	9/29/2023	9:43:12	IMG_0048.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20231004	9/29/2023 18:23	9/29/2023	18:23:38	IMG_0050.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20231004	10/2					

WN1.6	1.44009	103.77246	20231023	10/9/2023 12:26	10/9/2023	12:26:06	IMG_0042.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20231023	10/10/2023 20:48	10/10/2023	20:48:28	IMG_0045.AVI	Otus lempiji	1
WN1.6	1.44009	103.77246	20231023	10/15/2023 9:22	10/15/2023	9:22:58	IMG_0048.AVI	Garrulax leucolophus	1
WN1.6	1.44009	103.77246	20231023	10/17/2023 9:41	10/17/2023	9:41:06	IMG_0053.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20231023	10/17/2023 9:44	10/17/2023	9:44:38	IMG_0054.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20231023	10/17/2023 9:45	10/17/2023	9:45:12	IMG_0055.AVI	Callosciurus notatus	2
WN1.6	1.44009	103.77246	20231023	10/17/2023 11:58	10/17/2023	11:58:08	IMG_0057.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20231023	10/17/2023 12:01	10/17/2023	12:01:18	IMG_0059.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20231023	10/20/2023 9:00	10/20/2023	9:00:38	IMG_0065.AVI	Tupaia glis	1
WN1.6	1.44009	103.77246	20231023	10/21/2023 18:02	10/21/2023	18:02:00	IMG_0084.AVI	Tupaia glis	1
WN1.6	1.44009	103.77246	20231023	10/22/2023 10:28	10/22/2023	10:28:50	IMG_0085.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20231023	10/22/2023 10:29	10/22/2023	10:29:50	IMG_0086.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20231023	10/22/2023 12:32	10/22/2023	12:32:10	IMG_0087.AVI	Garrulax leucolophus	3
WN1.6	1.44009	103.77246	20231023	10/22/2023 12:41	10/22/2023	12:41:18	IMG_0088.AVI	Garrulax leucolophus	3
WN1.6	1.44009	103.77246	20231023	10/22/2023 12:53	10/22/2023	12:53:50	IMG_0089.AVI	Callosciurus notatus	1
WN1.6	1.44009	103.77246	20231023	10/22/2023 12:53	10/22/2023	12:53:50	IMG_0089.AVI	Garrulax leucolophus	2
WN1.6	1.44009	103.77246	20231023	10/22/2023 18:50	10/22/2023	18:50:30	IMG_0091.AVI	Tupaia glis	1
WN1.6	1.44009	103.77246	20231023	10/22/2023 19:02	10/22/2023	19:02:36	IMG_0092.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20230717	7/9/2023 8:58	7/9/2023	8:58:52	IMG_0012.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20230717	7/11/2023 19:26	7/11/2023	19:26:22	IMG_0013.AVI	Rattus tanezumi	1
WN1.7	1.43961	103.77348	20230717	7/13/2023 6:59	7/13/2023	6:59:22	IMG_0014.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20230717	7/13/2023 15:24	7/13/2023	15:24:14	IMG_0016.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20230717	7/13/2023 15:24	7/13/2023	15:24:36	IMG_0017.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20230818	7/19/2023 8:23	7/19/2023	8:23:42	IMG_0022.AVI	Picus vittatus	1
WN1.7	1.43961	103.77348	20230818	7/19/2023 8:28	7/19/2023	8:28:40	IMG_0023.AVI	Picus vittatus	1
WN1.7	1.43961	103.77348	20230818	7/19/2023 13:36	7/19/2023	13:36:56	IMG_0025.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20230818	7/19/2023 13:58	7/19/2023	13:58:16	IMG_0026.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20230818	7/24/2023 14:24	7/24/2023	14:24:06	IMG_0222.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20230818	7/24/2023 16:43	7/24/2023	16:43:30	IMG_0227.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20230818	7/25/2023 9:29	7/25/2023	9:29:16	IMG_0240.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20230818	7/25/2023 10:39	7/25/2023	10:39:00	IMG_0245.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20230818	7/25/2023 14:19	7/25/2023	14:19:46	IMG_0257.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20230818	7/25/2023 14:24	7/25/2023	14:24:20	IMG_0258.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20230818	7/26/2023 13:34	7/26/2023	13:34:58	IMG_0287.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20230818	7/26/2023 15:06	7/26/2023	15:06:24	IMG_0289.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20230904	8/28/2023 23:49	8/28/2023	23:49:52	IMG_0247.AVI	Canis lupus familiaris	2
WN1.7	1.43961	103.77348	20230904	9/1/2023 1:02	9/1/2023	1:02:40	IMG_0334.AVI	Canis lupus familiaris	2
WN1.7	1.43961	103.77348	20230911	9/8/2023 0:56	9/8/2023	0:56:32	IMG_0022.AVI	Rattus tanezumi	1
WN1.7	1.43961	103.77348	20230911	9/11/2023 1:37	9/11/2023	1:37:04	IMG_0033.AVI	Rattus tiomanicus	1
WN1.7	1.43961	103.77348	20230919	9/14/2023 7:27	9/14/2023	7:27:34	IMG_0021.AVI	Callosciurus notatus	1
WN1.7	1.43961	103.77348	20230919	9/14/2023 7:32	9/14/2023	7:32:14	IMG_0022.AVI	Callosciurus notatus	1
WN1.7	1.43961	103.77348	20230919	9/14/2023 13:53	9/14/2023	13:53:24	IMG_0023.AVI	Callosciurus notatus	1
WN1.7	1.43961	103.77348	20230919	9/19/2023 5:19	9/19/2023	5:19:42	IMG_0030.AVI	Rattus tiomanicus	1
WN1.7	1.43961	103.77348	20231004	9/21/2023 18:53	9/21/2023	18:53:50	IMG_0016.AVI	Tupaia glis	1
WN1.7	1.43961	103.77348	20231004	9/22/2023 9:14	9/22/2023	9:14:06	IMG_0021.AVI	Callosciurus notatus	1
WN1.7	1.43961	103.77348	20231004	9/22/2023 9:14	9/22/2023	9:14:54	IMG_0022.AVI	Callosciurus notatus	1
WN1.7	1.43961	103.77348	20231004	9/26/2023 3:48	9/26/2023	3:48:34	IMG_0054.AVI	Rattus tiomanicus	1
WN1.7	1.43961	103.77348	20231004	9/26/2023 20:23	9/26/2023	20:23:22	IMG_0057.AVI	Rattus tiomanicus	1
WN1.7	1.43961	103.77348	20231004	9/27/2023 18:53	9/27/2023	18:53:56	IMG_0058.AVI	Callosciurus notatus	2
WN1.7	1.43961	103.77348	20231004	9/28/2023 17:35	9/28/2023	17:35:06	IMG_0059.AVI	Callosciurus notatus	1
WN1.7	1.43961	103.77348	20231004	9/28/2023 17:39	9/28/2023	17:39:54	IMG_0060.AVI	Callosciurus notatus	1
WN1.7	1.43961	103.77348	20231004	9/29/2023 5:06	9/29/2023	5:06:50	IMG_0061.AVI	Rattus tiomanicus	1
WN1.7	1.43961	103.77348	20231004	9/29/2023 12:05	9/29/2023	12:05:10	IMG_0062.AVI	Callosciurus notatus	1
WN1.7	1.43961	103.77348	20231004	9/29/2023 13:01	9/29/2023	13:01:24	IMG_0063.AVI	Callosciurus notatus	1
WN1.7	1.43961	103.77348	20231004	10/1/2023 4:46	10/1/2023	4:46:42	IMG_0065.AVI	Rattus tiomanicus	1
WN1.7	1.43961	103.77348	20231004	10/2/2023 5:05	10/2/2023	5:05:36	IMG_0066.AVI	Rattus tiomanicus	1
WN1.7	1.43961	103.77348	20231004	10/2/2023 5:52	10/2/2023	5:52:50	IMG_0067.AVI	Rattus tiomanicus	1
WN1.7	1.43961	103.77348	20231004	10/2/2023 18:54	10/2/2023	18:54:14	IMG_0068.AVI	Callosciurus notatus	1

Appendix L Impact Assessment on Habitat Receptors

Receptor Type	Type	Site	Receptor	Phase	Impact type	Sensitivity (S)	Impact intensity (I)	Consequence (C = S × I)	Likelihood (L)	Key minimum controls	Impact significance (C × L)	Residual impact intensity	Residual consequence	Residual likelihood	Residual impact significance
Habitat	Direct	Woodlands N1	Native-dominated Secondary Forest	Construction	Loss of habitat	High	High	High	Certain		Major	Low	Low	Certain	Moderate
Habitat	Direct	Woodlands N1	Abandoned-land forest	Construction	Loss of habitat	Medium	High	Medium	Certain		Major	High	Medium	Certain	Major
Habitat	Direct	Woodlands N1	Scrubland	Construction	Loss of habitat	Low	High	Low	Certain		Moderate	High	Low	Certain	Moderate
Habitat	Direct	Woodlands N1	Urban Vegetation (Turf)	Construction	Loss of habitat	Low	Low	Very Low	Certain		Minor	Medium	Very Low	Certain	Minor
Habitat	Indirect	Woodlands N1	Native-dominated Secondary Forest	Construction	Formation of forest edge	High	High	High	Less Likely		Minor	Medium	Medium	Less Likely	Minor
Habitat	Indirect	Woodlands N1	Abandoned-land forest	Construction	Formation of forest edge	Medium	NA	#N/A	Unlikely		#N/A	Medium	Low	Unlikely	Negligible
Habitat	Indirect	Woodlands N1	Scrubland	Construction	Formation of forest edge	Low	NA	#N/A	Unlikely		#N/A	Medium	Very Low	Unlikely	Negligible
Habitat	Indirect	Woodlands N1	Urban Vegetation (Turf)	Construction	Formation of forest edge	Low	Low	Very Low	Less Likely		Negligible	Low	Very Low	Less Likely	Negligible
Habitat	Indirect	Woodlands N1	Native-dominated Secondary Forest	Construction	Habitat degradation	High	High	High	Less Likely		Minor	Medium	Medium	Less Likely	Minor
Habitat	Indirect	Woodlands N1	Abandoned-land forest	Construction	Habitat degradation	Medium	NA	#N/A	Unlikely		#N/A	Medium	Low	Unlikely	Negligible
Habitat	Indirect	Woodlands N1	Scrubland	Construction	Habitat degradation	Low	NA	#N/A	Unlikely		#N/A	Medium	Very Low	Unlikely	Negligible
Habitat	Indirect	Woodlands N1	Urban Vegetation (Turf)	Construction	Habitat degradation	Low	Low	Very Low	Less Likely		Negligible	Low	Very Low	Less Likely	Negligible
Habitat	Direct	Woodlands N1	Native-dominated Secondary Forest	Operational	Habitat degradation	High	High	High	Less Likely		Minor	Medium	Medium	Less Likely	Minor
Habitat	Direct	Woodlands N1	Abandoned-land forest	Operational	Habitat degradation	Medium	NA	#N/A	Unlikely		#N/A	Medium	Low	Unlikely	Negligible
Habitat	Direct	Woodlands N1	Scrubland	Operational	Habitat degradation	Low	NA	#N/A	Unlikely		#N/A	Medium	Very Low	Unlikely	Negligible
Habitat	Direct	Woodlands N1	Urban Vegetation (Turf)	Operational	Habitat degradation	Low	Low	Very Low	Less Likely		Negligible	Low	Very Low	Less Likely	Negligible
Habitat	Indirect	Woodlands N1	Native-dominated Secondary Forest	Operational	Changes in microclimatic conditions	High	High	High	Less Likely		Minor	Medium	Medium	Less Likely	Minor
Habitat	Indirect	Woodlands N1	Abandoned-land forest	Operational	Changes in microclimatic conditions	Medium	NA	#N/A	Unlikely		#N/A	Medium	Low	Unlikely	Negligible
Habitat	Indirect	Woodlands N1	Scrubland	Operational	Changes in microclimatic conditions	Low	NA	#N/A	Unlikely		#N/A	Medium	Very Low	Unlikely	Negligible
Habitat	Indirect	Woodlands N1	Urban Vegetation (Turf)	Operational	Changes in microclimatic conditions	Low	Low	Very Low	Less Likely		Negligible	Low	Very Low	Less Likely	Negligible

Appendix M Impact Assessment on Flora Receptors

Receptor Type	Type	Site	Receptor	Phase	Impact type	Sensitivity (S)	Impact intensity (I)	Consequence (C = S × I)	Likelihood (L)	Key minimum controls	Impact significance (C × L)	Residual impact intensity	Residual consequence	Residual likelihood	Residual impact significance
Flora	Direct	Biodiversity Study Area	<i>Aporosa falcifera</i>	Construction	Mortality	High	High	High	Certain		Major	Negligible	Very Low	Unlikely	Negligible
Flora	Direct	Biodiversity Study Area	<i>Aristolochia acuminata</i>	Construction	Mortality	High	High	High	Certain		Major	Low	Low	Unlikely	Negligible
Flora	Direct	Biodiversity Study Area	<i>Baccaurea polyneura</i>	Construction	Mortality	High	High	High	Certain		Major	Low	Low	Certain	Moderate
Flora	Direct	Biodiversity Study Area	<i>Bambusa vulgaris</i>	Construction	Mortality	High	High	High	Certain		Major	Negligible	Very Low	Unlikely	Negligible
Flora	Direct	Biodiversity Study Area	<i>Bouea oppositifolia</i>	Construction	Mortality	High	High	High	Certain		Major	Negligible	Very Low	Unlikely	Negligible
Flora	Direct	Biodiversity Study Area	<i>Curculigo latifolia</i>	Construction	Mortality	High	High	High	Certain		Major	Negligible	Very Low	Unlikely	Negligible
Flora	Direct	Biodiversity Study Area	<i>Dioscorea hispida</i>	Construction	Mortality	High	High	High	Certain		Major	Negligible	Very Low	Unlikely	Negligible
Flora	Direct	Biodiversity Study Area	<i>Ficus aurata</i>	Construction	Mortality	High	High	High	Certain		Major	Low	Low	Possible	Minor
Flora	Direct	Biodiversity Study Area	<i>Ficus benjamina</i>	Construction	Mortality	High	High	High	Certain		Major	High	High	Possible	Moderate
Flora	Direct	Biodiversity Study Area	<i>Ficus fistulosa</i>	Construction	Mortality	High	High	High	Certain		Major	Medium	Medium	Possible	Moderate
Flora	Direct	Biodiversity Study Area	<i>Ficus grossularioides</i> var. <i>grossularioides</i>	Construction	Mortality	High	High	High	Certain		Major	Medium	Medium	Possible	Moderate
Flora	Direct	Biodiversity Study Area	<i>Ficus heteropleura</i>	Construction	Mortality	High	High	High	Certain		Major	Medium	Medium	Possible	Moderate
Flora	Direct	Biodiversity Study Area	<i>Ficus microcarpa</i>	Construction	Mortality	High	High	High	Certain		Major	Medium	Medium	Possible	Moderate
Flora	Direct	Biodiversity Study Area	<i>Ficus punctata</i>	Construction	Mortality	High	High	High	Certain		Major	Medium	Medium	Possible	Moderate
Flora	Direct	Biodiversity Study Area	<i>Ficus variegata</i>	Construction	Mortality	High	High	High	Certain		Major	Medium	Medium	Possible	Moderate
Flora	Direct	Biodiversity Study Area	<i>Gymnacranthera farquhariana</i> var. <i>farquhariana</i>	Construction	Mortality	High	High	High	Certain		Major	Low	Low	Possible	Minor
Flora	Direct	Biodiversity Study Area	<i>Lindera lucida</i>	Construction	Mortality	High	High	High	Certain		Major	Low	Low	Possible	Minor
Flora	Direct	Biodiversity Study Area	<i>Litsea umbellata</i>	Construction	Mortality	High	High	High	Certain		Major	Negligible	Very Low	Unlikely	Negligible
Flora	Direct	Biodiversity Study Area	<i>Microlepia speluncae</i>	Construction	Mortality	High	High	High	Certain		Major	Negligible	Very Low	Unlikely	Negligible
Flora	Direct	Biodiversity Study Area	<i>Psychotria polycarpa</i>	Construction	Mortality	High	High	High	Certain		Major	Negligible	Very Low	Unlikely	Negligible
Flora	Direct	Biodiversity Study Area	<i>Thyrsostachys siamensis</i>	Construction	Mortality	High	High	High	Certain		Major	Negligible	Very Low	Unlikely	Negligible
Flora	Indirect	Biodiversity Study Area	<i>Aporosa falcifera</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Negligible	Very Low	Unlikely	Negligible
Flora	Indirect	Biodiversity Study Area	<i>Aristolochia acuminata</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Low	Low	Possible	Minor
Flora	Indirect	Biodiversity Study Area	<i>Baccaurea polyneura</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Negligible	Very Low	Unlikely	Negligible
Flora	Indirect	Biodiversity Study Area	<i>Bambusa vulgaris</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Negligible	Very Low	Unlikely	Negligible
Flora	Indirect	Biodiversity Study Area	<i>Bouea oppositifolia</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Negligible	Very Low	Unlikely	Negligible
Flora	Indirect	Biodiversity Study Area	<i>Curculigo latifolia</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Negligible	Very Low	Unlikely	Negligible
Flora	Indirect	Biodiversity Study Area	<i>Dioscorea hispida</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Negligible	Very Low	Unlikely	Negligible
Flora	Indirect	Biodiversity Study Area	<i>Ficus aurata</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Medium	Medium	Possible	Moderate
Flora	Indirect	Biodiversity Study Area	<i>Ficus benjamina</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Negligible	Very Low	Unlikely	Negligible
Flora	Indirect	Biodiversity Study Area	<i>Ficus fistulosa</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Low	Low	Possible	Minor
Flora	Indirect	Biodiversity Study Area	<i>Ficus grossularioides</i> var. <i>grossularioides</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Low	Low	Possible	Minor
Flora	Indirect	Biodiversity Study Area	<i>Ficus heteropleura</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Low	Low	Possible	Minor
Flora	Indirect	Biodiversity Study Area	<i>Ficus microcarpa</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Low	Low	Possible	Minor
Flora	Indirect	Biodiversity Study Area	<i>Ficus punctata</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Low	Low	less likely	Minor
Flora	Indirect	Biodiversity Study Area	<i>Ficus variegata</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Low	Low	Possible	Minor
Flora	Indirect	Biodiversity Study Area	<i>Gymnacranthera farquhariana</i> var. <i>farquhariana</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Negligible	Very Low	Unlikely	Negligible
Flora	Indirect	Biodiversity Study Area	<i>Lindera lucida</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Low	Low	Possible	Minor
Flora	Indirect	Biodiversity Study Area	<i>Litsea umbellata</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Low	Low	Possible	Minor
Flora	Indirect	Biodiversity Study Area	<i>Microlepia speluncae</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Negligible	Very Low	Unlikely	Negligible
Flora	Indirect	Biodiversity Study Area	<i>Psychotria polycarpa</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Negligible	Very Low	Unlikely	Negligible
Flora	Indirect	Biodiversity Study Area	<i>Thyrsostachys siamensis</i>	Construction	Decline in plant health and survival	High	Negligible	Very Low	Unlikely	Demarcate working space clearly/hoarding	Negligible	Negligible	Very Low	Unlikely	Negligible

Appendix N Impact Assessment on Fauna Receptors

Fauna Impact Assessment

[illegible]

Appendix O Tree Protection and Conservation Guidelines

TREE PROTECTION AND CONSERVATION GUIDELINES

By

Derek Yap

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, 1.8-m tall and firmly installed into the ground.
- ii. **Ground protection**
Mulching material (can be compost or woodchips) at 100-mm 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:

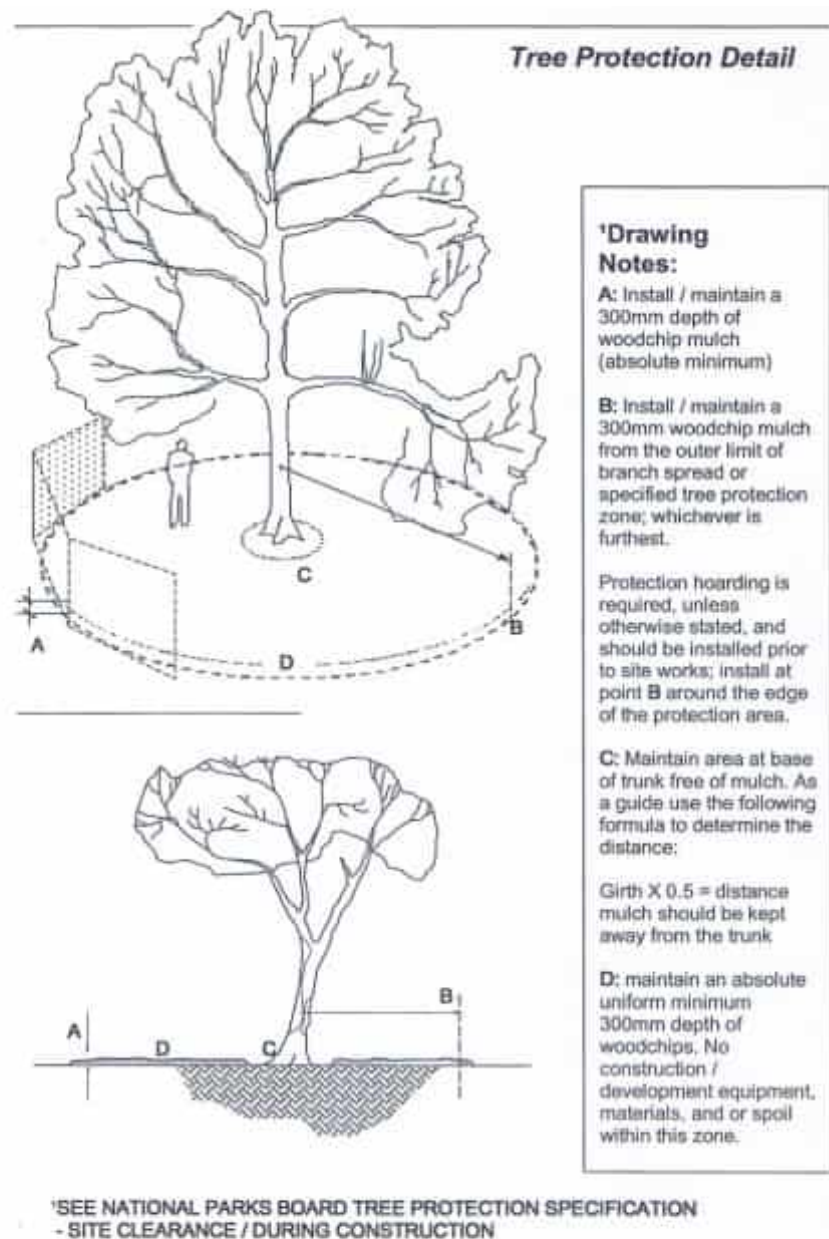


Entry prohibited. This fence shall remain in place throughout the entire construction period.

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 from 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 (see Point 4.3 Tree Conservation Guidelines) Arboriculture contractors be engage 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 carry 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: 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.

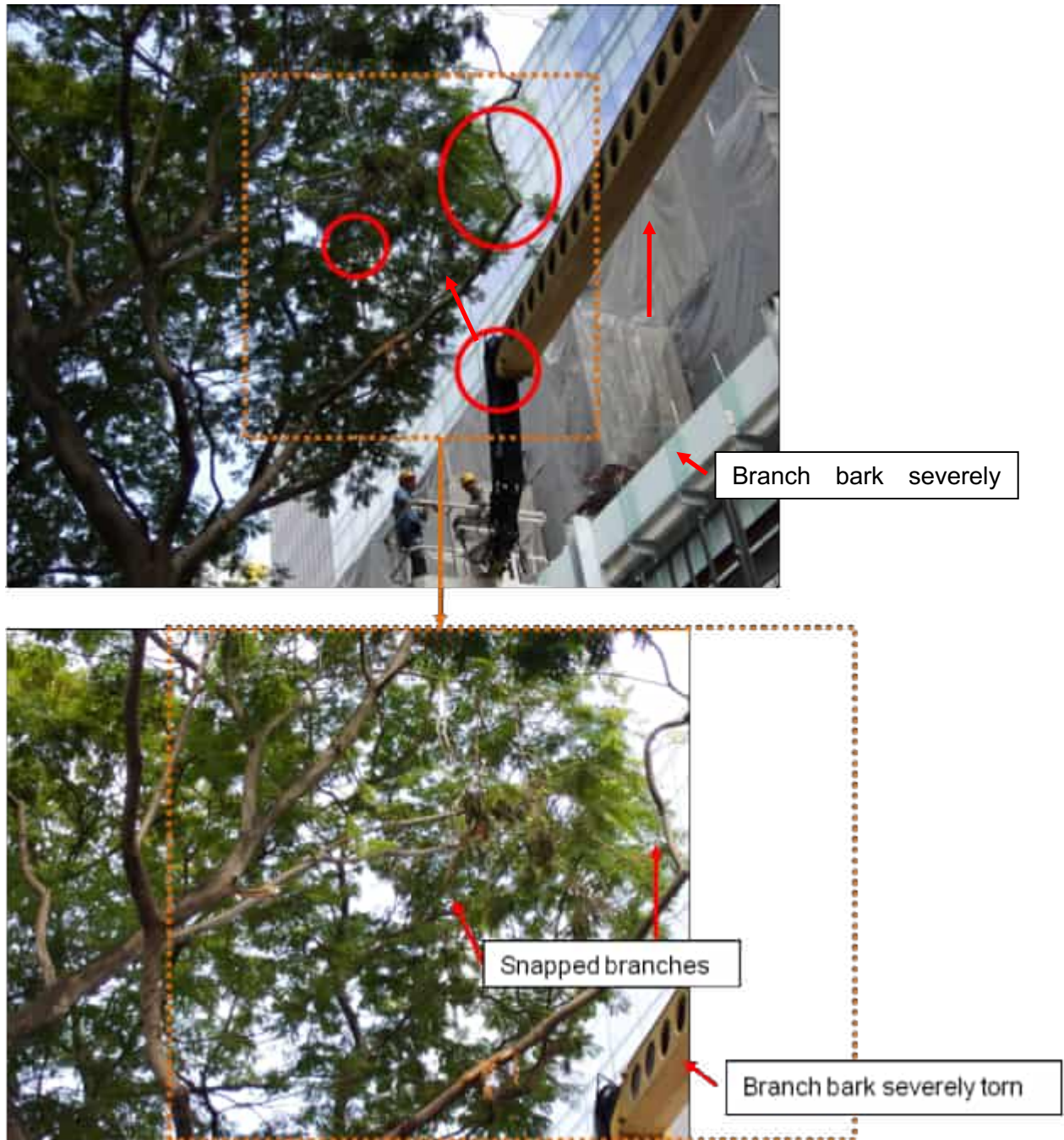


Figure 8: Tree branches were severed due to the negligence of the crane operator.

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.



Figure 10: 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, steel 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 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: _____

Appendix P
Guidelines for Sapling Harvesting
and Tree Transplantation and
Tree Maintenance

Appendix A

Guidelines for Sapling and Tree Transplantation and Tree Maintenance

CONTENT REQUIREMENTS

This document outlines guidelines for sapling harvesting and tree transplantation prior to construction works, and guidelines to tree maintenance and care for retained 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.

SAPLING HARVESTING AND TREE TRANSPLANTING

This section outlines the general guidelines for sapling harvesting and tree transplanting prior to construction. Additional measures may be added by the attending arborist on a case-by-case basis.

SPECIMEN SELECTION

Prior to site clearance works, any viable saplings and conservation significant trees that are suitable for harvesting shall be identified by the Arborist. Saplings or trees suitable for transplanting should:

- I. Exhibit good physiological health and vigour
- II. Have no structural defects
- III. Have good branch form

As a guidance, the size of the root ball that is to be extracted shall be based on the girth of the saplings or trees to be harvested

Girth (m)	Minimum root ball diameter to extract (m)
<0.1	0.4
0.1–0.2	0.6
0.2–0.3	0.8
0.3–0.4	1.2
0.4–0.5	1.5
>0.5	To be determined by Arborist

Prior to transplanting, dead branches and climbers shall be cleared from the plant and canopy load and spread will be reduced where necessary, in consultation with the Arborist. Manual trenching shall be carried out to determine the shape and size of root ball to be extracted. Where possible, feeder roots shall be retained without cutting. The root ball shall be burlapped with cellophane sheet to reduce desiccation effects. When directed by the Flora specialist or Arborist, leaves of the canopy may also need to be enclosed and covered by cellophane or clear plastic bags. The root ball shall be secured to the trunk to reduce risk of root ball disintegrating. When handling/carrying the plant, care shall be taken not to damage any vegetative parts.

Where trees and vegetation are moved or translocated within the Project area, the Arborist shall review the method statement proposed by the tree transplanting contractor and advise on additional recommendations necessary to ensure the tree's health during transplanting. The transplanting contract shall ensure in their best effort, intact and secured root balls at the point of extraction, during the lifting processes and during the installation at the receiving site. The transplant effort shall be documented for each individual tree to show intact root balls at all the stages mentioned. Transplanted trees shall be managed through adequate watering and monitoring of their health to ensure their long-term survival. Advice shall be sought from the Arborist if the tree exhibit signs of stress, e.g., peeling bark, withered leaves.

TREE MAINTENANCE AND CARE

This section outlines the general guidelines for tree maintenance and care during construction works. Additional measures may be added by the attending arborist on a case-by-case basis.

Where disease outbreaks are identified, the Arborist shall advise measures to manage them. 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.

Where forest edges are exposed following site clearance and where impacts to vegetation are evident (e.g., vegetation shows signs of drying out), additional watering shall be carried out to improve moisture differentials around forest edges.

The use of herbicides and pesticides shall be minimised. If herbicides or pesticides are used within the Project area, techniques that limit spray or non-target spray drift shall be used. These techniques include but are not limited to: cut and paint techniques and drilling injection. All use of herbicides and pesticides shall 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 shall be reported and investigated.

When the site experiences seven continuous days without rainfall, the Contractor shall carry out additional watering of conserved trees within the TPZs and at the forest edge (up to 10 m) around the development boundary. Post-heavy rainfall, any snapped hanging branches that pose imminent hazards to workers within the site should be removed immediately.

Appendix Q Wildlife Incident Form

Wildlife Incident Form

Date (YYYY/MM/DD):	Time:
Description of Location:	GPS Coordinates:
Wildlife Observed:	Animal Condition (circle): Alive / Killed / Dead / Injured Animal activity (circle): Moving / Resting / Trapped
Photographs Taken:	MFLG and NParks notified: Yes / No Name of staff notified:
Describe Incident (e.g., activities being carried out; what animal was doing; personnel involved):	
Actions Taken:	
Reported by:	Reported to:
Contact no.:	Contact no:
Remarks:	

Appendix R – Baseline Surface Water Quality Report

TEST REPORT

Our Reference No. : **R239000**
Project Code / Ref. : **Woodlands**

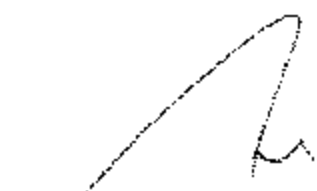
Date Received : 16/11/2023
Date Commenced : 16/11/2023
Date Reported : 05/12/2023

Customer Ref. No. : 60705888
Customer Name : AECOM Singapore Pte Ltd
Customer Address : 300 Beach Road
#23-00 The Concourse
Singapore 199555

Attention To : Mr. Grujica Sarenac

Sample Description : 1 Water sample as per received.

RESULTS : Refer to Page 2


Tan Thuan Piang
Senior Technical Manager

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R239000

RESULTS

Test Parameter	Unit	Test Method	Sample 1	LOR	Controlled Watercourse
			W-WQ1 16/11/2023		
Turbidity	NTU	APHA 2130B	16	0.1	-
Total Nitrogen as TN	mg/L	APHA 4500-P (J)	1.93	0.01	-
Total Phosphorus as TP	mg/L	APHA 4500-P (J)	0.043	0.01	-
Nitrate as NO ₃ -N	mg/L	APHA 4500-NO ₃ (I)	1.88	0.005	20
Phosphate as PO ₄ -P	mg/L	APHA 4500-P (G)	0.030	0.005	2
Total Suspended Solids, TSS	mg/L	APHA 2540D	12.2	1	30
Total Dissolved Solids, TDS	mg/L	APHA 2540C	76.0	10	1,000
Total Alkalinity	mg/L	APHA 2320B	38.0	2	-
Ammonia as NH ₄ -N	mg/L	APHA 4500-NH ₃ (H)	ND	0.01	-
Total Organic Carbon as TOC	mg/L	APHA 8130B	3.63	1	-
Manganese as Mn	mg/L	APHA 3125B	0.0087	0.0005	0.5
Arsenic as As	mg/L	APHA 3125B	0.00080	0.0005	0.01
Chloride as Cl	mg/L	APHA 4110B	ND	10	250
Sulphate as SO ₄ ²⁻	mg/L	APHA 4110B	5.88	5	200
Aluminium as Al	mg/L	APHA 3125B	0.42	0.0005	-
Iron as Fe	mg/L	APHA 3125B	0.19	0.0005	1
Enterococcus	cfu/100mL	APHA 9230C	700	1	-
Oil & Grease (Total)	mg/L	Accredited In-house Method MLS-SOP-WQ-033 Rev C (adapted from APHA 5520C)	0.22	0.1	1
Barium as Ba	mg/L	APHA 3125B	0.025	0.0005	1
Tin as Sn	mg/L	APHA 3125B	ND	0.0005	5
Beryllium as Be	mg/L	APHA 3125B	ND	0.0005	0.5
Boron as B	mg/L	APHA 3120B	0.0040	0.0005	0.5
Cadmium as Cd	mg/L	APHA 3125B	ND	0.0005	0.003
Chromium as Cr (trivalent and hexavalent)	mg/L	APHA 3125B	0.00056	0.0005	0.05
Copper as Cu	mg/L	APHA 3125B	0.0056	0.0005	0.1
Lead as Pb	mg/L	APHA 3125B	0.00064	0.0005	0.1
Mercury as Hg	mg/L	USEPA 245.1 (FIMS) (1994)	ND	0.0001	0.001
Nickel as Ni	mg/L	APHA 3125B	ND	0.0005	0.1
Selenium as Se	mg/L	APHA 3125B	ND	0.0005	0.01

Notes:

- APHA is a standard method for Determination of Water and Waste Water (APHA 23rd Edition, 2017) for Enterococcus only.
- APHA is a standard method for Determination of Water and Waste Water (APHA 24th Edition, 2023)
- LOR = Limit of Reporting. This value may also represent Detection Limit required for the project
- "ND" = Not detected. The data reported is less than the LOR



CHAIN OF CUSTODY DOCUMENT / ANALYSIS REQUEST

16 NOV 2023 (10:16)

Priority Queue / Urgent / Report Needed by:

Page 1 of 1

CLIENT : AECOM		TOTAL NOs OF CONTAINERS* / SAMPLING MEDIA*	STORAGE CONDITION**	Sample Seal (Y / N) ☐ Tick if all sealed	Table A	ANALYSIS PARAMETER (Enter 'X' below to indicate Request)										MLS LAB USE ONLY	
CONTACT (Name / Tel / email) : Grulica Sarenac grulica.sarenac@aecom.com																Job No: R051000	
ADDRESS / COUNTRY :																PRESERVATION DONE:	
PROJECT Code / Ref. : 00/0888																☐ On Site ☐ By Lab	
SITE : Woodlands																Cold Box temp. at receipt: °C (if applicable)	
QUOTATION / JOB REQUEST / PO No. :																☐ Sampling done by MLS	
SEND REPORT TO : grulica.sarenac@aecom.com, yileng.tan@aecom.com																REMARKS / OBSERVATION / SAMPLE CONDITION	
COMMENT / SPECIAL INSTRUCTION :																	
STORAGE / DISPOSAL :																	
S/N	SAMPLE ID / LOCATION	SAMPLING DEPTH (m)	MATRIX* (Water / Soil / Sediment)	DATE (DDMMYY)	TIME (h:m)												
1	W-WQ		W	16 Nov 23		2P+1G+1S	C		X								
2																	
3																	
4																	
5																	
6																	
7																	
8																	
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RELINQUISHED BY:		DATE / TIME		RECEIVED BY:		DATE / TIME		RELINQUISHED BY:		DATE / TIME		RECEIVED BY:		DATE / TIME		SHIPMENT BY COURIER:	
Name:	Grulica		16/11/2023	Name:	[Signature]		16/11/2023	Name:				Name:					Courier Co. / Carrier Name:
Sign:	Grulica			Sign:	[Signature]			Sign:				Sign:					Consignment Note/Airway Bill:
Company:	AECOM		hrs	Company:	[Signature]		hrs	Company:			hrs	Company:					

* For Water sample: Please Indicate FW (Fresh Water), SW (Seawater), BW (Bakat Water), DW (Drinking Water), GW (Ground water), WW (Wastewater), OW (Other type of water e.g. canal/storm water)

* Type of Sampling Containers/Bottles: G = Glass; P = Plastic; T = Tube; V = VOC vial; S = Sterilized bottle/bag; B = Bag.

** Storage Condition: C = Refrigerate at 4 °C; R = Room Temperature; P = Preserved as per Lab's instruction

* Type of Sampling Media: ST = Sorbent Tube; IM = Impinger solution; F = Filter; RT = Resin Trap;

AP = Agar Plate; W = Wipe Sample; Others (PJT, etc.) - please specify.

(25/3/17)

10 NOV 2017 (17/11)

2/2

2230000

1 sample

Table A

Test parameter
Turbidity
Total Nitrogen
Total Phosphorus
Nitrates ($\text{NO}_3\text{-N}$)
Orthophosphates ($\text{PO}_4\text{-P}$)
Total Suspended Solids (TSS)
Total Dissolved Solids (TDS)
Total Alkalinity
Ammonia-Nitrogen as $\text{NH}_4\text{-N}$
Total Organic Carbon (TOC)
Manganese as Mn
Arsenic as As
Cyanide
Sulphate as SO_4^{2-}
Aluminium as Al
Iron as Fe
Enterococci
Oil & Grease
List of metals from NEA's Allowable Limits for Trade Effluent Discharge: Barium, Tin, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium,

Appendix S
Baseline Groundwater
Water Quality

TEST REPORT

Our Reference No. : **R240 1356/2**
Project Code / Ref. : Woodlands N1

Date Received : 19/02/2024
Date Commenced : 19/02/2024
Date Reported : 27/02/2024

Customer Ref. No. : 60705888
Customer Name : AECOM Singapore Pte Ltd
Customer Address : 300 Beach Road
#23-00 The Concourse
Singapore 199555

Attention To : Mr. Zhi Ming, Boey
Sample Description : 3 Groundwater samples as per received.

RESULTS : Refer to Page 2 to Page 6



Tan Thuan Piang
Senior Technical Manager

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R240 1356/2

TEST RESULTS FOR WATER (in unit, unless otherwise specified):

Sample ID / Monitoring Well	MWQ01	MWQ02	MWQ03	Method BLK	DUTCH (Target)	DUTCH (Intervention)	LOR
Sample No.	Sample 1	Sample 2	Sample 3	-	-	-	-
Static Water Table Depth (m-TOC)	-	-	-	-	-	-	-
Sampling Date	19/02/2024	19/02/2024	19/02/2024	-	-	-	-
pH value	5.0	5.0	4.8	-	-	-	-
@ Temperature (deg. C)	22.1	22.2	23.0	-	-	-	-
							APHA 4500-H ⁺ B

Metals by APHA 3125B / USEPA 245.1 (FIMS) (1994)

Arsenic (As)	N.D.	N.D.	N.D.	N.D.	10	60	1.0
Antimony (Sb)	N.D.	N.D.	N.D.	N.D.	-	20	1.0
Barium (Ba)	4.5	8.0	7.9	N.D.	50	825	1.0
Cadmium (Cd)	N.D.	N.D.	N.D.	N.D.	0.4	6	0.25
Chromium (Cr)	N.D.	N.D.	N.D.	N.D.	1	30	0.1
Cobalt (Co)	N.D.	N.D.	N.D.	N.D.	20	100	1.0
Copper (Cu)	N.D.	N.D.	N.D.	N.D.	15	75	1.5
Mercury (Hg)	N.D.	N.D.	N.D.	N.D.	0.05	0.3	0.02
Lead (Pb)	N.D.	N.D.	N.D.	N.D.	15	75	1.5
Molybdenum (Mo)	N.D.	N.D.	N.D.	N.D.	5	300	0.5
Nickel (Ni)	N.D.	N.D.	N.D.	N.D.	15	75	1.5
Zinc (Zn)	12.7	17.2	39.2	N.D.	65	800	1.0

Miscellaneous Analytes by APHA 24th Edition 2023

BOD (mg/L)	N.D.	N.D.	N.D.	N.D.	-	-	2.0
COD (mg/L)	N.D.	N.D.	N.D.	N.D.	-	-	50
TOC (mg/L)	N.D.	N.D.	N.D.	N.D.	-	-	1.0
Fluoride (mg/L)	N.D.	N.D.	N.D.	N.D.	-	-	0.5
Chloride (mg/L)	7.6	6.9	3.3	N.D.	100	-	1.0
Bromide (mg/L)	N.D.	N.D.	N.D.	N.D.	-	-	1.0
Phosphate (mg/L)	N.D.	N.D.	N.D.	N.D.	-	-	0.06
Sulphate (mg/L)	1.9	3.0	N.D.	N.D.	-	-	1.0
Total Ammoniacal Nitrogen (mg/L)	N.D.	N.D.	N.D.	N.D.	-	-	0.01

Inorganic Compound : Cyanide (CN) by APHA 4500-CN(H) - Total Cyanide after Distillation using Micro Dist by Lachat FIA

Cyanide (total)	N.D.	N.D.	N.D.	N.D.	5	1,500	20

Total Cyanide consists of Free Cyanide, Complex Cyanide and Total Thiocyanates. In this study, the Target and Intervention values of Free Cyanide, which are the most stringent Target and Intervention values of all three Cyanide species, are applied to the concentration of Total Cyanide (i.e. Free Cyanide + Complex Cyanide + Total Thiocyanates).

R240 1356/2

TEST RESULTS FOR WATER (in ug/L, unless otherwise specified):

Sample ID / Monitoring Well	MWQ01 Sample 1	MWQ02 Sample 2	MWQ03 Sample 3	Method BLK	DUTCH (Target)	DUTCH (Intervention)	LOR
Sample No.	-	-	-	-	-	-	-
Static Water Table Depth (m-TOC)	-	-	-	-	-	-	-
Sampling Date	19/02/2024	19/02/2024	19/02/2024	-	-	-	-
pH value	5.0	5.0	4.8	-	-	-	-
@ Temperature (deg. C)	22.1	22.2	23.0	-	-	-	-
							APHA 4500-H ⁺ B

Aromatic Compounds : BTEX - Volatile Organic Compounds (VOC's) by USEPA 5021A (Jul 2014) / 8260D (Jun 2018)

Benzene	N.D.	N.D.	N.D.	N.D.	0.2	30	1.0
Ethylbenzene	N.D.	N.D.	N.D.	N.D.	4	150	1.0
Toluene	N.D.	N.D.	N.D.	N.D.	7	1,000	1.0
Xylene	N.D.	N.D.	N.D.	N.D.	0.2	70	2.0
Styrene	N.D.	N.D.	N.D.	N.D.	6	300	2.0

Aromatic Compounds : Semi-Volatile Organic Compounds (SVOC's) by USEPA 3510C (Dec 1996) / 8270E (Jun 2018)

Phenol	N.D.	N.D.	N.D.	N.D.	0.2	2,000	1.0
Cresols	N.D.	N.D.	N.D.	N.D.	0.2	200	2.0
Catechol	N.D.	N.D.	N.D.	N.D.	-	-	10
Resorcinol	N.D.	N.D.	N.D.	N.D.	-	-	4.0
Hydroquinone	N.D.	N.D.	N.D.	N.D.	-	-	4.0

Polynuclear Aromatic Hydrocarbon (PAH) : Semi-Volatile Organic Compounds (SVOC's) by USEPA 3510C (Dec 1996) / 8270E (Jun 2018)

Naphthalene	N.D.	N.D.	N.D.	N.D.	0.01	70	1.0
Anthracene	N.D.	N.D.	N.D.	N.D.	0.0007	5	1.0
Phenanthrene	N.D.	N.D.	N.D.	N.D.	0.003	5	1.0
Fluoranthene	N.D.	N.D.	N.D.	N.D.	0.003	1	1.0
Benz(a)anthracene	N.D.	N.D.	N.D.	N.D.	0.0001	0.5	0.0001
Chrysene	N.D.	N.D.	N.D.	N.D.	0.003	0.2	0.001
Benzo(b)pyrene	N.D.	N.D.	N.D.	N.D.	0.0005	0.05	0.0001
Benzo(g,h,i)perylene	N.D.	N.D.	N.D.	N.D.	0.0003	0.05	0.001
Benzo(k)fluoranthene	N.D.	N.D.	N.D.	N.D.	0.0004	0.05	0.0001
Indeno(1,2,3-cd)pyrene	N.D.	N.D.	N.D.	N.D.	0.0004	0.05	0.001
PAH (total of 10)	N.D.	N.D.	N.D.	N.D.	-	-	-



R240 1356/2

TEST RESULTS FOR WATER (in ug/L unless otherwise specified):

Sample ID / Monitoring Well	MWQ01	MWQ02	MWQ03	Method	BLK	DUTCH (Target)	DUTCH (Intervention)	LOR
Sample No.	Sample 1	Sample 2	Sample 3	-	-	-	-	-
Static Water Table Depth (m-TOC)	-	-	-	-	-	-	-	-
Sampling Date	19/02/2024	19/02/2024	19/02/2024	-	-	-	-	-
pH value	5.0	5.0	4.8	-	-	-	-	-
@ Temperature (deg. C)	22.1	22.2	23.0	-	-	-	-	-
								APHA 4500-H ⁺ B

Chlorinated Hydrocarbons : Volatile Organic Compounds (VOC's) by USEPA 5021A (Jul 2014) / 8250D (Jun 2018)

Vinyl Chloride	N.D.	N.D.	N.D.	N.D.	0.01	5	2.0
Dichloromethane	N.D.	N.D.	N.D.	N.D.	0.01	1,000	5.0
1,1-Dichloroethane	N.D.	N.D.	N.D.	N.D.	7	900	1.0
1,2-Dichloroethane	N.D.	N.D.	N.D.	N.D.	7	400	1.0
1,1-Dichloroethene	N.D.	N.D.	N.D.	N.D.	0.01	10	1.0
1,2-Dichloroethene (cis + trans)	N.D.	N.D.	N.D.	N.D.	0.01	20	1.0
Dichloropropanes	N.D.	N.D.	N.D.	N.D.	0.8	80	1.0
Trichloromethane (Chloroform)	N.D.	N.D.	N.D.	N.D.	6	400	1.0
1,1,1-Trichloroethane	N.D.	N.D.	N.D.	N.D.	0.01	300	1.0
1,1,2-Trichloroethane	N.D.	N.D.	N.D.	N.D.	0.01	130	1.0
Trichloroethene	N.D.	N.D.	N.D.	N.D.	24	500	1.0
Tetrachloromethane	N.D.	N.D.	N.D.	N.D.	0.01	10	1.0
Tetrachloroethene	N.D.	N.D.	N.D.	N.D.	0.01	40	1.0
Chlorobenzenes (total of 6)	N.D.	N.D.	N.D.	N.D.	-	-	3.0
Monochlorobenzene	N.D.	N.D.	N.D.	N.D.	7	180	1.0
Dichlorobenzenes (total)	N.D.	N.D.	N.D.	N.D.	3	50	3.0

Chlorinated Hydrocarbons : Semi-Volatile Organic Compounds (SVOC's) by USEPA 3510C (Dec 1996) / 8270E (Jun 2018)

Trichlorobenzenes (total)	N.D.	N.D.	N.D.	N.D.	0.01	10	1.0
Tetrachlorobenzenes (total)	N.D.	N.D.	N.D.	N.D.	0.01	2.5	2.0
Pentachlorobenzenes	N.D.	N.D.	N.D.	N.D.	0.003	1	1.0
Hexachlorobenzenes	N.D.	N.D.	N.D.	N.D.	0.00009	0.5	1.0
Chlorophenols (total of 5)	N.D.	N.D.	N.D.	N.D.	-	-	3.0
Monochlorophenols (total)	N.D.	N.D.	N.D.	N.D.	0.30	100	2.0
Dichlorophenols (total)	N.D.	N.D.	N.D.	N.D.	0.20	30	3.0
Trichlorophenols (total)	N.D.	N.D.	N.D.	N.D.	0.03	10	1.0
Tetrachlorophenols (total)	N.D.	N.D.	N.D.	N.D.	0.01	10	3.0
Pentachlorophenol	N.D.	N.D.	N.D.	N.D.	0.04	3	0.04
Chloronaphthalene	N.D.	N.D.	N.D.	N.D.	-	6	2.0
Monochloroanilines	N.D.	N.D.	N.D.	N.D.	-	30	2.0
Polychlorobiphenyls (total)	N.D.	N.D.	N.D.	N.D.	0.01 (d)	0.01	0.001



R240 1356/2

TEST RESULTS FOR WATER (in ug/L, unless otherwise specified):

Sample ID / Monitoring Well	MWQ01	MWQ02	MWQ03	Method BLK	DUTCH (Target)	DUTCH (Intervention)	LOR
Sample No.	Sample 1	Sample 2	Sample 3	-	-	-	-
Static Water Table Depth (m-TOC)	-	-	-	-	-	-	-
Sampling Date	19/02/2024	19/02/2024	19/02/2024	-	-	-	-
pH value	5.0	5.0	4.8	-	-	-	-
@ Temperature (deg. C)	22.1	22.2	23.0	-	-	-	-
							APHA 4500-H ⁺ B

Pesticides : Semi-Volatile Organic Compounds (SVOC's) by USEPA USEPA 3510C (Dec 1996) / 8270E (Jun 2018)

sum DDT/DDD/DDE	N.D.	N.D.	N.D.	N.D.	0.000004	0.01	0.01
DOT	N.D.	N.D.	N.D.	N.D.	-	-	2.0
DOE	N.D.	N.D.	N.D.	N.D.	-	-	1.0
DOO	N.D.	N.D.	N.D.	N.D.	-	-	1.0
sum aldrin, dieldrin, endrin	N.D.	N.D.	N.D.	N.D.	0.000009	0.1	0.1
Aldrin	N.D.	N.D.	N.D.	N.D.	-	-	1.0
Dieldrin	N.D.	N.D.	N.D.	N.D.	0.0001	-	1.0
Endrin	N.D.	N.D.	N.D.	N.D.	0.00004	-	1.0
sum HCH	N.D.	N.D.	N.D.	N.D.	0.05	1	1.0
α-HCH	N.D.	N.D.	N.D.	N.D.	0.033	-	1.0
β-HCH	N.D.	N.D.	N.D.	N.D.	0.008	-	1.0
γ-HCH	N.D.	N.D.	N.D.	N.D.	0.009	-	1.0
δ-HCH	N.D.	N.D.	N.D.	N.D.	-	-	1.0
Atrazine	N.D.	N.D.	N.D.	N.D.	0.029	150	1.0
Carbaryl	N.D.	N.D.	N.D.	N.D.	0.002	50	4.0
Carbofuran	N.D.	N.D.	N.D.	N.D.	0.009	100	4.0
Chlordane	N.D.	N.D.	N.D.	N.D.	0.00002	0.2	0.01
Endosulfan	N.D.	N.D.	N.D.	N.D.	0.0002	5	1.0
Heptachlor	N.D.	N.D.	N.D.	N.D.	0.000006	0.3	0.01
Heptachlor Epoxide	N.D.	N.D.	N.D.	N.D.	0.000006	3	1.0

Other Pollutants : Volatile Organic Compounds (VOC's) by USEPA 5021A (Jul 2014) / 8260D (Jun 2018)

Cyclohexanone	N.D.	N.D.	N.D.	N.D.	0.5	15,000	10
Tetrahydrofuran	N.D.	N.D.	N.D.	N.D.	0.5	300	2.0
Tetrahydrothiophene	N.D.	N.D.	N.D.	N.D.	0.5	5,000	2.0
Tribromomethane (Bromoform)	N.D.	N.D.	N.D.	N.D.	-	630	1.0

Other Pollutants : Semi-Volatile Organic Compounds (SVOC's) by USEPA 3510C (Dec 1996) / 8270E (Jun 2018)

Phthalates (total)	2.2	N.D.	2.2	N.D.	0.6	5	2.0
Pyridine	N.D.	N.D.	N.D.	N.D.	0.5	30	2.0



R240 1356/2

TEST RESULTS FOR WATER (in ug/L unless otherwise specified):

Sample ID / Monitoring Well	MWQ01	MWQ02	MWQ03	Method BLK	DUTCH (Target)	DUTCH (Intervention)	LQR
Sample No.	Sample 1	Sample 2	Sample 3	-	-	-	-
Static Water Table Depth (m-TOC)	-	-	-	-	-	-	-
Sampling Date	19/02/2024	19/02/2024	19/02/2024	-	-	-	-
pH value	5.0	5.0	4.6	-	-	-	-
Temperature (deg. C)	22.1	22.2	23.0	-	-	-	-
APHA 4500-H ⁺ B							-

Other Pollutants : Total Petroleum Hydrocarbons (TPH) by US EPA Method 8015C (Feb 2007)

C8 - C9	N.D.	N.D.	N.D.	N.D.	-	-	20
C10 - C14 (as C12)	N.D.	N.D.	N.D.	N.D.	-	-	100
C15 - C28 (as C21)	N.D.	N.D.	N.D.	N.D.	-	-	100
C29 - C36 (as C32)	N.D.	N.D.	N.D.	N.D.	-	-	100
C8 - C36 (Total)	N.D.	N.D.	N.D.	N.D.	50*	600*	100

(*Dutch Standard for mineral oil)

Surrogate Recovery by USEPA 8260D (Jun 2018)

1,2-Dichloroethane-d4 (%)	101	115	109	81.9
Toluene-d8 (%)	100	94.5	93.6	108
p-Bromofluorobenzene (%)	118	103	109	114

Surrogate Recovery by USEPA 8270E (Jun 2018)

Benzene-d5, nitro (%)	82.1	63.2	84.2	77.4
1,1'-biphenyl-2-fluoro (%)	78.0	62.7	84.4	72.9
p-Terphenyl-d14 (%)	100	58.6	54.7	94.4
Phenol, 2-fluoro (%)	82.7	84.3	87.9	107
Phenol-d5 (%)	51.8	50.8	54.4	67.3
Phenol, 2,4,6-Trinitro (%)	108	62.2	-	90.6

Notes:

1. APHA is a standard method for Determination of Water and Waste Water (APHA 24th Edition, 2023).
2. LQR = Limit of Reporting, Detection Limit is based on the highest detection limit obtained from the individual compound.
3. "N.D." = Not detected. The data reported is less than the LQR.
4. C10-C14, C15-C28, C29-C36 results are derived using the area under the peak against a hydrocarbon reference standard. For range C10-C14, C15-C28 and C29-C36, the reference standard used are C12, C21 and C32 peaks respectively.
5. The target and intervention values are derived from Soil Remediation Circular 2013.
6. "-": There is no surrogate recovery for the following Groundwater Sample ID: MWQ03 due to sample matrix interference.



MARCHWOOD LABORATORY SERVICES PTE LTD

CHAIN OF CUSTODY DOCUMENT / ANALYSIS REQUEST

Priority Queue / Urgent / Report Needed by:

19 FEB 2024

CLIENT		AECOM	
CONTACT (Name / Tel / email)		Zhiming Boey@aecom.com	
ADDRESS / COUNTRY		Woodlands, NT	
PROJECT Code / Ref.		50705688	
SITE		Woodlands, NT	
QUOTATION / JOB REQUEST / PO No.		Zhiming Boey@aecom.com	
SEND REPORT TO			
COMMENT / SPECIAL INSTRUCTION			
STORAGE / DISPOSAL			

SN	SAMPLE ID / LOCATION	SAMPLING DEPTH (m)	MATRIX* (Invert/Normal/Sediment)	DATE (DD/MM/YY)	TIME (HRS)
1	1MW001		GW	19-Feb-24	
2	1MW002		GW	19-Feb-24	
3	1MW003		GW	19-Feb-24	
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

ANALYSIS PARAMETER (Enter "x" below to indicate Request)	
Job No.: R2401356	
PRESERVATION DONE: ☐ On Site ☐ By Lab Cold Box temp. at receipt: °C (If applicable) ☐ Sampling done by MLS	
REMARKS / OBSERVATION / SAMPLE CONDITION	

TOTAL NO. OF CONTAINERS /	SAMPLING MEDIA	STORAGE CONDITION**	Sample Seal (Y / N) - ☐ Tick if all sealed
3P, 20, 2V, 1B	C		
2P, 20, 2V, 1B	C		
2P, 20, 2V, 1B	C		

RELINQUISHED BY:	DATE / TIME	RECEIVED BY:	DATE / TIME
Name: Zhi Ming	19/02/2024	Name:	
Sign: ZM		Sign:	
Company: AECOM	hrs	Company:	hrs

RELINQUISHED BY:	DATE / TIME	RECEIVED BY:	DATE / TIME
Name:		Name:	
Sign:		Sign:	
Company:	hrs	Company:	hrs

RELINQUISHED BY:	DATE / TIME	RECEIVED BY:	DATE / TIME
Name:		Name:	
Sign:		Sign:	
Company:	hrs	Company:	hrs

* For Water sample: Please indicate FW (Fresh Water), SW (Seawater), BW (Babst Water), DW (Drinking Water), GW (Ground water), WW (Wastewater), OW (Other type of water e.g. capillatorm water)

* Type of Sampling Containers/Bottles: G = Glass; P = Plastic; T = Tube; V = VOC vial; S = Sterilized bottle/bag; B = Bag

** Storage Condition: C = Refrigerate at 4 °C; R = Room Temperature; P = Preserved as per Lab's instruction

* Type of Sampling Media: ST = Sorbent Tube; IM = Impinger solution; F = Filter; RT = Resin Trap; AP = Agar Plate; W = Wipe Sample; Others (PUF, etc. - please specify)

EBS - Water

Job:

2240 1356

Client/Location :

Arcom

Test Parameters	Method	
pH / Temperature	APHA 4500-H+	-
BOD	APHA 5210B	-
COD	HACH 8000	-
TOC	APHA 5310B	-
Fluoride, F	APHA 4110B / 4500-F (C)	IC
Chloride, Cl	APHA 4110B	
Bromide, Br	APHA 4110B	
Sulphate, SO4	APHA 4110B	
Phosphate, PO4	APHA 4500-P (G)	FIA
Total Ammonical Nitrogen, NH3-N	APHA 4500-NH3	
Cyanide	APHA 4500 (CN)	ICP-MS
Heavy Metals	APHA 3125	
SVOC	US EPA 3510C / 8270D	Liquid-liquid Extraction
		GCMS
VOC	US EPA 5021A / 8260C	GCMS
TPH (C6-C9)	US EPA 5021A / 8015C	GC-FID
TPH (C10-C36)	US EPA 3510C / 8015C	Liquid-liquid Extraction
		GC-FID

3 spb

Table A
Test parameter
Total Nitrogen (TN)
Total Phosphorus (TP)
Nitrates (NO ₃ -N)
Orthophosphates (PO ₄ -P)
Total Suspended Solids (TSS)
Total Dissolved Solids (TDS)
Total Alkalinity
Ammonia-Nitrogen as NH ₄ -N
Total Organic Carbon as TOC
Chloride as Cl-
Sulphate as SO ₄
Enterococci
Oil and Grease
Arsenic
Barium
Tin
Iron as Fe
Beryllium
Boron
Manganese
Cadmium
Chromium
Copper
Lead
Mercury
Nickel
Selenium
Silver
Zinc
Aluminium as Al
Standard EBS Suite of Parameters

Aecom

19 FEB 2024

R240 1356

3 samples

TEST REPORT

Our Reference No. : **R240 1356/1**
Project Code / Ref. : **Woodlands N1**

Date Received : **19/02/2024**
Date Commenced : **19/02/2024**
Date Reported : **26/02/2024**

Customer Ref. No. : **60705888**
Customer Name : **AECOM Singapore Pte Ltd**
Customer Address : **300 Beach Road
#23-00 The Concourse
Singapore 199555**

Attention To : **Mr. Zhi Ming, Boey**

Sample Description : **3 Groundwater samples as per received.**

RESULTS : **Refer to Page 2 to 3**


Tan Thuan Piang
Senior Technical Manager

Terms & Conditions:

- 1) This report shall not be reproduced except in full, unless approval in writing has been given by MLS.
- 2) The results in this report only apply to the sample received/analysed.
- 3) MLS agrees to use reasonable diligence in the performance of the service.

Marshwood Laboratory Services Pte Ltd:
Main (Office and Laboratory):
Branch (Site and Laboratory):
Website:

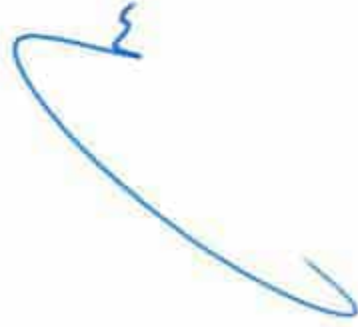
Co. Reg No. : 201422086C
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 : +65 6790 0118
 : +65 6262 3735 (Lab)

 : +65 6790 0091
 : +65 6262 3726 / 3776 (Site)

RESULTS

Test Parameter	Unit	Test Method	Sample 1	Sample 2	Sample 3	LOR
			MWQ01 19/02/2024	MWQ02 19/02/2024	MWQ03 19/02/2024	
Total Suspended Solids, TSS	mg/L	APHA 2540D	5,734	5,407	18,436	10
Total Dissolved Solids, TDS	mg/L	APHA 2540C	31.0	39.0	50.0	10
Total Alkalinity	mg/L	APHA 2320B	ND	ND	ND	20
Oil & Grease (Total)	mg/L	Accredited In-house Method	0.19	0.58	0.14	0.1
		MLS-SOP-WQ-033 Rev 0 (adapted from APHA 5520C)				
Chloride as Cl	mg/L	APHA 4110B	7.63	6.89	3.31	1
Sulphate as SO ₄	mg/L	APHA 4110B	1.93	3.03	ND	1
Total Organic Carbon as TOC	mg/L	APHA 5310B	ND	ND	ND	1
Total Nitrogen as TN	mg/L	APHA 4500-P (J)	0.38	1.80	6.36	0.01
Ammonia-Nitrogen as NH ₄ -N	mg/L	APHA 4500-NH ₃ (H)	ND	ND	ND	0.01
Total Phosphorus as TP	mg/L	APHA 4500-P (J)	0.045	0.045	0.044	0.025
Nitrate as NO ₃ -N	mg/L	APHA 4500-NO ₃ (I)	0.36	1.77	5.84	0.015
Phosphate as PO ₄ -P	mg/L	APHA 4500-P (G)	ND	ND	ND	0.025
Enterococcus	cfu/100mL	APHA 9230C	440	230	420	1



R240 1356/1

RESULTS

Test Parameter	Unit	Test Method	Sample 1	Sample 2	Sample 3	LOR
			MWQ01 19/02/2024	MWQ02 19/02/2024	MWQ03 19/02/2024	
Silver as Ag	µg/L	APHA 3125B	ND	ND	ND	0.5
Aluminium as Al	µg/L	APHA 3125B	76.4	68.6	168	0.5
Arsenic as As	µg/L	APHA 3125B	ND	ND	ND	1
Boron as B	µg/L	APHA 3125B	4.69	7.14	ND	0.5
Barium as Ba	µg/L	APHA 3125B	4.52	6.02	7.86	1
Beryllium as Be	µg/L	APHA 3125B	ND	ND	ND	0.5
Cadmium as Cd	µg/L	APHA 3125B	ND	ND	ND	0.25
Chromium as Cr (trivalent and hexavalent)	µg/L	APHA 3125B	ND	ND	ND	0.1
Copper as Cu	µg/L	APHA 3125B	ND	ND	ND	1.5
Iron as Fe	µg/L	APHA 3125B	4.14	10.4	92.5	0.5
Mercury as Hg	µg/L	APHA 3125B	ND	ND	ND	0.02
Manganese as Mn	µg/L	APHA 3125B	10.5	12.3	41.9	0.5
Nickel as Ni	µg/L	APHA 3125B	ND	ND	ND	1.5
Lead as Pb	µg/L	APHA 3125B	ND	ND	ND	1.5
Selenium as Se	µg/L	APHA 3125B	ND	ND	ND	0.5
Tin as Sn	µg/L	APHA 3125B	ND	ND	1.88	0.5
Zinc as Zn	µg/L	APHA 3125B	12.7	17.2	39.2	1

Note:

1. APHA is a standard method for Determination of Water and Waste Water (APHA 24th Edition, 2023)
2. LOR = Limit of Reporting. This value may also represent Detection Limit required for the project.
3. "ND" = Not detected. The data reported is less than the LOR.



MARCHWOOD LABORATORY SERVICES PTE LTD

CHAIN OF CUSTODY DOCUMENT / ANALYSIS REQUEST

MLS-QF 001 Rev (4), Mar 2017
Page 1 of 2

Priority Queue / Urgent / Report Needed by:

19 FEB 2024

CLIENT : AECOM CONTACT (Name / Tel / email) : ZhiMing.Boye@aecom.com ADDRESS / COUNTRY : PROJECT Code / Ref. : 60705888 SITE : Woodlands N1 QUOTATION / JOB REQUEST / PO No. : SEND REPORT TO : ZhiMing.Boye@aecom.com COMMENT / SPECIAL INSTRUCTION : STORAGE / DISPOSAL :				ANALYSIS PARAMETER (Enter "x" below to indicate Request) Job No.: R2401356 PRESERVATION DONE: ☐ On Site ☐ By Lab Cold Box temp. at receipt: _____ °C (If applicable) ☐ Sampling done by MLS				MLS LAB USE ONLY REMARKS / OBSERVATION / SAMPLE CONDITION			
BIN	SAMPLE ID / LOCATION	SAMPLING DEPTH (m)	MATRIX*	DATE (DD/MM/YY)	TIME (HRS)	TOTAL NO. OF CONTAINERS ¹	SAMPLING MEDIA ¹	STORAGE CONDITION ¹	Sample Good (Y / N) - ☐ Tick if not sealed	Table A	
1	MWQ01		GW	19-Feb-24		2P, 2G, 2V, 1S		C		X	
2	MWQ02		GW	19-Feb-24		2P, 2G, 2V, 1S		C		X	
3	MWQ03		GW	19-Feb-24		2P, 2G, 2V, 1S		C		X	
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

RELINQUISHED BY: Name: Zhi Ming, DATE / TIME: 19/02/2024
 SIGN: ZM, DATE / TIME: 19/2/24
 Company: AECOM, DATE / TIME: 1615 hrs

RECEIVED BY: Name: LYL, DATE / TIME: 19/2/24
 SIGN: YH, DATE / TIME: 1615 hrs
 Company: MLS, DATE / TIME: 1615 hrs

RELINQUISHED BY: Name: _____, DATE / TIME: _____
 SIGN: _____, DATE / TIME: _____
 Company: _____, DATE / TIME: _____

RECEIVED BY: Name: _____, DATE / TIME: _____
 SIGN: _____, DATE / TIME: _____
 Company: _____, DATE / TIME: _____

SHIPMENT BY COURIER: Courier Co. / Carrier Name: _____
 Consignment Note/Arreary Bill: _____

* = For Water sample; Please indicate FW (Fresh Water), SW (Seawater), BW (Ballast Water), GW (Ground water), WW (Wastewater), CW (Other type of water e.g. canal/storm water)
 * Type of Sampling Containers/Bottles: G = Glass; P = Plastic; T = Tube; V = VOC vial; S = Sterilized bottle/bag; B = Bag.
 ** Storage Condition: C = Refrigerate at 4 °C; R = Room Temperature; P = Preserved as per Lab's instruction.

EBS - Water

Job:

2240 1356

Client/Location :

Arcom

Test Parameters	Method	
pH / Temperature	APHA 4500-H+	-
BOD	APHA 5210B	-
COD	HACH 8000	-
TOC	APHA 5310B	-
Fluoride, F	APHA 4110B / 4500-F (C)	IC
Chloride, Cl	APHA 4110B	
Bromide, Br	APHA 4110B	
Sulphate, SO ₄	APHA 4110B	
Phosphate, PO ₄	APHA 4500-P (G)	FIA
Total Ammonical Nitrogen, NH ₃ -N	APHA 4500-NH ₃	
Cyanide	APHA 4500 (CN)	
Heavy Metals	APHA 3125	ICP-MS
SVOC	US EPA 3510C / 8270D	Liquid-liquid Extraction
		GCMS
VOC	US EPA 5021A / 8260C	GCMS
TPH (C6-C9)	US EPA 5021A / 8015C	GC-FID
TPH (C10-C36)	US EPA 3510C / 8015C	Liquid-liquid Extraction
		GC-FID

3 sps

ARUM

19 FEB 2024

R2401356

3 samples

Table A
Test parameter
Total Nitrogen (TN)
Total Phosphorus (TP)
Nitrates (NO3-N)
Orthophosphates (PO4-P)
Total Suspended Solids (TSS)
Total Dissolved Solids (TDS)
Total Alkalinity
Ammonia-Nitrogen as NH4-N
Total Organic Carbon as TOC
Chloride as Cl-
Sulphate as SO4
Enterococci
Oil and Grease
Arsenic
Barium
Tin
Iron as Fe
Beryllium
Boron
Manganese
Cadmium
Chromium
Copper
Lead
Mercury
Nickel
Selenium
Silver
Zinc
Aluminium as Al
Standard EBS Suite of Parameters

Appendix T – Impact Assessment on Drinking Water Reservoir (Upper Seletar Reservoir)

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1 Construction Phase

1.1 Potential Sources of Impact

Potential sources of impact during the construction phase on the Upper Seletar Reservoir are summarised in the table below.

Table 1-1 Potential impacts during the construction phase

Environmental Parameter	Potential Source(s) of Impacts	Potential Associated Impact on Environmental Parameter	Potential Associated Impacts on Receptor
Water Resources (Surface Water Quality and Groundwater Quality)	- Discharge of potentially contaminated surface water runoff originating from exposed soil during site clearance and earthworks; - Discharge of potentially contaminated stormwater and/ or groundwater pumped out from excavated areas; - Discharge of construction wastewater, grouting and cement materials; - Seepage of contaminants from excavated contaminated soil (if encountered) into the underlying soil and groundwater; - Discharge of contaminants due to improper handling, transfer, storage and disposal of solid waste and chemical substances (e.g. construction debris); - Accidental spills and leaks of chemical substances used for construction phase activities, including the fuel and lubricants spillage from maintenance of construction vehicles and mechanical equipment; - Seepage of contaminants due to inappropriate discharge of domestic sewage and poor maintenance of the portable chemical toilets, storage tanks and septic tanks	- Elevated levels of suspended solids (e.g. silt) in receiving watercourses; - Increased quantity of solid waste and contaminated material in receiving watercourses; - Increase in the levels of oil, grease and other chemical substances in receiving watercourses - Discharge of contaminated water into the underlying soil and groundwater	- Altered water quality of waterbodies used for beneficial purposes such as Upper Seletar Reservoir, may impede the regular functioning of such systems - In the events of serious contamination, water systems may completely cease to operate until the contamination is removed from water

Environmental Parameter	Potential Source(s) of Impacts	Potential Associated Impact on Environmental Parameter	Potential Associated Impacts on Receptor
Water Resources (Groundwater Level)	Temporary or permanent land use change with more impervious surfaces due to: • Site clearance (e.g. clearance of vegetation and trees within Study Area not designated to be preserved, demolition of existing structures within and in the vicinity of Study Area); • Earthworks, including site levelling and excavation works; • Construction of temporary and permanent structures and infrastructure	• Reduced seepage of water into the soil, potentially disturbing current hydrological cycle of the site; • Reduction in groundwater baseflow feeding into the watercourses	• It is understood that currently in Singapore groundwater is not used for any beneficial purposes (i.e. drinking or industrial purposes, irrigation)

1.2 Categorisation of Sensitive Receptor

Sensitive receptors are those receptors within or in the vicinity of the Study Area which may potentially be impacted by the activities intended for Project's construction and operational phases. The identified receptors can be categorised into three categories: Priority 1, Priority 2 and Priority 3 (from the most sensitive to the least) as shown in the following table. It is to be noted that currently, groundwater in Singapore is not directly used for any beneficial purposes.

Table 1-2 Receptor sensitivity classification

Environmental Parameter	Receptor Sensitivity		
	Priority 1	Priority 2	Priority 3
Water Resources	Developments within and in the vicinity of the Project Site that use surface water for beneficial purposes (e.g. irrigation, drinking purposes, industrial purposes) and require water of particular physico-chemical characteristics at the intake location	Developments within and in the vicinity of the Project Site that use surface water for beneficial purposes (e.g. irrigation, drinking purposes, industrial purposes) and do not require water of particular physico-chemical characteristics at the intake location	Developments that do not directly use surface water for beneficial purposes (e.g. irrigation, drinking purposes, industrial purposes)

Although there are no permanent watercourses within the Project site, the water from southern portion of the site gets discharged into the Marsiling Park Pond via drains and culvert. The part of the water from the Pond flows northwards, over the dam eventually reaching Sungei Mandai Kechil (for the assessment of impacts on the ecological receptors please refer to the Main Report). From the Pond, part of the water will also reach the Upper Seletar Reservoir. As the water within the Upper Seletar Reservoir is used for beneficial purposes, it was categorised as Priority 1 sensitive receptor.

1.3 Minimum Control Measures

Minimum control measures to be implemented during the construction phase of the Project are detailed in Section 7.3. of the Main Report and summarised in the table below.

Table 1-3 Minimum control measures during construction phase

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
Water Resources (Surface Water Quality and Groundwater Quality)	Discharge of potentially contaminated surface water runoff originating from exposed soil containing elevated levels of suspended solids	• Planning, designing, approval and implementation of Earth Control Measures (ECM) plans by a Qualified Erosion Control Professional to PUB, including the installation, maintenance, monitoring, reporting, erosion control blankets, CCTV at discharge points, SIDS, sedimentation tanks, to comply with PUB's COP on Surface Water Drainage. To note that this must take into account the requirement for site hoardings to be buried 300mm deep into the ground • The Contractor should moderate the earthworks in tandem with the ECM provision. The earthworks' progress should be regulated carefully to prevent exposure of more areas than what proposed ECM could handle. • Interim changes to ECM during startup of the site, levelling (cutting and backfilling), in each phase of works must be planned and approved prior to start of any works at the site; • Biodegradable erosion blankets must be provided to the areas with bare soil surface within the same day of the soil exposure • Scheduling of demolition and earthworks to reduce the quantity of stockpiles (including horticultural waste) to be stored on site • ECM tanks/ ponds need to be designed in sufficient capacity to hold the turbid stormwater prior to treatment at the ECM facility. Prior to any discharge, water must meet NEA Trade Effluent Criteria. • The Contractor should ensure that their CCTV system is properly operated and maintained at all times as per the PUB's circular on Preventing Muddy Waters from the Construction Sites. This is also meant to curb Contractors from deliberately tempering with the CCTV system to mask the silty discharge. • Effective implementation of ECM and monitoring to be implemented as per Code of Practice on Surface Water Drainage to ensure that discharge into stormwater drainage system does not contain TSS in concentrations greater than the prescribed limits under the Sewerage and Drainage (Surface Water Drainage) Regulations • Sediment Control Plan should be prepared to include, but not limited to, the sealing of site hoarding, berms along the site hoarding, etc.

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
		This is to prevent silty water to leak out from the site and ramp at the site entrance. • Topsoil removed will be stockpiled in a designated area and covered as necessary to prevent soil loss from secondary erosion. Soil conserved can be used for backfilling while the excess soil material should be stored properly where it can be reused. • Use of approved materials, of the same or better quality as the surrounding area, for backfilling works. All backfilled material must be free of debris and of good material soil. • Whenever possible, segregate clean water flow from silty water flow to maximize the sedimentation tank holding capacity • Manholes should always be adequately covered and temporary sealed • Implement a construction EMMP and ensure full preparation of associated plans and procedures
Water Resources (Surface Water Quality and Groundwater Quality)	Discharge of liquid waste, including construction wastewater	• A full inventory of all anticipated wastewater streams and volumes should be finalised before the onset of construction phase works • Daily record volume of wastewater, as well as the volumes of sludge and other produced wastes should be kept onsite • The containment ponds will be of impervious material and be designed with sufficient capacity to hold volumes of wastewater produced on site, as well as allowance for stormwater runoff and potential firefighting wastewater • Temporary storage volumes should be provided for overflow situations of untreated wastewater. Temporary storage with sufficient capacity will capture any expected additional volumes to ensure that untreated wastewater is not released to watercourses unless it complies with NEA Guidelines on trade effluent discharge concentrations. • The containment ponds, as well as wastewater generating areas on site should be equipped with spill clean-up kits • Adequate drainage, cut-off drains sump pit, road kerb, piping and toe wall will be designed for channelling of construction process wastewater streams (e.g. wash water) and stormwater runoff separately through detailed design to capture and treatment in the containment pond(s)/ kerb(s). Where applicable, this infrastructure should also include oil-water separators. • The approval will be sought from relevant authorities (i.e. PUB and NEA) as per PUB Sewerage and Drainage (Trade Effluent) Regulations, if the wastewater is planned to be disposed to public sewer, or NEA's Trade Effluent Discharge Limits to controlled watercourse if the treated trade effluent is

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
		planned to be disposed to surface watercourses. In the event that such discharges are not approved, the trade effluent will be stored, treated or recycled on site and finally disposed off-site to a licenced waste collector only. • Contractor will seek comment and approval from relevant authorities (e.g. Singapore Civil Defence Force [SCDF] and NEA) on the use of the treated wastewater for firefighting purposes. • Appropriate concrete wash out areas to be provided. These areas should not be near the watercourses and/or the discharge must drain to ECM treatment system • All vehicles should run via wheel washing process before leaving the site to ensure no earth, mud, debris, etc. is disposed on the surrounding roads. The wastewater generated from this activity should be stored and or moved to ECM treatment system after sedimentation. • Regular and dedicated procedures for the inspection and maintenance of wastewater collection, storage and treatment infrastructure (e.g. pipes, oil-water separators, etc.) • Regular and dedicated procedures for the management of stormwater collection, settling, testing and eventual discharge of water to watercourse(s) • Regular six monthly toolbox/ training to be conducted for all on-site workers, including sub-contractors, in relation to their obligations for ensuring proper water quality management • Unmanaged discharge of any wastewater stream is prohibited • No trade effluent other than the nature or type approved by NEA Director-General is discharged into any watercourse or soil • Reduce, reuse and recycle hierarchy principle to be applied to wastewater on site • Hazardous wastewater, such as oily water, thinners, solvents, or paints, should be stored on hard stand, under shelter with a kerb around the storage area. The wastewater should be removed for treatment and disposal off-site by an approved Waste Management Contractor. Hazardous liquids to be handled as Hazardous Waste. • Discharge of extracted groundwater shall be to an area approved for such disposal by the NEA. It is recommended that the construction contractor to be vigilant of site conditions and extracted groundwater to be tested at regular intervals, especially for extracted groundwater with oily sheens or noticeable odour. If a contaminant concentration in

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
		excess of the DIV is detected, the contractor shall assess the potential inhalation and dermal impacts of the chemical identified and assess potential health and safety considerations for exposure to groundwater before commencement of construction activities. Such contaminated wastewater may need to be disposed of to a licenced toxic waste collector. • Prepare and implement a construction site specific EMMP and ensure full preparation of associated plans and procedures
Water Resources (Surface Water Quality and Groundwater Quality)	Seepage and leakage of contaminants from solid waste generated, handled and stored on site	• Provision of adequate number of enclosed bins • Waste disposal facilities should be cleared up as often as necessary to prevent the build-up. Housekeeping checks should be carried out at least once a day to ensure all the litter is cleared from the site. • Development of Standard Operating Procedure (SOP) for safe handling, transfer, storage and disposal of solid waste • Appropriate tests to be carried out to ascertain the presence/ absence of contamination of the excavated soil • Appropriate disposal of any waste listed in the Environmental Public Health (General Waste Collection) Regulations by licensed waste operator • Handle and dispose excavated soil following the procedure shown in Figure 7.3.1 of the main report. This flow chart explains how to handle excavated soils and identify potential areas of contamination as well as potential of contamination (POC) in excavated soils. If the POC soils are tested for exceedance in DIVs, the soils can be disposed of to toxic waste collectors or undergo soil treatment. If contaminated soils were sent for treatment to an acceptable standard such as the DIV, the treated soil can be disposed in the staging ground or through a general waste collector, depending on the level of the contaminants during the staging ground testing. • Upon receipt of results on the tested parameters (chemicals, heavy metals) exceeding the regulatory limits, the construction contractor should further assess the potential inhalation and dermal contact impacts of the exceeded parameters to the site workers exposed to areas where soil and/or groundwater contamination is identified. The risk assessment should be conducted before the commencement of construction activities and the findings incorporated into the contractors' construction risk assessment and health, safety and environment plan. If health impacts to workers are foreseen, necessary precautionary measures, as per the

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
		respective chemical SDS, should be implemented on site. Implement construction EMMP and ensure full preparation of associated plans and procedures
Water Resources (Surface Water Quality and Groundwater Quality)	Seepage of contaminants due to inappropriate discharge of domestic sewage and poor maintenance of portable chemical toilets, storage tanks and septic tanks	- Provide sufficient number of proper sanitary facilities and maintenance of such facilities. It is recommended to have one portable toilet per 10 pax and serviced 3 times per week. NEA's Licensed Waste Collector (LWC) must be appointed to conduct regular collection of sewage discharges for disposal. - Appropriate location of toilet facilities away from any nearby watercourses - On-site dormitories (if any) are recommended to install container toilets and secure written approval from PUB to connect into public sewers - Establish a regular maintenance work schedule to check and maintenance cleanliness and ensure functioning ability of sanitary facilities on site, at least once a week, depending on the amount of sanitary facilities - Inspection and audits to ascertain the hygienic conditions on site - Implement a construction EMMP and ensure full preparation of associated plans and procedures
Water Resources (Surface Water Quality and Groundwater Quality)	Seepage and leakage of contaminants from toxic waste generated, handled and stored on site	- Leak detection tests of toxic waste storage containers to be conducted periodically - Toxic waste and hazardous substances should be stored on hard stand, under shelter with a kerb around the storage area - Spill trays to be provided for all waste containers. Spill trays to be regularly maintained to prevent the rain from washing out the pollutive substances - Appropriate disposal of toxic waste as per Environmental Public Health (Toxic Industrial Waste) Regulations by Licensed Waste Operator/ Collector - Consignment notification/ tracking system and transport emergency response plan for transport of toxic waste - Development of SOP for safe handling, transfer and storage of toxic waste; Housekeeping checks should be carried out at least once a day to ensure all toxic waste is cleared from the site - Implement a construction EMMP and ensure full preparation of associated plans and procedures
Water Resources (Surface Water Quality and Groundwater Quality)	Direct or indirect (e.g. via seepage into soil and groundwater) contamination of watercourses originating from	- Remove any hazardous substances or chemicals if there is a safer alternative - Chemical storage areas should be adequate, on paved ground, bunded, sheltered with adequate ventilation and located away from

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
	chemicals used and/ or stored on site	waterways and drains. Safety Data Sheets (SDS) should be kept together with the stored chemicals. - The proposed infrastructure for separate channelling of construction wastewater streams and stormwater runoff should include oil-water separators to capture inadvertent spills or leaked oils or greases, especially in the vicinity of liquid storage or refuelling areas - Any construction equipment which causes pollution to the water system due to leakage of oil or fuel should be maintained or removed off-site immediately - Ensure all activities involving repair, servicing, engine overhaul works, etc. shall be carried out on an area which is appropriately contained (e.g. concreted area and with proper containment) and all wastes are channelled for appropriate treatment or disposal to meet the regulations - Preparation of an emergency response plan, training of the Emergency Response Team (ERT) to be competent in the response mechanism and provision of response kits for any spillages - Good housekeeping practices shall be implemented to minimise careless spillage and to keep the storage and the workspace in a tidy and clean condition. A responsible person (e.g. ECO) to be assigned to oversee the efficient operation of the containment pond/ kerbs where 'Good Housekeeping' practices would be adhered to. Also, the area would be carefully managed to avoid spills, leaks, and odour issues with the containment pond/ kerbs checked at least daily to ensure proper functionality. Appropriate training, including safety codes and relevant manuals should be given to the personnel who regularly handle the chemicals on site. - Implement a construction EMMP and ensure full preparation of associated plans and procedures
Water Resources (Groundwater Levels)	- Decreased infiltration into the ground due to increased runoff from hard standing surfaces - Groundwater extraction during construction activities that require soil dewatering	- Install piezometers to monitor the changes in groundwater level in compliance with Building Control Regulations 2003 as part of its instrumentation and monitoring plan to be endorsed by the Qualified Professional (QP) - Proper Earth Retaining Stabilising Structures (ERSS) should be selected and designed to limit groundwater settlement - Plan soil dewatering in phases to avoid as much as practicably possible groundwater drawdown

1.4 Impacts due to Surface Water Quality Changes

Surface water quality of the watercourses in the vicinity of the site (and consequently Marsiling Park Pond and Upper Seletar Reservoir) could be affected by the various pollution sources and waste streams during the construction phase. The key sources of impact include:

- Silty effluent originating from surface runoff from exposed soil
- Extracted groundwater
- Other liquid effluents and construction wastewater
- Leachate of pollutants from waste stored on-site
- Accidental spills and leaks of pollutants due to improper managements (storage, handling, disposal) of chemicals and waste

Silty Effluent

Activities such as site clearance, earthworks and foundation works are expected to increase the amount of bare soil within the Study Area. Rainfall events could cause erosion of uncovered bare soil, resulting in elevated concentrations of suspended solids (e.g. silt) and any pollutants within the soil (if any) within the generated surface runoff. If left untreated, such discharges with high concentration of suspended solids could deteriorate the quality of the downstream receiving watercourses by increasing its sedimentation rates and turbidity. Such changes could have an impact on the regular functioning of the Upper Seletar Reservoir.

As mentioned earlier, there are no watercourses present within the site and surface runoff from the southern portion of the site gets discharged into Pond at Marsiling Park (via drains and culvert), and eventually reaches Upper Seletar Reservoir. If silty effluent gets discharged into roadside drains accidentally, baseline conditions of the immediate receiving waterbody may alter, consequently impacting downstream watercourses. The impact intensity of this impact was assessed to be **Medium**, taking into account that the current water quality baseline shows that the surface runoff from the site has relatively low concentrations of TDS and TSS. As Upper Seletar Reservoir was categorised as Priority 1 sensitive receptor, impact consequence on this receptor was assessed to be **Medium** (as per impact consequence matrix, as shown in the Report). The biodegradable erosion blankets should be used to cover any bare soil on site which will reduce the amount of TSS getting discharged into the environment, especially during the heavy storm events. In addition, appropriate ECM must be implemented on the site to ensure that no silty effluent, other than the one with allowed concentrations of TSS as per NEA Trade Effluent guidelines, gets discharged into the surrounding waterbodies. Under the assumption that the proposed minimum control measures have been successfully implemented, it is **Less Likely** that such uncontrolled discharges of silty effluent would occur during the construction phase of the Project. The overall impact significance was therefore assessed to be **Minor** (as per Impact Significance Matrix, as shown in Table 5-17 of the Report).

Other Liquid Effluents and Construction Wastewater

Besides silty effluents, it is expected that the proposed construction activities will result in significant amount of other liquid effluents and construction wastewater which may include sanitary discharges, stormwater runoff from waste storage facilities etc. Such effluents besides elevated silty content may also contain variety of other pollutants ranging from human pathogens (e.g. from sanitary discharges) to heavy metals and other toxic substances (e.g. from waste storage areas). Given the variety of pollutants, both in nature and concentration, uncontrolled discharge of such effluent could affect the baseline quality of receiving watercourse, potentially affecting the downstream waterbodies. Therefore, the impact intensity was assessed to be **Medium**.

As Upper Seletar Reservoir was categorised as Priority 1 sensitive receptor, impact consequence was assessed to be **Medium** (as per Table 5-15 in the Report). However, dedicated procedures for inspection and maintenance of wastewater collection, storage and treatment structure(s) must be developed prior to construction works and adhere to over the course of the Project. Under the assumption that the minimum control measures have been successfully implemented it is not expected that the potentially polluted liquid effluents would get discharged uncontrollably into the surrounding area. In addition, prior to any discharge into surrounding watercourses and/ or soil, the Contractor will have to seek an approval from NEA Director-General and effluent will have to meet certain water quality criteria prior to discharge. Hence, the likelihood of this impact was assessed to be **Rare**. Therefore,

the overall impact significance was assessed to be **Minor** (as per Impact Significance Matrix, as shown in Table 5-17 in the Report).

Leachate of pollutants from waste stored on-site

Based on the planned activities during the construction phase of the Project, it is expected that significant amount of solid waste would be generated. This includes waste such as faulty construction material, solid materials from excavation and site clearance activities, empty containers, etc. If not stored and managed properly, pollutants originating from these materials/ waste may seep into the ground, potentially contaminating groundwater and consequently downgradient surface watercourses either via transmission through soil or direct discharge of groundwater via soil drainage pipe. If these contaminants reach downgradient watercourses, they can alter the water quality of the receiving watercourse, potentially impacting the downstream waterbodies.

Given the fact that baseline surface water quality indicates generally low concentrations of tested parameters, majority of which do not exceed the adopted aquatic life criteria, potential leachate of pollutants could alter the baseline quality and hence the impact intensity was assessed to be **Medium**.

Since the Upper Seletar Reservoir was categorised as Priority 1 sensitive receptor, as per Impact Consequence Matrix, the impact consequence was assessed to be **Medium**. Under the assumption that the dedicated minimum control measures have been successfully implemented (e.g. appropriate waste storage and/ or facilities, dedicated SOP for waste handling, appropriate disposal of toxic waste, locating the storage facilities away from watercourses, etc) potential for leachate to reach watercourses is considered to be minimal, if any. Quantity of waste stored on-site is expected to be limited, with the assumption that the generated waste will be periodically removed and disposed off-site. Therefore, the likelihood of this impact was assessed to be **Rare**. Therefore, the overall impact significance was assessed to be **Minor**, as per Impact Significance Matrix.

Accidental spills and leaks of pollutants

Another potential mechanism to surface water contamination during construction phase of the Project could be through accidental spills and leaks of chemicals used and stored on site due to improper management practices, human mistakes and faulty equipment. In the event of such releases, contaminants could either be discharged directly into the watercourse or it can reach watercourse via soil and groundwater. Taking into consideration the localised nature of such uncontrolled discharges into the environment (if any) and dilution effects that naturally occur in water, the impact intensity was assessed to be **Low**. As the Upper Seletar Reservoir was assessed to be Priority 1 sensitive receptor, and as per adopted Impact Consequence Matrix, the impact consequence was assessed to be **Low**. It is to be noted that it is assumed (as part of minimum control measures) chemicals used during the construction phase will be stored at designated sheltered area with access-controlled entrance and concrete bund walls or in storage containers with good ventilation. In the event that chemical spillage does occur, spill kits will be provided on-site to be operated by an emergency response team competent in their use. With beforementioned in mind, quantities of this type of pollutants released in the environment are expected to minimal and quickly remediated (i.e. removed). With the minimum controls being successfully implemented, the likelihood of such accidental spills was assessed to be **Less Likely**. Therefore, the overall impact significance of this impact to Upper Seletar Reservoir was assessed to be **Minor**.

1.5 Impacts due to Groundwater Changes

As explained earlier, and as detailed in the main Report, there are no watercourses within the Project site. Furthermore, the watercourses adjacent to the site are all concrete drains with ephemeral flow. This implies that the water quantity within those watercourses is mostly going to be dependent on the rainfall rather than constant groundwater baseflow. In addition, the groundwater drawdown is expected to be local, and during the construction phase only, after which the groundwater level will find a new equilibrium. Therefore, the potential decrease of groundwater level during the construction phase of the Project is **Unlikely** to have impact on Upper Seletar Reservoir.

Groundwater contamination is possible to occur during the construction phase of the Project and assessment of such impacts was carried out in Section 1.4 of this Appendix.

1.6 Proposed Mitigation Measures

No additional mitigation measures aside from the proposed minimum controls were proposed to further minimise the adverse impacts as none of the impacts on the Upper Seletar Reservoir have been assessed to be Moderate or Major.

1.7 Residual Impact Assessment

No residual impact assessment has been undertaken as no Moderate or Major impact significance on sensitive receptor was assessed.

1.8 Cumulative Impact Assessment

It is assumed that all the concurrent developments will comply with the construction standards and environmental management and control. Therefore, it is not expected that they will increase impacts on water resources and Upper Seletar Reservoir.

2 Operational Phase

2.1 Potential Sources of Impact

Potential sources of impact during the construction phase on the Upper Seletar Reservoir are summarised in the table below.

Table 2-1 Potential impacts on Upper Seletar Reservoir during operational phase

Environmental Parameter	Potential Source of Impacts	Potential Associated Impact on Environmental Parameter	Potential Associated Impacts on Receptor
Water Resources (Surface Water and Groundwater Quality)	- Discharge of potentially contaminated surface water runoff, especially during storm events in the new development area and leachate into the soil and groundwater - Improper management of liquid and solid wastes generated within the site. This could also potentially lead to contamination of underlying soil and groundwater	- Elevated levels of suspended solids (e.g. silt) and anthropogenic pollutants in receiving watercourses and/ or groundwater - Solid waste can block the watercourses and lead to contamination - Inappropriate discharge of liquid wastes to the watercourses may result in contamination of surface water and groundwater	- Altered water quality of waterbodies used for beneficial purposes such as Upper Seletar Reservoir, may impede the regular functioning of such systems - In the events of serious contamination, water systems may completely cease to operate until the contamination is removed from water

2.2 Categorisation of Sensitive Receptor

As detailed in the Section 1.2 of this Appendix, the water within the Upper Seletar Reservoir is used for beneficial purposes, and hence was categorised as Priority 1 sensitive receptor.

2.3 Minimum Control Measures

Minimum control measures to be implemented during the construction phase of the Project are detailed in Section 8.3. of the Main Report and summarised in the table below.

Table 2-2 Minimum control measures during operational phase

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
Water Resources (Surface Water Quality)	Heavy rain and stormwater wash-off pollutants built-up in the new development area and discharge to the surrounding watercourses	- Adequate drainage, piping and/ or channelling of stormwater runoff to be assured through detailed design for capturing and treatment before discharge into receiving watercourses. - Regular and dedicated procedures for the inspection and maintenance of stormwater collection, storage, and treatment infrastructure, such as pipes, oil water separation, silt screens, etc. - Regular and dedicated procedures for the management of stormwater collection, settling, testing and eventual discharge of 'clean' water to surface waters, including associated measures required to prevent high sediment concentration stormwater drainage to surface waters.
	- Accidental spill and leaks (e.g., during storm event) - Improper handling, transfer, and storage of solid and liquid wastes (e.g., rubbish collection and sewage disposal)	- To prepare sufficient disposal bins surrounding of the Project to avoid improper disposal of waste. - To conduct regular inspection on wastes' storage system of the Project. - To monitor the proposed watercourses and its surroundings with CCTV surveillance regularly to ensure no contamination occurred. - To develop an emergency response plan and conduct adequate training to maintenance workers to cope the accidental water contamination. - Raising awareness of various stakeholders with community/ stakeholder engagement (e.g., signage boards, warning signs, etc.).
Water Resources (Groundwater Level)	More areas with impervious surfaces in the new development	- Incorporate more pervious surfaces in the development plan - Installation of recharge wells, if necessary
Water Resources (Groundwater Quality)	Stormwater wash-off pollutants built-up in the new development area and discharge to surrounding soil and groundwater	Ensure no trade effluent other than that of a nature or type approved by NEA Director-General shall be discharged into any watercourse or land.
	Discharge or leakage of waste and chemicals into the soil	- Conduct regular inspections on waste storage system within the Project to prevent system's clogging and leachate entering the underlying soil - Store all toxic waste and hazardous substances/chemicals (if any) at designated sheltered area provided with access-controlled entrance and concrete bund walls or in storage of containers with good ventilation. Spill trays shall be provided for all chemical drums and potentially pollutive substances. Spill trays shall be regularly maintained to prevent the rain from washing out the pollutive substances

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
		- Dispose all toxic waste chemicals to licensed Toxic Industrial Waste (TIW) collectors for treatment - Ensure all hazardous chemicals/substances (if stored on site) are labelled, its movement is recorded and returned to the designated storage areas when not in use - Ensure all activities involving the use of hazardous chemicals/substances are carried out on an area which is appropriately contained (e.g., concreted area and with proper containment/sumps). - Provide emergency spill kits on site in the event of any chemical spillages. The emergency response team shall also be competent in the use of these spill kits

2.4 Impacts due to Surface Water Quality Changes

The key surface water quality impacts associated with operational phase of the Project include the discharge of stormwater runoff potentially contaminated with pollutant build-up from urbanised areas and discharge of contaminants into the watercourses and soil due to inappropriate disposal and storage of liquid and solid wastes generated within the site.

Potentially Contaminated Stormwater Runoff

As the majority of the Project site will eventually become urbanised, imperviousness of the site will significantly increase. Consequently, potential pollutants that may fall onto the ground (e.g. domestic waste, chemicals due to accidental spills, etc.) will remain on the surfaces until removed (by dedicated procedures) or flashed out via stormwater. If these pollutants reach the downstream watercourses, they have a potential to alter existing water quality conditions, consequently affecting Upper Seletar Reservoir. Although the runoff may be significantly contaminated with various pollutants, taking into consideration the dilution effects and distance of Upper Seletar Reservoir from the site, impact intensity was assessed to be **Low**. As this receptor was categorised as Priority 1 sensitive receptor, impact consequence was assessed to be **Low**. Regular and dedicated procedures for stormwater collection settling, testing and eventual discharge should be implemented to assure that the water is of appropriate quality before the discharge. In addition, as such discharges with potential pollutants are expected to occur only during the storm events, likelihood was assessed to be **Occasional**. Therefore, the overall impact significance was assessed to be **Minor**, as per impact consequence matrix (refer to the Main Report).

Direct Discharge of Contaminants into Soil and/ or Watercourses due to Inappropriate Disposal and Storage of Liquid and Solid Wastes

During the operational phase, solid and liquid waste will be generated frequently by the residents in the proposed development (e.g. domestic waste, car wash wastewater, etc.). In addition, as the site will be highly urbanised, there is a potential for point discharge of contaminants due to accidental spillages and leakages of chemicals (e.g. car oil, faulty car parts, etc.), implying that there could be a great variety of chemicals to enter the environment. Adequate waste management practices are expected to be successfully implemented within the Project site (e.g. sufficient disposal bins, regular inspection of waste storage systems, etc.) which is expected to significantly reduce the likelihood of discharge of contaminants into the surrounding area. Localised point discharges due to human errors (e.g. accidental spillages) and/ or use of faulty vehicles are more difficult to prevent, even with the implemented minimum controls (e.g. emergency response plan, raising awareness of stakeholders, etc.). However, given the small quantities of such discharges and dilution effect by the time they reach watercourses (if they reach), impact intensity was assessed to be **Low**. As the Upper Seletar Reservoir was categorised as Priority 1 receptor, the impact consequence was assessed to be **Low**. The likelihood would be **Rare**, hence the overall significance was assessed to be **Minor**.

2.5 Impacts due to Groundwater Changes

As explained in Section 1.5 of this Appendix, the potential decrease of groundwater level during the construction phase of the Project is **Unlikely** to have impact on Upper Seletar Reservoir.

Groundwater contamination is possible to occur during the operational phase of the Project and assessment of such impacts was carried out in Section 0 of this Appendix.

2.6 Proposed Mitigation Measures

No additional mitigation measures aside from the proposed minimum controls were proposed to further minimise the adverse impacts as none of the impacts on the Upper Seletar Reservoir have been assessed to be Moderate or Major.

2.7 Residual Impact Assessment

No residual impact assessment has been undertaken as no Moderate or Major impact significance on sensitive receptor was assessed.

2.8 Cumulative Impact Assessment

It is assumed that all the concurrent developments will comply with the construction standards and environmental management and control. Therefore, it is not expected that they will increase impacts on water resources and Upper Seletar Reservoir.

3 Water Resources Monitoring Programme

3.1 Construction Phase

In order to ensure that procedures are followed appropriately, the construction phase of the projects should be accompanied by an EMMP. The proposed water resources monitoring programme, as detailed below, should be carried out by the Contractor's ECO, under supervision of SO Rep. Monthly site inspection should also be carried out by EMMP consultant.

Water quality monitoring is essential as discharge of excess contaminants, especially pH, nutrients and heavy metals, may lead to severe consequences (e.g. algae blooms). Effluent will be discharged from sedimentation ponds during the construction phase, and therefore the monitoring of sedimentation pond effluent was recommended to be undertaken to ensure that the surface water quality will be in compliance with the relevant standards. It was also recommended to monitor their water quality throughout the construction period to ensure minor construction impacts on their water quality. For all discharge points from construction worksites, it is recommended to monitor water quality following Singapore's NEA Allowable Limits for Trade Effluent Discharge to Controlled Watercourse.

Table 3-1 Recommended monitoring programme during construction phase

Test	Parameters	Monitoring Recommendation and Frequency
In-situ	Temperature	
	pH	
	Conductivity ($\mu\text{S}/\text{cm}$)	
	Total Dissolved Solids (TDS)	
	Turbidity and Total Suspended Solids (TSS)	

Test	Parameters	Monitoring Recommendation and Frequency
	Dissolved Oxygen (DO)	- Online real time monitoring for TSS at the discharge point location at all the construction sites throughout the construction period - Monthly monitoring for temperature, pH, conductivity, TDS and DO at all the discharge point locations at the construction sites throughout the construction period and upstream of Marsiling Park Pond
Ex-situ	Biochemical Oxygen Demand (BOD ₅)	Monthly monitoring for all the ex-situ parameters at the discharge points and upstream of Marsiling Park Pond throughout the construction period
	Chemical Oxygen Demand (COD)	
	Total Suspended Solids (TSS)	
	Ammoniacal Nitrogen (NH ₄ -N)	
	Total Nitrogen (TN)	
	Nitrate (NO ₃ -N)	
	Total Phosphorus (TP)	
	Orthophosphate (PO ₄)	
	Total Organic Carbon (TOC)	
	Oil & Grease (Total)	
	Oil & Grease (Hydrocarbon)	
	Cadmium	
	Chromium (trivalent and hexavalent)	
	Copper	
	Lead	
	Mercury	
	Nickel	
	Selenium	
	Silver	
	Zinc	
	Metals in Total	
	Enterococcus	

3.2 Operational Phase

The operational phase of the Project should be accompanied by an EMMP to ensure the proposed development will have minor impact on the surrounding watercourses. Water quality monitoring is essential as discharge of excess contaminants, especially pH and suspended solids may lead to severe consequences (e.g. turbid waters) due to the operational activities. It was recommended to monitor their water quality during the first three (3) months of operational period to ensure minor operational impacts on their water quality. For main outlets/ drains of the proposed development, it is recommended to monitor water quality following Singapore NEA's Allowable Limits for Trade Effluent Discharge to Controlled Watercourse.

Table 3-2 Recommended monitoring programme during construction phase

Test	Parameters	Monitoring Recommendation and Frequency
In-situ	Temperature	Monthly monitoring for all the in-situ parameters at the main outlet/ drain of the Project site towards Marsiling Park Pond, during the first three (3) months of operation period.
	pH	
	Conductivity	
	Total Dissolved Solids (TDS)	
	Turbidity	
	Dissolved Oxygen (DO)	
Ex-situ	Biochemical Oxygen Demand (BOD ₅)	
	Chemical Oxygen Demand (COD)	
	Total Suspended Solids (TSS)	

Test	Parameters	Monitoring Recommendation and Frequency
	Ammoniacal Nitrogen (NH ₄ -N)	Monthly monitoring for all the ex-situ parameters at the main outlets/ drains of the Project site towards Marsiling Park Pond, during the first three (3) months of operation period.
	Total Nitrogen (TN)	
	Nitrate (NO ₃ -N)	
	Total Phosphorus (TP)	
	Orthophosphate (PO ₄)	
	Total Organic Carbon (TOC)	
	Oil & Grease (Total)	
	Oil & Grease (Hydrocarbon)	
	Cadmium	
	Chromium (trivalent and hexavalent)	
	Copper	
	Lead	
	Mercury	
	Nickel	
	Selenium	
	Silver	
	Zinc	
	Metals in Total	
	Enterococcus	

Appendix U Baseline Airborne Noise Monitoring Report

Wildlife Incident Form

Date (YYYY/MM/DD):	Time:
Description of Location:	GPS Coordinates:
Wildlife Observed:	Animal Condition (circle): Alive / Killed / Dead / Injured Animal activity (circle): Moving / Resting / Trapped
Photographs Taken:	MFLG and NParks notified: Yes / No Name of staff notified:
Describe Incident (e.g., activities being carried out; what animal was doing; personnel involved):	
Actions Taken:	
Reported by:	Reported to:
Contact no.:	Contact no:
Remarks:	

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Introduction

The Housing Development Board (HDB) appointed AECOM Singapore Pte. Ltd. (AECOM) to carry out an Environmental Impact Assessment (EIA) on Woodlands N1 to establish the baseline airborne noise conditions and to assess for potential environmental impacts arising from, and associated with, the construction and operational phases of the proposed residential development (hereafter 'the Project') planned to be developed within the Project Site.

This study will focus on the determination of the existing baseline airborne conditions at the identified monitoring locations detailed in **Table 1** in accordance with the work schedules of 7am – 7pm, 7pm – 10pm and 10pm – 7am for periods of 12 hours (long term), 1 hour, and 5 minutes (short term) detailed in the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008/ NEA Construction Noise Control regulations at each of the proposed locations.

Airborne Noise Monitoring Schedule

To determine the baseline airborne noise levels, unattended noise monitoring was conducted for one (1) weekday and one (1) weekend at the proposed locations in the vicinity of Project Site. The monitoring dates and locations of the monitoring points are reflected in **Table 1** below.

Table 1 Baseline Monitoring Locations

No.	Monitoring ID	Location	Date of Monitoring
1	NM01	Marsiling Park	21 July – 27 July 2023

Airborne Noise Monitoring Equipment

One (1) 131 Norsonic sound level meters (SLMs) with microphones were utilized to collect data for the Project. For the purpose of QA/ QC, the SLM was calibrated before each monitoring session without any drift in calibration before and after monitoring to ensure that equipment readings remain within acceptable margins of error. In order to reduce the changes to recording unwanted noise caused by the wind, a windshield was attached to the microphone. Noise levels were recorded in 1-minute intervals using the L_{Aeq} descriptor, under a 'fast' time-weighting. Calibration certificates of the noise monitoring equipment as per **Table 2** are presented in **Annex B**.

Table 2 Airborne Noise Monitoring Equipment

Instrument	Brand	Model	Serial Numbers	Type
131 Norsonic	131	Norsonic	1313950	1



Figure 1 Airborne Noise Monitoring Setup

Baseline Airborne Noise Monitoring Data

The daily baseline airborne noise monitoring results recorded at NN01 – NN07 for 7am – 7pm, 7pm – 10pm, and 10pm – 7am (i.e. reflected in **Table 3**) in line with the work schedules detailed in the NEA Construction Noise Control regulations (<https://www.nea.gov.sg/our-services/pollution-control/noise-pollution/construction-noise-control/>) Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008 are listed in this section for $L_{Aeq}(12 \text{ hrs})$, $L_{Aeq}(1 \text{ hr})$, and $L_{Aeq}(5 \text{ mins})$.

The corresponding graphs for the daily monitoring data are displayed in **Annex A**.

Baseline Airborne Noise Monitoring Data

Table 3 Baseline Noise Monitoring Results at NM01 – Marsiling Park

Monitoring period		L _{Aeq} (12hours), dB		L _{Aeq} (1hour), dB			L _{Aeq} (5mins), dB			L _{Aeq} (15mins), dB		
		7:00 am – 7:00 pm	7:00 pm – 7:00 am	7:00 am – 7:00 pm	7:00 pm – 10:00 pm	10:00 pm – 7:00 am	7:00 am – 7:00 pm	7:00 pm – 10:00 pm	10:00 pm – 7:00 am	7:00 am – 7:00 pm	7:00 pm – 11:00 pm	11:00 pm – 7:00 am
21-Jul-23	Min				60	58		58	57		58	57
Friday	Max				60	63		61	64		61	64
	Average / Overall		60		60	60		60	60		59	60
22-Jul-23	Min			60	59	57	59	58	57	60	58	57
Saturday	Max			62	60	60	63	61	61	63	60	61
	Average / Overall	62	59	61	60	59	61	60	59	61	59	59
23-Jul-23	Min			59	60	58	58	59	57	58	59	57
Sunday	Max			61	61	64	62	63	65	62	61	64
	Average / Overall	60	61	60	60	61	60	60	61	60	60	61
24-Jul-23	Min			61	59	57	60	58	56	61	57	57
Monday	Max			64	61	64	67	64	65	64	60	64
	Average / Overall	62	60	62	60	60	62	60	60	62	58	60
25-Jul-23	Min			61	59	57	60	58	56	60	57	56
Tuesday	Max			63	60	63	66	61	65	65	61	64
	Average / Overall	62	60	62	59	61	62	59	61	62	59	60
26-Jul-23	Min			61	58	57	59	58	56	60	57	56
Wednesday	Max			62	60	63	65	61	65	63	60	63
	Average / Overall	62	60	61	59	60	61	59	60	61	59	60
27-Jul-23	Min			61	59	57	60	57	56	60	57	57
Thursday	Max			63	61	63	65	63	65	64	62	64
	Average / Overall	62	60	62	60	60	62	60	59	62	59	60

Summary of Baseline Airborne Noise Monitoring Results

The baseline airborne noise monitoring results recorded at NM01 are summarized in this section in Table 4 – Table 5 for results recorded for Weekdays (Monday – Saturday) and Weekends (Sunday/ Public Holidays).

Summary of Baseline Airborne Noise Monitoring Data

Table 4 Summary of Baseline Airborne Noise Monitoring Results for Monday – Saturday at NM01 – Marsiling Park

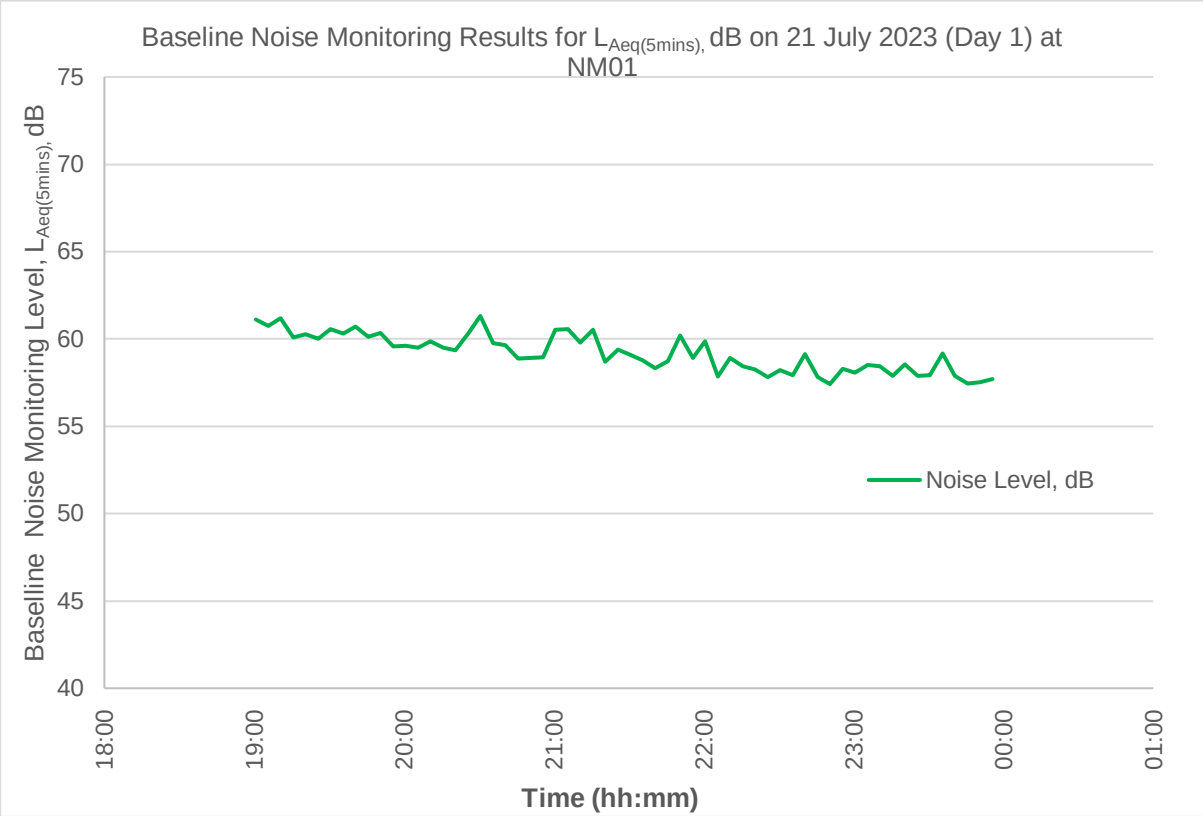
Monitoring period		L _{Aeq} (12hours), dB		L _{Aeq} (1hour), dB			L _{Aeq} (5mins), dB			L _{Aeq} (15mins), dB		
		7:00 am – 7:00 pm	7:00 pm – 7:00 am	7:00 am – 7:00 pm	7:00 pm – 10:00 pm	10:00 pm – 7:00 am	7:00 am – 7:00 pm	7:00 pm – 10:00 pm	10:00 pm – 7:00 am	7:00 am – 7:00 pm	7:00 pm – 11:00 pm	11:00 pm – 7:00 am
Monday - Saturday	Min			60	58	57	59	57	56	60	57	56
	Max			64	61	64	67	64	65	65	62	64
	Average / Overall	62	60	62	60	60	62	60	60	62	59	60

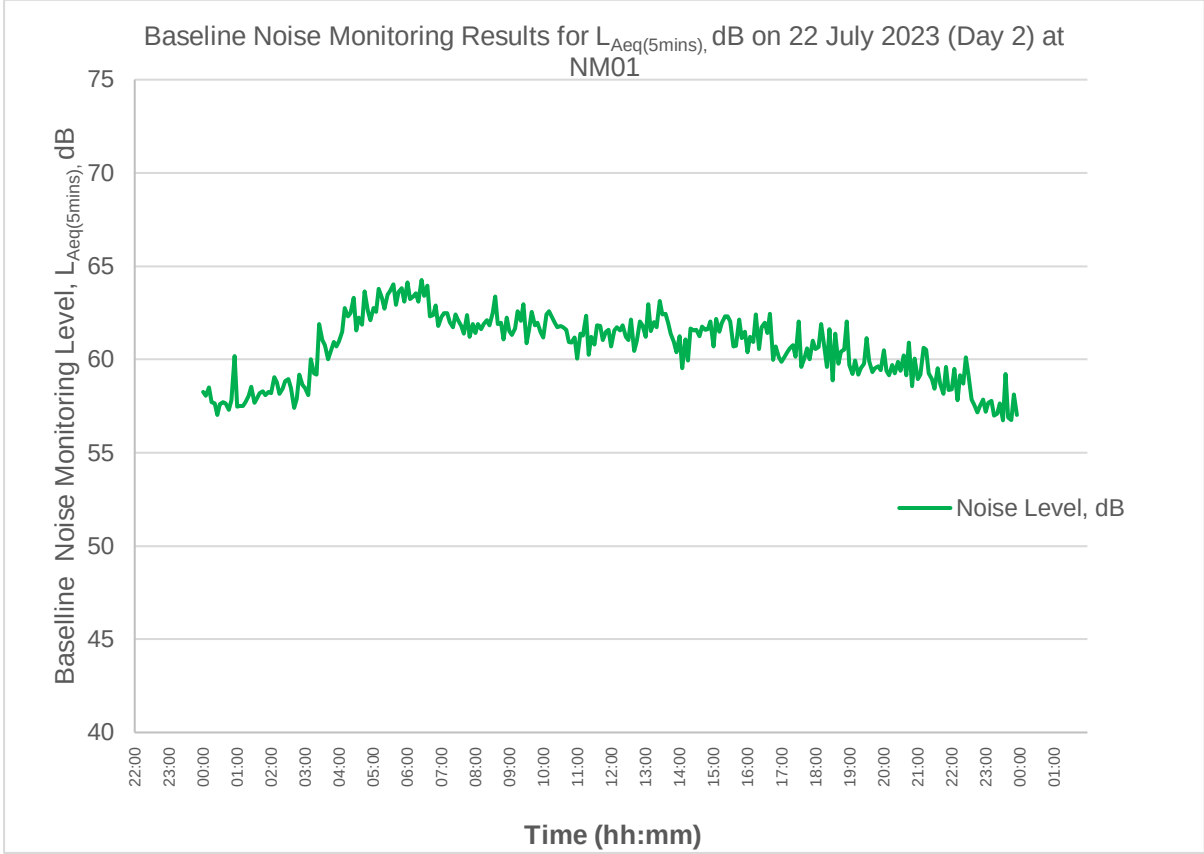
Table 5 Summary of Baseline Airborne Noise Monitoring Results for Sunday and Public Holidays at NM01 – Marsiling Park

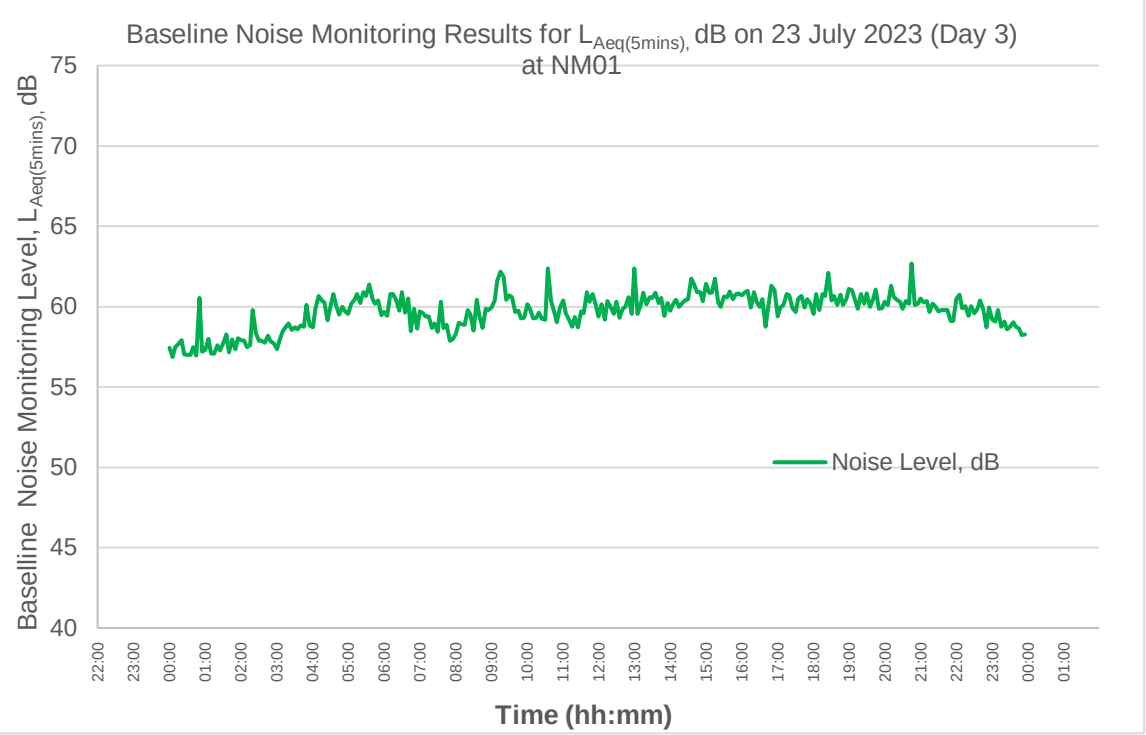
Monitoring period		L _{Aeq} (12hours), dB		L _{Aeq} (1hour), dB			L _{Aeq} (5mins), dB			L _{Aeq} (15mins), dB		
		7:00 am – 7:00 pm	7:00 pm – 7:00 am	7:00 am – 7:00 pm	7:00 pm – 10:00 pm	10:00 pm – 7:00 am	7:00 am – 7:00 pm	7:00 pm – 10:00 pm	10:00 pm – 7:00 am	7:00 am – 7:00 pm	7:00 pm – 11:00 pm	11:00 pm – 7:00 am
Sunday	Min			59	60	58	58	59	57	58	59	57
	Max			61	61	64	62	63	65	62	61	64
	Average / Overall	60	61	60	60	61	60	60	61	60	60	61

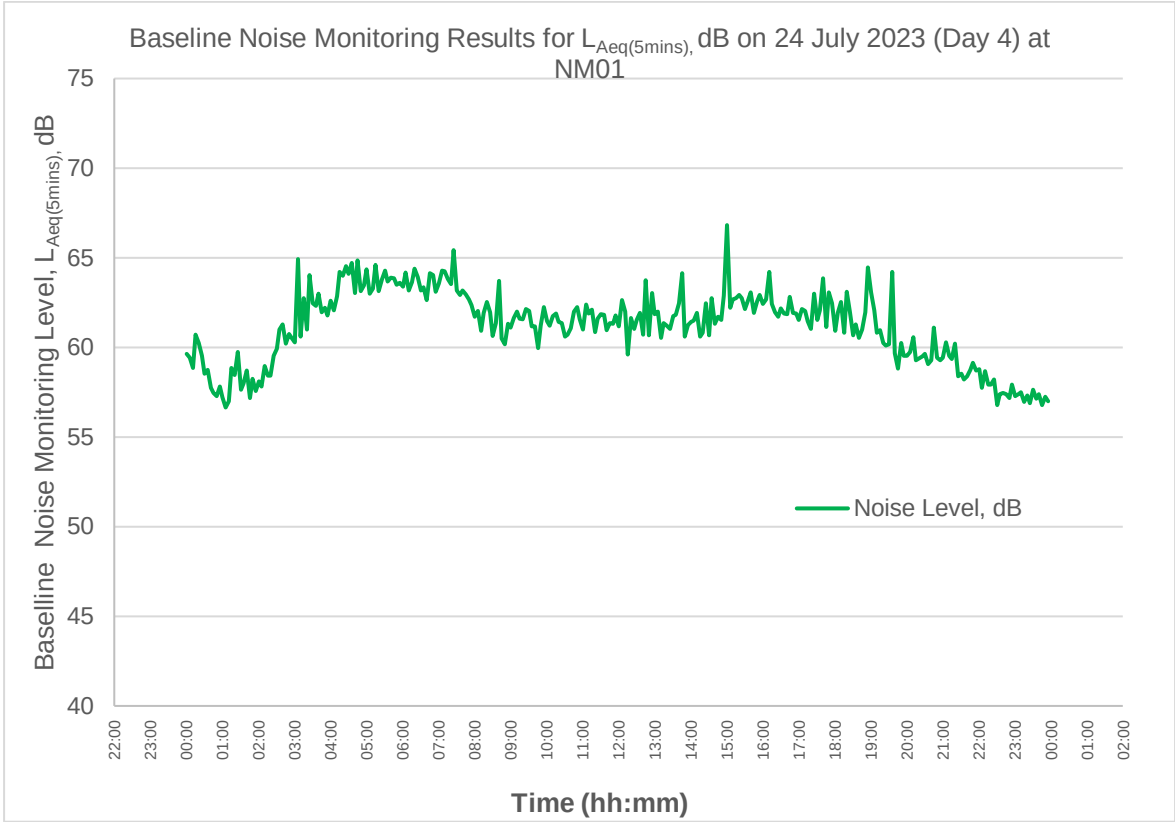
Annex A

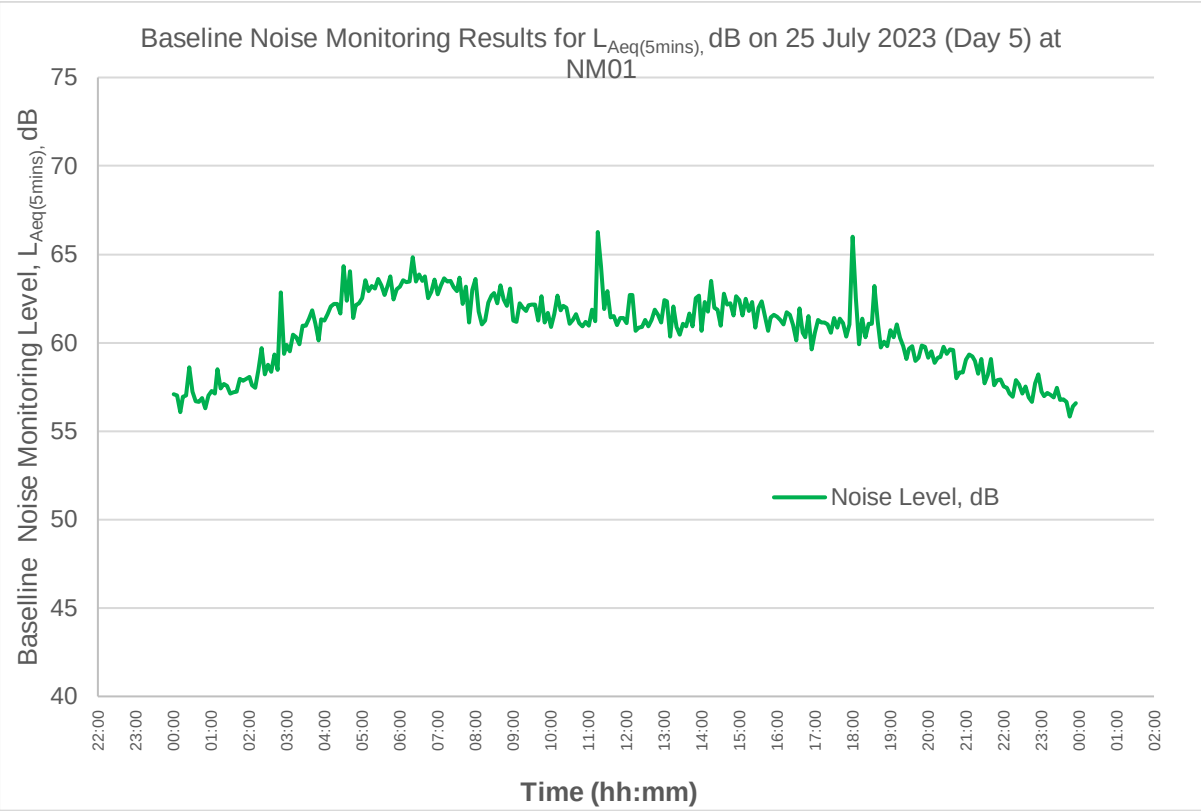
Daily Monitoring Data at NM01 – Marsiling Park

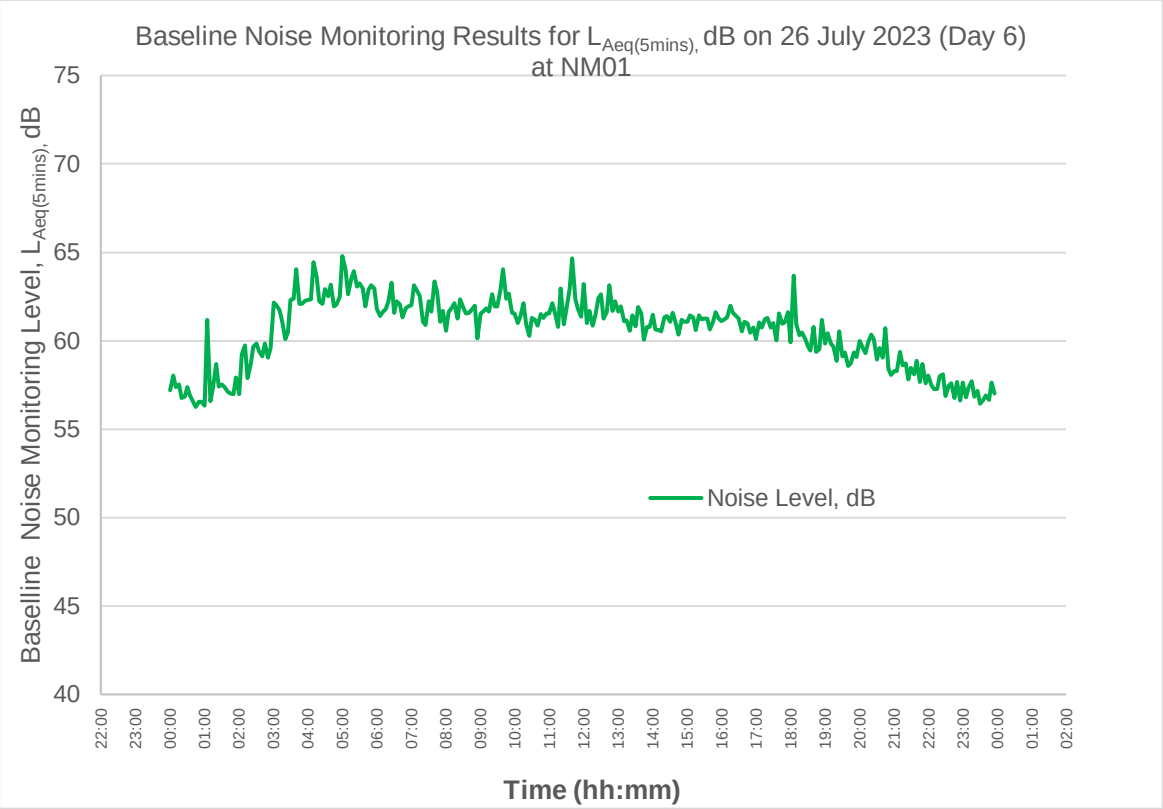


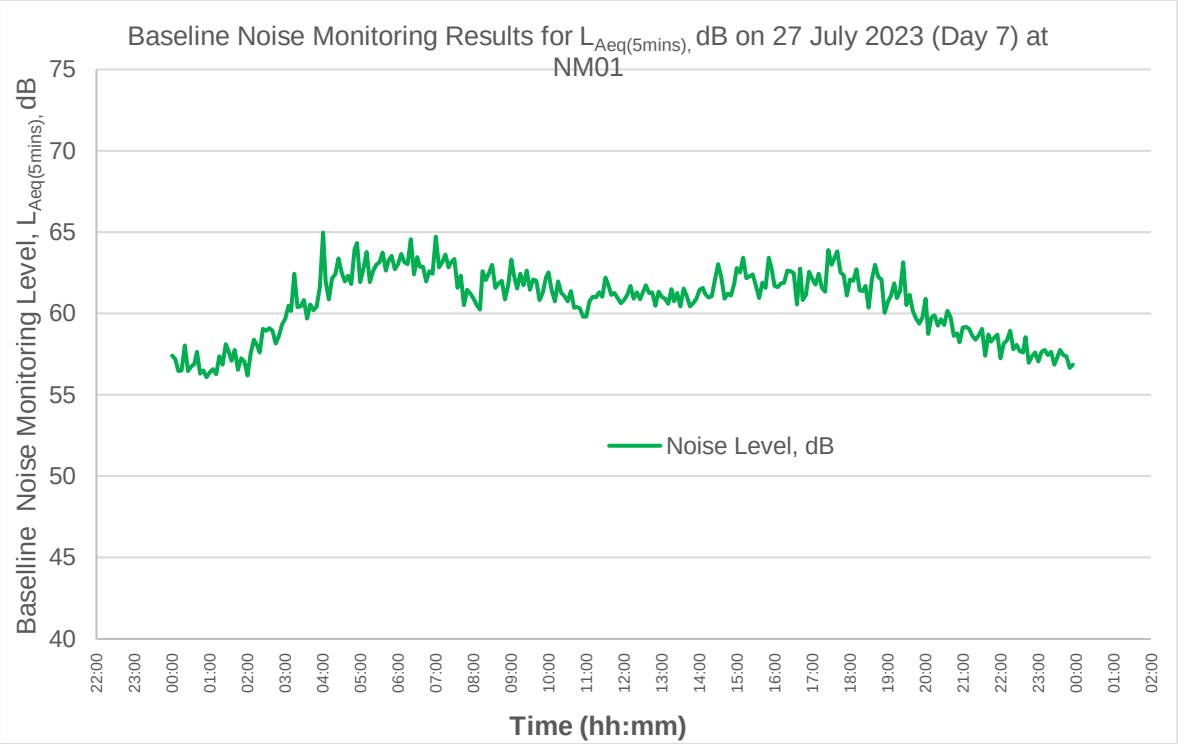












Annex B

Certificate of Calibration

Certificate No.: S2303-0374

Customer: AECOM SINGAPORE PTE LTD.

Date of calibration: 2023-03-02
Date of issue: 2023-03-07
Instrument Calibrated: Sound Level Meter
Manufacturer: Norsonic
Type: 131
Serial no: 1313950

Calibration and verification performed:

Acoustical levels are stated relative to 20 μ Pa. Other dB levels are relative values.

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k, which with the reported effective degree of freedom corresponds to coverage probability of approximately 95%.

The sound level meter instrument submitted for periodic testing following the periodic tests of IEC 61672-3.

Preconditioning:

The equipment was preconditioned 16 hours at the specified calibration temperature and humidity.

Instruments and Program:

A complete list of instruments, hardware, and software, that has been used for this calibration is separately available from the calibration laboratory.

Equipment standards used:

- Sound measuring equipment calibration unit 483B S/N31083
- Digital multimeter Keysight S/N IIP34401A
- Ultra-low distortion function generator Stanford SRS DS360 S/N123625
- Acoustic calibrator class 0 Nor1253 S/N32941
- System software Nor1504A

Traceability

The measured values are traceable to following the ISO/IEC 17025 laboratories:

Sound Pressure Level: NCL, Norway

Reference microphone: NCL, Norway

Voltage: TPA, Thailand

Frequency: TPA, Thailand

This certificate of calibration is issued by Acoustic Laboratory Thailand (ALT). It also states that the laboratory has a satisfactory quality assurance system and traceability to accredited or national calibration laboratories. This certificate may not be reproduced other than in full.

Certificate No.: S2303-0374

Environmental conditions:	Pressure:	Temperature:	Relative humidity:
Reference conditions:	101.325 kPa	23.0 °C	50 %RH
Measurement conditions:	101.69 ± 0.10 kPa	21.8 ± 1.0 °C	49.4 ± 2.0 %RH

1. Absolute Sensitivity check

Reference Acoustic Signal (dB)	Measured value (dB)		Deviated value (dB)	Acceptant limit (dB)
	Before adjust	After adjust		
94.0	93.9	94.0	0.0	±0.7

Note: Absolute sensitivity was adjusted to 94.0 dB by the sound calibrator

2. Self-generated noise without microphone

Frequency Weighting	Measured value (dB)
A-Weighting	14.7
C-Weighting	16.4
Z-Weighting	19.5

3. Electrical signal test of frequency weighting at 92 dB

Frequency (Hz)	Deviation from various frequency weighting response curve			
	A-weighting (dB)	C-weighting (dB)	Z-weighting (dB)	Tolerance limit (dB)
63.1	0.0	-0.1	-0.1	±1.0
125.9	0.0	0.0	-0.1	±1.0
251.2	-0.1	-0.1	-0.1	±1.0
501.2	-0.1	0.0	0.0	±1.0
1000.0	0.0	0.0	0.0	±0.7
1995.3	-0.1	0.0	-0.1	±1.0
3981.1	-0.1	-0.1	-0.1	±1.0
7943.3	0.0	0.0	0.0	+1.5,-2.5
15848.9	0.0	0.0	0.0	+2.5,-16.0

Date of calibration : 2023-03-02
Date of issue : 2023-03-07

Certificate No.: S2303-0374

4. Frequency and time weightings at 1 kHz

4.1 Frequency weightings at 1kHz

Frequency weightings	Measured value (dB)	Deviated value (dB)	Acceptant limit (dB)
A	114.0	0.0	±0.2
C	114.0	0.0	±0.2
Z	114.0	0.0	±0.2

4.2 Time weightings at 1kHz

Time weightings	Measured value (dB)	Deviated value (dB)	Acceptant limit (dB)
Fast	114.0	0.0	+1.0
Slow	114.0	0.0	±1.0
1-sec	114.0	0.0	+1.0
SEL	134.1	0.1	±1.0

5. Long term stability test

Time interval (min:ss)	Start level (dB)	Stop level (dB)	Deviated value (dB)	Acceptant limit (dB)
41:37	114.0	114.0	0.0	0.1

6. Level linearity on the reference level range

6.1 Measured at 31.5kHz

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Tolerance limit (dB)
84.0	84.0	0.0	±0.8
89.0	89.0	0.0	±0.8
93.6	93.6	0.0	±0.8
94.6	94.6	0.0	±0.8
95.6	95.6	0.0	±0.8
96.6	96.6	0.0	±0.8
97.6	97.6	0.0	±0.8
84.0	84.0	0.0	±0.8
79.0	79.0	0.0	±0.8
74.0	74.0	0.0	±0.8

Date of calibration : 2023-03-02
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69.0	69.0	0.0	±0.8
64.0	64.0	0.0	±0.8
59.0	59.0	0.0	±0.8
54.0	54.0	0.0	±0.8
49.0	49.0	0.0	±0.8
44.0	44.0	0.0	±0.8
39.0	39.0	0.0	±0.8
38.0	38.0	0.0	±0.8
37.0	37.0	0.0	±0.8
36.0	36.0	0.0	±0.8
35.0	35.0	0.0	±0.8

6.2 Measured at 1kHz

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Tolerance limit (dB)
114.0	114.0	0.0	±0.8
119.0	119.0	0.0	±0.8
124.0	124.0	0.0	±0.8
129.0	129.0	0.0	±0.8
133.0	133.0	0.0	±0.8
134.0	134.0	0.0	±0.8
135.0	135.0	0.0	±0.8
136.0	136.0	0.0	±0.8
137.0	137.0	0.0	±0.8
114.0	114.0	0.0	±0.8
109.0	109.0	0.0	±0.8
104.0	104.0	0.0	±0.8
99.0	99.0	0.0	±0.8
94.0	94.0	0.0	±0.8
89.0	89.0	0.0	±0.8
84.0	84.0	0.0	±0.8
79.0	78.9	-0.1	±0.8
74.0	74.0	0.0	±0.8
69.0	68.9	-0.1	±0.8
64.0	63.9	-0.1	±0.8
59.0	59.0	0.0	±0.8
54.0	53.9	-0.1	±0.8
49.0	48.9	-0.1	±0.8
44.0	43.9	-0.1	±0.8
39.0	38.9	-0.1	±0.8
38.0	38.0	0.0	±0.8
37.0	37.0	0.0	±0.8
36.0	36.0	0.0	±0.8
35.0	35.0	0.0	±0.8

Date of calibration : 2023-03-02
Date of issue : 2023-03-07

Certificate No.: S2303-0374

6.3 Measured at 8 kHz

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Tolerance limit (dB)
114.0	114.0	0.0	+0.8
119.0	119.0	0.0	±0.8
124.0	124.0	0.0	±0.8
129.0	129.0	0.0	±0.8
131.9	131.9	0.0	±0.8
132.9	132.9	0.0	±0.8
133.9	133.9	0.0	±0.8
134.9	134.9	0.0	±0.8
135.9	135.9	0.0	±0.8
114.0	114.0	0.0	±0.8
109.0	109.0	0.0	±0.8
104.0	104.0	0.0	±0.8
99.0	99.0	0.0	±0.8
94.0	94.0	0.0	±0.8
89.0	89.0	0.0	±0.8
84.0	83.0	-0.1	±0.8
79.0	78.9	-0.1	±0.8
74.0	73.9	-0.1	±0.8
69.0	68.9	-0.1	±0.8
64.0	63.9	-0.1	±0.8
59.0	58.9	-0.1	±0.8
54.0	53.9	-0.1	±0.8
49.0	48.9	-0.1	±0.8
44.0	43.9	-0.1	±0.8
39.0	38.9	-0.1	±0.8
38.0	37.9	-0.1	±0.8
37.0	37.0	0.0	±0.8
36.0	36.0	0.0	±0.8
35.0	34.9	-0.1	±0.8

7. Tone burst response

Time weightings	Tone burst duration, Tb (ms)	Measured value (dB)	Deviated value (dB)	Tolerance limit (dB)
Fast	200	134.0	0.0	+0.5
	2	116.5	-0.5	+1.0; -1.5
	0.25	107.5	-0.5	+1.0; -3.0
Slow	200	127.6	0.0	±0.5
	2	107.9	-0.1	+1.0; -3.0
SEL	200	128.0	0.0	±0.5
	2	107.9	-0.1	+1.0; -1.5
	0.25	98.8	-0.2	+1.0; -5.0

Date of calibration : 2023-01-02

Date of issue : 2023-03-07

Certificate No.: S2303-0374

8. Peak C sound level

Number of cycles in test signal	Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Tolerance limit (dB)
Complete cycle	129.4	128.5	-0.9	±2.0
Positive half cycle	131.4	131.3	-0.1	±1.0
Negative half cycle	131.4	131.2	-0.2	±1.0

9. Overload indication

Measured value (dB)		Deviated value (dB)	Tolerance limit (dB)
Positive one half cycle	Negative one half cycle		
141.7	141.8	0.1	1.5

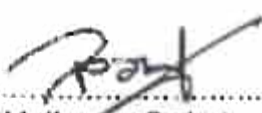
10. High level stability test

Initial level (dB)	Final level (dB)	Deviated value (dB)	Tolerance limit (dB)
136.0	136.0	0.0	0.1

Uncertainty of measurement

Parameters	Uncertainty
1. Absolute Sensitivity	0.12
2. Self-generated noise	0.20
3. Electrical signal test of frequency weighting	0.20
4. Frequency and time weightings at 1 kHz	0.20
5. Long term stability test	0.20
6. Level linearity on the reference level range	0.20
7. Tone burst response	0.20
8. Peak C sound level	0.20
9. Overload indication	0.20
10. High level stability test	0.20

The reported expanded uncertainty is based upon a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%.

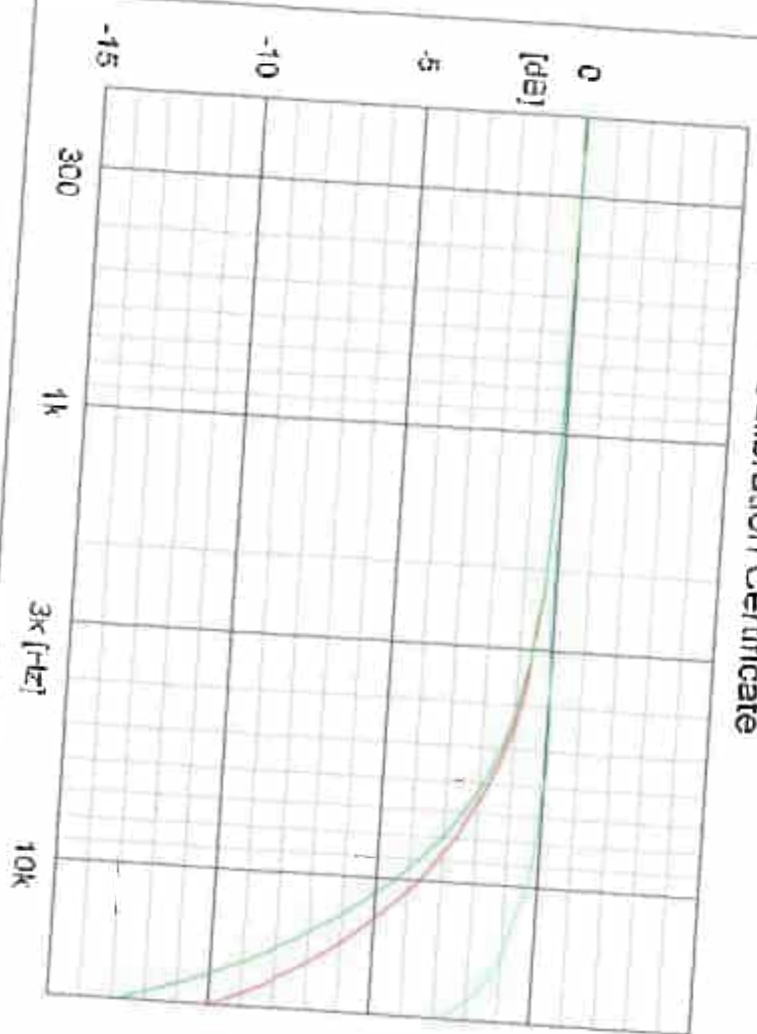
Calibrated By: 
(Mr. Sarawut Sapha)

Approved By: 
(Mr. Pitapong Surapho)

----- End of Certificate of Calibration -----

Date of calibration : 2023-03-02
Date of issue : 2023-03-07

Microphone Calibration Certificate



Norsonic

Type: 1228

Serial no: 04134

Sensitivity: 55.4 mV/Pa
-26.1 dB re 1 V/Pa

Date: 2023-02-24

Signature: *EP*

Measurement conditions:
Polarisation voltage: 5.0 V
Frequency: 06.50 kHz
Temperature: 23.7 °C
Relative humidity: 44.4 %RH
Results are normalized to
the reference conditions

Free field response

Diffuse field response

Pressure (Advection) responses

Norsonic AS

info@norsonic.com

Appendix V Equipment Inventory List

Proposed Residential Development

					DAY - LAeq(12hrs)						NIGHT - LAeq(12hrs)						DAY - LAeq(5mins)						EVENING - LAeq(5mins)						NIGHT - LAeq(5mins)					
					Activities 7:00am - 7:00pm						Activities 7:00pm - 7:00am						Activities 7:00am - 7:00pm						Activities 7:00pm - 10:00pm						Activities 10:00pm - 7:00pm					
No.	Phase of Construction	PME	Approximate no of months for this activity [in months]	Equipment ID	No [Quantity of that particular construction equipment used for that particular construction activity]	On-time(%) / daily working hours [how long in percentage that particular equipment will be used in a day]	PWL, dB(A)	10*(Lw/10)	No [Quantity of that particular construction equipment used for that particular construction activity]	On-time(%) / daily working hours [how long in percentage that particular equipment will be used in a day]	PWL, dB(A)	10*(Lw/10)	No [Quantity of that particular construction equipment used for that particular construction activity]	On-time(%) / daily working hours [how long in percentage that particular equipment will be used in a day]	PWL, dB(A)	10*(Lw/10)	No [Quantity of that particular construction equipment used for that particular construction activity]	On-time(%) / daily working hours [how long in percentage that particular equipment will be used in a day]	PWL, dB(A)	10*(Lw/10)	No [Quantity of that particular construction equipment used for that particular construction activity]	On-time(%) / daily working hours [how long in percentage that particular equipment will be used in a day]	PWL, dB(A)	10*(Lw/10)										
1.Site Clearance and Earthwork (1Q 2025 – 2Q 2026)																																		
1	Site clearance and earthworks to prepare platform	Excavator	16	E	2	50%	106	3.9811E+10	NA	NA	NA	NA	2	100%	109	7.96E+10	NA	NA	NA	NA	NA	NA	NA	NA	NA									
		Lorry	16	LZ	15	50%	117	4.7322E+11	NA	NA	NA	NA	15	100%	120	9.46E+11	NA	NA	NA	NA	NA	NA	NA	NA	NA									
		Generator	16	G	2	50%	106	3.9811E+10	NA	NA	NA	NA	2	100%	109	7.96E+10	NA	NA	NA	NA	NA	NA	NA	NA	NA									
		Concrete Vibrator	16	V	1	50%	94	2505936168	NA	NA	NA	NA	1	100%	97	5.01E+09	NA	NA	NA	NA	NA	NA	NA	NA	NA									
		Air Compressor	16	C	1	50%	100	9976311575	NA	NA	NA	NA	1	100%	103	2E+10	NA	NA	NA	NA	NA	NA	NA	NA	NA									
2	Construction Access	Lorry	4	LZ	1	2%	91	1261914689	NA	NA	NA	NA	1	100%	108	6.31E+10	NA	NA	NA	NA	NA	NA	NA	NA	NA									
		Excavator	4	E	1	50%	103	1.9905E+10	NA	NA	NA	NA	1	100%	106	3.98E+10	NA	NA	NA	NA	NA	NA	NA	NA	NA									
Summation							118								121																			
2. Road Construction (2Q/3Q 2024 to 1Q2028)																																		
1	Clearing and Excavation	Excavator	18	E	1	50%	103	1.9905E+10	NA	NA	NA	NA	1	100%	109	7.96E+10	NA	NA	NA	NA	NA	NA	NA	NA	NA									
2	Mounting	Excavator	18	E	1	50%	103	1.9905E+10	NA	NA	NA	NA	1	100%	118	5.97E+11	NA	NA	NA	NA	NA	NA	NA	NA	NA									
3	Fine Grading/ Surface Levelling	Grader	12	GR	1	50%	103	1.9905E+10	NA	NA	NA	NA	1	100%	109	7.96E+10	NA	NA	NA	NA	NA	NA	NA	NA	NA									
4	Aggregate Base (Aggregate Laying Truck)	Concrete Truck	12	RMC	1	50%	104	2.5059E+10	NA	NA	NA	NA	1	100%	107	5.01E+10	NA	NA	NA	NA	NA	NA	NA	NA	NA									
5	Asphalt Paving	Roller	12	R	1	50%	98	6294627059	NA	NA	NA	NA	1	100%	101	1.26E+10	NA	NA	NA	NA	NA	NA	NA	NA	NA									
Summation							110								119																			
3. Foundation Work (Substructures including piles and pile caps) 18 months (from Jul 2025 - Dec 2026)																																		
1	Erection of crawler crane & boring rig	Mobile Crane	3	MC	1	90%	110	9E+10	1	50%	107	5E+10	1	100%	110	1E+11	1	100%	110	1E+11	1	100%	110	1E+11										
2	Installation of Casing	Crawler Crane	15	CC	2	90%	117	4.5214E+11	2	50%	114	2.512E+11	2	100%	117	5.02E+11	2	100%	117	5.024E+11	2	100%	117	5.0238E+11										
3	Boring Work	Bored Piling Machine	15	BPM	4	90%	123	1.8043E+12	4	50%	120	1.002E+12	4	100%	123	2E+12	4	100%	123	2.005E+12	4	100%	123	2.0047E+12										
4	Rebar Cage & Tremix Pipe Installation	Crawler Crane	15	CC	2	90%	117	4.5214E+11	2	50%	114	2.512E+11	2	100%	117	5.02E+11	2	100%	117	5.024E+11	2	100%	117	5.0238E+11										
5	Concreting works	Ready Mix Concrete Truck & Crawler Crane	15	RMC	2	90%	110	9.0214E+10	2	50%	107	5.012E+10	2	100%	111	1.26E+11	2	100%	111	1.262E+11	2	100%	111	1.2619E+11										
6	Pile Head hacking	Excavator via breaker and 40 pounds breaker	15	PNEU	2	90%	123	1.8E+12	2	50%	120	1E+12	2	100%	123	2E+12	2	100%	123	2E+12	2	100%	123	2E+12										
7	Hot works - welding of steel beams, brackets, etc	Welding Equipment	15	WE	1	90%	101	1.133E+10	1	50%	98	6.295E+09	1	100%	101	1.26E+10	1	100%	101	1.259E+10	1	100%	101	1.2589E+10										
8	Delivery of Steel sections	40 ft Trailer	15	TT	2	90%	111	1.1357E+11	2	50%	108	6.31E+10	2	100%	111	1.26E+11	2	100%	111	1.262E+11	2	100%	111	1.2619E+11										
9	Hoisting of Waler & Struts	Excavator with lifting appliance	15	E	1	90%	106	3.583E+10	1	50%	103	1.991E+10	1	100%	106	3.98E+10	1	100%	106	3.981E+10	1	100%	106	3.9811E+10										
10	Stage excavation for walers & struts	Excavator with lifting appliance	15	E	1	90%	106	3.583E+10	1	50%	103	1.991E+10	1	100%	106	3.98E+10	1	100%	106	3.981E+10	1	100%	106	3.9811E+10										
11	Stage Excavation	Excavator	15	E	4	90%	112	1.4332E+11	4	50%	109	7.962E+10	4	100%	112	1.59E+11	4	100%	112	1.592E+11	4	100%	112	1.5924E+11										
		Mini Excavator	15	ME	2	90%	99	7165929070	2	50%	96	3.981E+09	2	100%	99	7.96E+09	2	100%	99	7.962E+09	2	100%	99	7962143411										
12	Spoil and slurry removal	Dump trucks	15	DT	2	90%	110	9.0214E+10	2	50%	107	5.012E+10	2	100%	110	1E+11	2	100%	110	1.002E+11	2	100%	110	1.0024E+11										
Summation							127				125				128				128				128											
4. Superstructure (Prefab installation) - 36 months (from Jul 2026 - Jun 2029)																																		
1	Pumping of water from ground or rain	Temporary Water Pump	36	TWP	2	90%	96	3591472167	2	50%	93	1.995E+09	2	100%	96	3.99E+09	2	100%	96	3.991E+09	2	100%	96	3990524630										
2	Power supply for lighting, pumps and temporary ventilation fans	Generator	36	G		90%	109	7.1659E+10		50%	106	3.981E+10		100%	109	7.96E+10		100%	109	7.962E+10		100%	109	7.9621E+10										
					2				2				2				2				2													
3	Excavation below surface for working platform	Excavator	36	E	4	90%	112	1.4332E+11	4	50%	109	7.962E+10	4	100%	112	1.59E+11	4	100%	112	1.592E+11	4	100%	112	1.5924E+11										
4	Stage Excavation to prepare Lean concrete	Mini Excavator	36	ME	2	90%	99	7165929070	2	50%	96	3.981E+09	2	100%	99	7.96E+09	2	100%	99	7.962E+09	2	100%	99	7962143411										

					DAY - LAeq(12hrs)				NIGHT - LAeq(12hrs)				DAY - LAeq(5mins)				EVENING - LAeq(5mins)				NIGHT - LAeq(5mins)			
					Activities 7:00am - 7:00pm				Activities 7:00pm - 7:00am				Activities 7:00am - 7:00pm				Activities 7:00pm - 10:00pm				Activities 10:00pm - 7:00pm			
No.	Phase of Construction	PME	Approximate no of months for this activity [in months]	Equipment ID	No [Quantity of that particular construction equipment used for that particular construction activity]	On-time(%) / daily working hours [how long in percentage that particular equipment will be used in a day]	PWL, dB(A)	10*(Lw/10)	No [Quantity of that particular construction equipment used for that particular construction activity]	On-time(%) / daily working hours [how long in percentage that particular equipment will be used in a day]	PWL, dB(A)	10*(Lw/10)	No [Quantity of that particular construction equipment used for that particular construction activity]	On-time(%) / daily working hours [how long in percentage that particular equipment will be used in a day]	PWL, dB(A)	10*(Lw/10)	No [Quantity of that particular construction equipment used for that particular construction activity]	On-time(%) / daily working hours [how long in percentage that particular equipment will be used in a day]	PWL, dB(A)	10*(Lw/10)	No [Quantity of that particular construction equipment used for that particular construction activity]	On-time(%) / daily working hours [how long in percentage that particular equipment will be used in a day]	PWL, dB(A)	10*(Lw/10)
5	Excavation below surface - removal of spoil	Crane	36	CR																				
6	Spoil removal	Dump Trucks	36	DT	2	90%	110	9.0214E+10	2	50%	107	5.012E+10	2	100%	110	1E+11	2	100%	110	1.002E+11	2	100%	110	1.0024E+11
7	Air compressor for cleaning formwork before casting	Compressor	36	C	1	90%	103	1.7957E+10	1	50%	100	9.976E+09	1	100%	103	2E+10	1	100%	103	1.995E+10	1	100%	103	1.9953E+10
8	Handle re-bar & hoisting of false work, scaffolding, temporary working platforms	Mobile Crane	36	MC	1	90%	110	9E+10	1	50%	107	5E+10	1	100%	110	1E+11	1	100%	110	1E+11	1	100%	110	1E+11
9	For Casting	Ready Mix Concrete Truck	36	RMC	2	90%	110	9.0214E+10	2	50%	108	6.31E+10	2	100%	111	1.26E+11	2	100%	111	1.262E+11	2	100%	111	1.2619E+11
		Concrete pump	36	CP	1	90%	106	3.583E+10	1	50%	103	1.991E+10	1	100%	106	3.98E+10	1	100%	106	3.981E+10	1	100%	106	3.9811E+10
	Summation						117				115				118				118				118	
5. Landscape Works - 12 months (from Jul 2028 - Jun 2029)																								
	Landscape works	Generator excavator mounted sheetpile vibrator	12	G	2	90%	109	7.E+10	2	50%	106	3.98E+10	2	100%	109	7.96E+10	2	100%	109	7.96E+10	2	100%	109	7.96E+10
			12	EVD	2	90%	119	7.E+11	2	50%	116	3.98E+11	2	100%	119	7.96E+11	2	100%	119	7.96E+11	2	100%	119	7.96E+11
			12	M	2	90%	98	6.E+09	2	50%	95	3.16E+09	2	100%	98	6.32E+09	2	100%	98	6.32E+09	2	100%	98	6.32E+09
			12	WE	4	90%	107	5.E+10	4	50%	104	2.52E+10	4	100%	107	5.04E+10	4	100%	107	5.04E+10	4	100%	107	5.04E+10
	Summation						119				117				120				120					
6. Remove all temporary works and re-instatement - 12 months (from Jul 2028 - Jun 2029)																								
1	Removal of ERSS	Generator excavator mounted sheetpile vibrator	12	G	2	90%	109	7.17E+10	2	50%	106	3.98E+10	2	100%	109	7.96E+10	2	100%	109	7.96E+10	2	100%	109	7.96E+10
			12	EVD	2	90%	119	7.17E+11	2	50%	116	3.98E+11	2	100%	119	7.96E+11	2	100%	119	7.96E+11	2	100%	119	7.96E+11
			12	M	2	90%	98	5.69E+09	2	50%	95	3.16E+09	2	100%	98	6.32E+09	2	100%	98	6.32E+09	2	100%	98	6.32E+09
			12	WE	4	90%	107	4.53E+10	4	50%	104	2.52E+10	4	100%	107	5.04E+10	4	100%	107	5.04E+10	4	100%	107	5.04E+10
2	Reininstae working area to original condition or required condition	Lorry		LZ			111	1.14E+11			108	6.31E+10	2	100%	111	1.26E+11	2	100%	111	1.26E+11	2	100%	111	1.26E+11
	Summation		12		2	90%			2	50%					120				120					

Appendix W List of Airborne Noise Ecological Receptors

Noise Sensitivity Level	Scientific name	Common name	Taxon	Native	Global status	National status	Conservation significance (CS)	Higher national or global threatened status
Priority 3	<i>Acridotheres javanicus</i>	Javan myna	Bird	No	Vulnerable	NA	No	NA
Priority 1	<i>Aegithina tiphia</i>	Common iora	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Aerodramus</i> sp.	NA	Bird	NA	NA	NA	NA	NA
Priority 1	<i>Amaurornis phoenicurus</i>	White-breasted waterhen	Bird	Yes	Least Concern	Least Concern	No	NA
Priority 1	<i>Anthreptes malacensis</i>	Brown-throated sunbird	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Aplonis panayensis</i>	Asian glossy starling	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Caprimulgus macrurus</i>	Large-tailed nightjar	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Chalcophaps indica</i>	Common emerald dove	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Chrysophlegma miniaceum</i>	Banded woodpecker	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Cinnyris jugularis</i>	Olive-backed sunbird	Bird	Yes	Least Concern	Least	No	NA
Priority 3	<i>Corvus splendens</i>	House crow	Bird	No	Least Concern	NA	No	NA
Priority 1	<i>Dicaeum cruentatum</i>	Scarlet-backed flowerpecker	Bird	Yes	Least Concern	Least Concern	No	NA
Priority 1	<i>Dinopium javanense</i>	Common flameback	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Eudynamis scolopaceus</i>	Asian koel	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Eurystomus orientalis</i>	Oriental dollarbird	Bird	Yes	Least Concern	Least	No	NA
Priority 3	<i>Garrulax leucolophus</i>	White-crested laughingthrush	Bird	No	Least Concern	NA	No	NA
Priority 1	<i>Geopelia striata</i>	Zebra dove	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Gracula religiosa</i>	Common hill myna	Bird	Yes	Least Concern	Near	No	NA
Priority 1	<i>Halcyon smyrnensis</i>	White-throated kingfisher	Bird	Yes	Least Concern	Least Concern	No	NA
Priority 1	<i>Haliastur indus</i>	Brahminy kite	Bird	Yes	Least Concern	Least	No	NA
Priority 3	<i>Lonchura leucogastroides</i>	Javan munia	Bird	No	Least Concern	NA	No	NA
Priority 1	<i>Loriculus galgulus</i>	Blue-crowned hanging-parrot	Bird	Yes	Least Concern	Least Concern	No	NA

Noise Sensitivity Level	Scientific name	Common name	Taxon	Native	Global status	National status	Conservation significance (CS)	Higher national or global threatened status
Priority 1	<i>Merops viridis</i>	Blue-throated bee-eater	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Mixornis gularis</i>	Pin-striped tit-babbler	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Oriolus chinensis</i>	Black-naped oriole	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Orthotomus atrogularis</i>	Dark-necked tailorbird	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Orthotomus sutorius</i>	Common tailorbird	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Phylloscopus borealis</i>	Arctic warbler	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Picus vittatus</i>	Laced woodpecker	Bird	Yes	Least Concern	Least	No	NA
Priority 3	<i>Psittacula alexandri</i>	Red-breasted parakeet	Bird	No	Near Threatened	NA	No	NA
Priority 1	<i>Pycnonotus goiavier</i>	Yellow-vented bulbul	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Rallina fasciata</i>	Red-legged crane	Bird	Yes	Least Concern	Near	No	NA
Priority 1	<i>Todiramphus chloris</i>	Collared kingfisher	Bird	Yes	Least Concern	Least	No	NA
Priority 1	<i>Treron vernans</i>	Pink-necked green pigeon	Bird	Yes	Least Concern	Least Concern	No	NA
Priority 1	<i>Zosterops simplex</i>	Swinhoe's white-eye	Bird	Yes	Least Concern	Vulnerable	Yes	Vulnerable
Priority 3	<i>Acraea terpsicore</i>	Tawny coster	Butterfly	No	Not Listed	Least Concern	No	NA
Priority 3	<i>Appias lyncida vasava</i>	Chocolate albatross	Butterfly	Yes	Not Listed	Data Deficient	No	NA
Priority 3	<i>Arhopala major major</i>	NA	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	<i>Catopsilia pomona pomona</i>	Lemon emigrant	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	<i>Catopsilia pyranthe pyranthe</i>	Mottled emigrant	Butterfly	Yes	Not Listed	Least Concern	No	NA

Noise Sensitivity Level	Scientific name	Common name	Taxon	Native	Global status	National status	Conservation significance (CS)	Higher national or global threatened status
Priority 3	<i>Delias hyparete metarete</i>	Painted jezebel	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	<i>Doleschallia bisaltide bisaltide</i>	Autumn leaf	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	<i>Dryas iulia</i>	Julia heliconian	Butterfly	Yes	Not Listed	Not Evaluated	No	NA
Priority 3	<i>Elymnias hypermnestra agina</i>	Common palmfly	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	<i>Eurema blanda snelleni</i>	Three spot grass yellow	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	<i>Hypolimnias anomala anomala</i>	Malayan eggfly	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	<i>Iambrix salsala salsala</i>	Chestnut bob	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	<i>Ideopsis vulgaris macrina</i>	Blue glassy tiger	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 2	<i>Jamides caeruleus caeruleus</i>	Sky blue	Butterfly	Yes	Not Listed	Critically Endangered	Yes	Critically Endangered
Priority 3	<i>Junonia almana javana</i>	Peacock pansy	Butterfly	Yes	Least Concern	Least Concern	No	NA
Priority 3	<i>Junonia hedonia ida</i>	Chocolate pansy	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	<i>Leptosia nina malayana</i>	Psyche	Butterfly	Yes	Not Listed	Least Concern	No	NA

Noise Sensitivity Level	Scientific name	Common name	Taxon	Native	Global status	National status	Conservation significance (CS)	Higher national or global threatened status
Priority 3	Pachliopta aristolochiae asteris	Common rose	Butterfly	Yes	Not Listed	Near threatened	No	NA
Priority 3	Papilio demoleus malayanus	Lime butterfly	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	Papilio polytes romulus	Common mormon	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	Parantica agleoides agleoides	Dark glassy tiger	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	Phaedyra columella singa	Short banded sailor	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	Phalanta phalantha phalantha	Leopard	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	Plastingia naga	Chequered lancer	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	Potanthus omaha omaha	Lesser dart	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 2	Troides helena cerberus	Common birdwing	Butterfly	Yes	Not Listed	Vulnerable	Yes	Vulnerable
NA	Unidentified Lycaenidae	Line blue sp.	Butterfly	NA	NA	NA	NA	NA
Priority 3	Zizina otis lampa	Lesser grass blue	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	Zizula hylax pygmaea	Pygmy grass blue	Butterfly	Yes	Not Listed	Least Concern	No	NA
Priority 3	Camacinia gigantea	Sultan	Odonata	Yes	Least Concern	Least Concern	No	NA
Priority 2	Gynacantha sp.	NA	Odonata	NA	NA	NA	NA	NA

Noise Sensitivity Level	Scientific name	Common name	Taxon	Native	Global status	National status	Conservation significance (CS)	Higher national or global threatened status
Priority 3	<i>Hydrobasileus croceus</i>	Water monarch	Odonata	Yes	Least Concern	Least Concern	No	NA
Priority 3	<i>Lathrecista asiatica</i>	Scarlet grenadier	Odonata	Yes	Least Concern	Least Concern	No	NA
Priority 3	<i>Neurothemis fluctuans</i>	Common parasol	Odonata	Yes	Least Concern	Least Concern	No	NA
Priority 3	<i>Zygomma petiolatum</i>	Slender duskdarter	Odonata	Yes	Least Concern	Least Concern	No	NA
Priority 3	<i>Bronchocela cristatella</i>	Green crested lizard	Reptile	Yes	Least Concern	Least Concern	No	NA
Priority 3	<i>Calotes versicolor</i>	Changeable lizard	Reptile	No	Least Concern	NA	No	NA
Priority 3	<i>Dendrelaphis pictus</i>	Painted bronzeback	Reptile	Yes	Least Concern	Least Concern	No	NA
Priority 3	<i>Draco sumatranus</i>	Sumatran flying dragon	Reptile	Yes	Least Concern	Least Concern	No	NA
Priority 3	<i>Subdoluseps bowringii</i>	Bowring's agile skink	Reptile	Yes	Least Concern	Least Concern	No	NA
Priority 3	<i>Malayopython reticulatus</i>	Reticulated python	Reptile	Yes	Least Concern	Least Concern	No	NA
Priority 3	<i>Duttaphrynus bengalensis</i>	Bengal toad	Amphibian	No	Not Listed	NA	No	NA
Priority 3	<i>Eleutherodactylus planirostris</i>	Greenhouse frog	Amphibian	No	Least Concern	NA	No	NA
Priority 1	<i>Microhyla heymonsi</i>	Dark-sided chorus frog	Amphibian	Yes	Least Concern	Least Concern	No	NA
Priority 1	<i>Polypedates leucomystax</i>	Four-lined tree frog	Amphibian	Yes	Least Concern	Least Concern	No	NA

Noise Sensitivity Level	Scientific name	Common name	Taxon	Native	Global status	National status	Conservation significance (CS)	Higher national or global threatened status
Priority 1	Callosciurus notatus	Plantain squirrel	Mammal	Yes	Least Concern	Least Concern	No	NA
Priority 1	Paradoxurus musangus	Sumatran palm civet	Mammal	Yes	Least Concern	Least Concern	No	NA
Priority 1	Tupaia glis	Common treeshrew	Mammal	Yes	Least Concern	Least Concern	No	NA
Priority 1	Suncus murinus	House shrew	Mammal	Yes	Least Concern	Least Concern	No	NA
Priority 1	Rattus tiomanicus	Malaysian wood rat	Mammal	Yes	Least Concern	Least Concern	No	NA
Priority 1	Rattus tanezumi	Asian house rat	Mammal	Yes	Least Concern	Least Concern	No	NA
Priority 3	Canis lupus familiaris	Feral dog	Mammal	No	Not Listed	Not Evaluated	No	NA
Priority 1	Cynopterus brachyotis	Lesser short-nosed fruit bat	Mammal	Yes	Least Concern	Least Concern	No	NA
Priority 1	Eonycteris spelaea	Cave nectar bat	Mammal	Yes	Least Concern	Vulnerable	Yes	Vulnerable
Priority 1	Myotis muricola	Asian whiskered myotis	Mammal	Yes	Least Concern	Least Concern	No	NA
Priority 1	Saccolaimus saccolaimus	Pouch tomb bat	Mammal	Yes	Least Concern	Least Concern	No	NA
Priority 1	Scotophilus kuhlii	Lesser Asian house bat	Mammal	Yes	Least Concern	Least Concern	No	NA
Priority 1	Taphozous melanopogon	Black-bearded tomb bat	Mammal	Yes	Least Concern	Least Concern	No	NA

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