Contract CR2005
Provision of Services to Conduct Environmental Impact Study

Environmental Impact Study (Clementi Forest and Maju Forest)

Study Stage: Final

Volume 2 of 5

Submitted by:
AECOM Singapore Pte Ltd

Submitted to:
Land Transport Authority

06 October 2022

7. Biodiversity

7.1 Introduction

The Biodiversity Impact Assessment (BIA) aims to establish baseline biodiversity information of the three Study Areas and the mitigated worksites. In addition, the BIA also aims to evaluate the impacts of the proposed construction works 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. Actual field surveys were then carried out to verify and supplement the data.

Through the 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 of construction and operational works. Mitigation measures were then recommended to reduce and/or minimise the impacts.

This section reports biodiversity field findings from surveys conducted from 7th November 2019 to 24th March 2020 at Maju Forest and Clementi Forest.

7.2 Methodology

7.2.1 Study Areas

The floristic and faunistic field assessments covered a total area of 91.5 ha (Table 7-1), comprising two main worksites and adjacent areas of known or potential ecological sensitivity. Arboricultural assessments covered a total area of 32.4 ha (Table 7-1; Figure 7-1)

Table 7-1 Size of Floristic and Faunistic Study Areas, and Arboricultural Study Areas

Site	Worksite (Base Scenario)	Flora and Fauna (ha)	Arboriculture (ha)
Maju Forest	Access to CR16	33.2	5.0
Clementi Forest	CR16	58.3	27.4
Total area	**N.A.**	**91.5**	**32.4**

Legend

- Floristic and faunistic Study Area
- Arboricultural Study Area
- Old Jurong Railway Corridor
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

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Project Title :
**CONTRACT 2005
ENVIRONMENTAL IMPACT STUDY
(CLEMENTI FOREST AND
MAJU FOREST)**

Figure Title :
STUDY AREAS FOR FLORISTIC AND FAUNISTIC SURVEYS, AND ARBORICULTURAL SURVEYS AT MAJU FOREST AND CLEMENTI FOREST

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-1	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.2.2 Nomenclature, Taxonomy and Definitions

7.2.2.1 Nomenclature and Taxonomy

The nomenclature and taxonomy for each taxonomic group follows these key references:

- Plants: World Checklist of Selected Plant Families and Plants of the World Online
- Aculeate hymenopterans: Soh and Ngiam (2013) and Ascher and Pickering (2018)
- Odonates: Soh et al. (2019)
- Butterflies: Khew (2015)
- Freshwater fish: Suzuki et al. (2015), Kottelat (2013) and Ho et al. (2016)
- Freshwater decapod crustaceans: Ng (1997) and Cai et al. (2007)
- Birds: Gill and Donsker (2020)
- Amphibians, reptiles, non-volant mammals and bats: Baker and Lim (2012)

7.2.2.2 Flora Classification System

Species of flora were first classified as native, exotic, or cryptogenic (i.e., they do not have a known origin). Native species are then further classified as nationally Extinct or Extant, i.e., still surviving. Extant native species are additionally classified as Common, Vulnerable, Endangered, or Critically Endangered. Exotic species are classified as Cultivated Only, Casual, or Naturalised (Table 7-2). The definitions were adapted from Chong et al. (2009).

Table 7-2 Classification System for Species of Flora

Origin	Status	Definition
Native	*Species that have originated in an area without human intervention or have arrived there without intentional or unintentional intervention of humans*	
	Extinct	Native species that have not been seen or collected locally from the wild in the last 30 years
	Extant	Native species that are common, i.e., have more than 1,000 mature individuals locally, vulnerable, endangered, or Critically Endangered
Exotic	*Species that are present in an area as a result of intentional or unintentional human involvement*	
	Cultivated Only	Exotic species that persist locally as a result of cultivation or other direct human care
	Casual	Exotic species that persist locally by repeated introductions or limited asexual reproduction and do not form self-replacing populations
	Naturalised	Exotic species that persist locally without direct human intervention and are self-replacing, usually through sexual reproduction
Cryptogenic	*Species with no historical or biogeographical evidence of being exotic, yet are restricted to only habitats modified or disturbed by humans*	

7.2.2.3 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) 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 is 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, we will corroborate findings from field surveys of fauna and/or adopt the more conservative approach by considering them of conservation significance. In carrying out such assessments, we are then able to prioritise conservation needs and focus resources in conserving them.

Faunal species of conservation significance include both threatened and non-threatened species which are regarded as notable records. Threatened species of fauna are those listed as Vulnerable, Endangered, Critically Endangered, or Extinct under its global or national status. Both global and national conservation statuses were considered to provide a holistic view of the conservation value of the Study Areas. The national conservation statuses reference the Singapore Red Data Book (SRDB; Davison et al., 2008) and other more updated local checklists, where available, such as Soh et al. (2019) for odonates and Jain et al. (2018) for butterflies. The global conservation status references the Red List of Threatened Species by the International Union for Conservation of Nature (IUCN, 2012).

Few resources with the national conservation status of species from the order Hymenoptera are available. Only a few bee species are listed in the SRDB (Davison et al., 2008). A paper on the updated conservation status of bees and wasps found in Singapore by Ascher et al. is in preparation. However, no comparable study has been done for stinging wasps. For this Study, the assessment was conducted based on personal records by Lee JXQ, together with specimen records in the Lee Kong Chian Natural History Museum (LCKNHM) and NUS' Insect Diversity Lab (IDL) collections. The assessment adopts the same conservation statuses used in Ascher et al. (in prep).

Table 7-3 Definition of Each Global and/or National Conservation Status Following the IUCN Red List (IUCN, 2012) and Singapore Red Data Book (Davison et al., 2008)

National conservation status	Definition
Vulnerable **(VU)**	Species facing a high risk of extinction in the wild/in Singapore
Endangered **(EN)**	Species facing a very high risk of extinction in the wild/in Singapore
Critically Endangered **(CR)**	Species facing an extremely high risk of extinction in the wild/in Singapore
Presumed **Nationally** Extinct **(NE)**	There is no reasonable doubt that the last reproductively capable individual within Singapore has died or disappeared in the last 50 years (fauna) or 30 years (vascular plants).

7.2.3 Desktop Assessment

Historical and present-day land use of the Study Areas were reviewed. Information on land use history was primarily gathered from old maps in the online collection of the National Archives of Singapore (NAS) as well as historical maps on the OneMap and the National University of Singapore (NUS) Libraries portals. A list of faunal species that are likely to occur at the site ("species of probably occurrence") was also generated using information on past faunal records and existing habitat types and past fauna records up to 2 km from the Study Areas.

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 Lee Kong Chian Natural History Museum (LCKNHM, 2020), Flora and Fauna Web by National Parks Board (NParks, 2020) and iNaturalist. Other key references include the Singapore Red Data Book (Davison et al., 2008), Singapore Biodiversity Records, encyclopaedia on Singapore's biodiversity (Ng et al., 2011) and the database of flora and fauna records compiled by Camphora Pte Ltd.

Local and regional references were examined for the various taxonomic groups:

- Plants (Boo, 1996; Keng, 2003; Chong et al., 2009);
- Aculeate hymenopterans (Soh & Ngiam, 2013; Ascher & Pickering, 2018; BOS);
- Odonates (Tang et al., 2010; Ngiam & Cheong, 2016; Soh et al., 2019);

- Butterflies (Khew, 2015; Jain et al., 2018; Theng et al., 2020);
- Freshwater fish (Ng & Lim, 1997; Giam et al., 2011; Ho et al., 2016; Tan et al., 2020);
- Freshwater decapod crustaceans (Ng, 1997; Cai et al., 2007; Wowor & Ng, 2010, Yeo, 2010; Ho et al., 2016);
- Birds (NSS, 2020; Singapore Birds; Singapore Bird Group; Singapore Birds Project);
- Herptofauna, (Baker & Lim, 2012);
- Non-volant mammals and bats (Corlett, 1992; Teo & Rajathurai, 1997; Brook et al., 2003; Lane et al., 2006; Chua & Lim, 2011; Baker & Lim, 2012).

7.2.4 Floristic Field Assessment

The field assessment for flora consists of (1) vegetation mapping, (2) vegetation plot sampling, (3) floristic surveys, and (4) arboricultural surveys.

7.2.4.1 Vegetation Mapping

A preliminary vegetation map for each of the Study Area was prepared based on visual interpretations of satellite images from Google Earth 7.1.2.2041 (Google Inc. 2013). Preliminary classification of the vegetation types—for example, forest, grassland, or managed vegetation—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 was conducted throughout the survey area with the aid of the GPS receiver. Photographs were also taken. The boundaries of each vegetation type were tracked on the GPS receiver and mapped out on Google Earth 7.1.2.2041. The classification of forest types—excluding scrublands and managed vegetation—references NParks (2021) and Yee et al. (2016).

7.2.4.2 Vegetation Plot Sampling

A total of 17 vegetation plots measuring 20 × 20 m were set up (Figure 7-2) – six in Maju Forest and eleven plots in Clementi Forest. The number of plots in each site were determined based on the sampling density of one plot for every 5 ha of spontaneous vegetation. Hence, the number of vegetation plots is proportionate to the relative size of the spontaneous vegetation within the site, i.e., vegetation that occurs naturally and is neither manicured nor managed by humans.

Locations of the vegetation plots were first randomly generated. The actual locations were then adjusted on-site based on accessibility and suitability, i.e., not covered in dense vegetation and/or tree falls that would render the site inaccessible. We identified to species and measured the girth of all tree and shrub specimens, as well as single-stemmed palms, of ≥ 0.05 m girth. Specimens with < 0.05 m girth were also counted. For Ficus stranglers and palm clusters, we measured the circumference of each aerial root or stem, respectively, of ≥ 0.05 m girth. All other plant species observed in the plots were also recorded.

Figure 7-2 A 20 × 20 m Vegetation Plot Set Up.

7.2.4.3 Floristic Surveys

All plants observed in the Study Areas during floristic surveys were identified to species whenever possible. A checklist of plant species recorded from the present floristic surveys was compiled. 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 were 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.

7.2.4.3.1 *Plant Species of Conservation Significance*

Threatened species of flora—i.e., listed in Chong et al. (2009) as nationally Vulnerable, Endangered, Critically Endangered, or Presumed Extinct (which indicates a rediscovery)—were assessed to determine whether they are of conservation significance (Section 7.2.2.3). The geographic coordinates of plants of conservation significance were marked using a Global Positioning System (GPS) handheld receiver (Garmin GPSMap® 64s). 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 approximated centre of the area is marked using the GPS receiver.

7.2.4.3.2 *Large Plant Specimens*

The GPS handheld receiver was used to record locations of all trees—excluding that of storm-vulnerable species, such as *Spathodea campanulata* and *Falcataria moluccana* (Figure 7-3)—of $\geqslant$ 3.0 m girth, as well as bamboo clusters and strangling *Ficus* species of $\geqslant$ 3.0 m spread. We identified the individuals to species, whenever possible. Girth (for trees) and spread (for bamboo clusters and strangling *Ficus* species) were measured and estimated, respectively. The height of the specimens was also estimated and recorded.

Figure 7-3 *Falcataria moluccana*. (A) A Standing Tree; (B, C) Trees That Have Fallen Over Owing to the Storm-Vulnerable Nature of this Species That Causes the Trees to be Prone to Failing.

7.2.4.3.3 *Other Plant Specimens of Value*

Locations of other specimens that do not meet the minimum size requirement detailed in Section 7.2.4.3.2 above but are of value, were also recorded using the GPS receiver. Examples of such specimens include bamboo clusters of < 3 m spread but may be important refugia for rare bamboo bats, amongst others, as well as exotic trees with raptor nests (Figure 7-4).

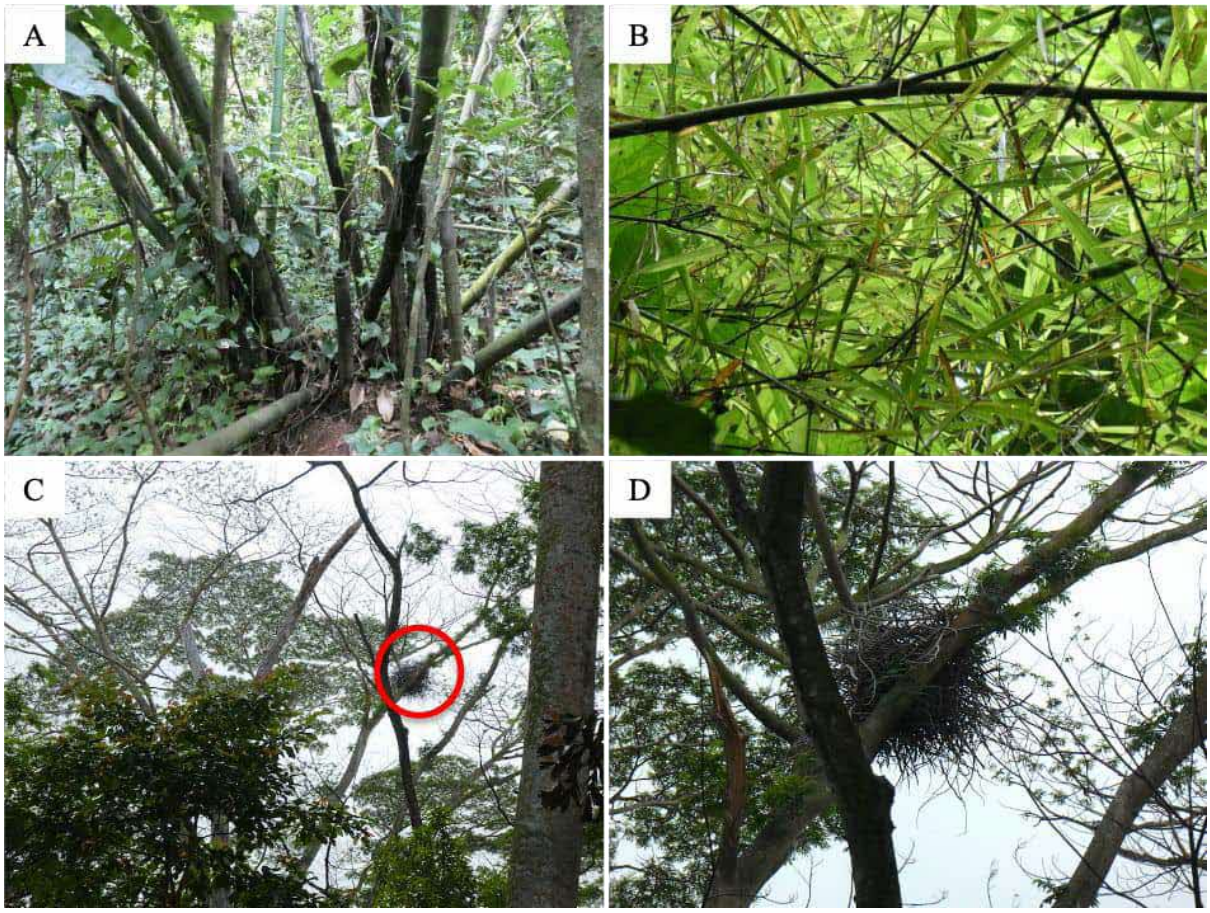


Figure 7-4 Other Plant Specimens of Value. (A) Bamboo Cluster Of < 3 m Spread; (B) A Close-Up of the Bamboo Leaves; (C) Raptor Nest on a *Falcataria moluccana* Tree; (D) A Close-Up of the Raptor Nest.

7.2.4.4 Arboricultural Surveys

Plant health and structural stability were assessed for all trees, single-stemmed palms, and strangling *Ficus* species of ≥ 1.0 m girth or spread, respectively, as well as those of species of conservation significance of ≥ 0.3 m girth or spread. Single-stemmed palms are defined in this Study as having one obvious and erect stem (Figure 7-5). The assessment was conducted using the Safe Useful Life Expectancy (SULE) method 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 (Barrell, 1993).

Figure 7-5 Single-Stemmed Palms, Defined in This Study as Having one Obvious and Erect Stem. (A–B) *Elaeis guineensis*; (C) *Caryota no*.

Specimens were tagged with a unique serial number. Geographic locations, girth/spread and height were also recorded. A Differential Global Positioning System (DGPS) receiver (Trimble® Geo 7X or CHC® Navigation HCE320 GNSS data controller with the CHC® Navigation i90 Pro GNSS receiver and Leica DISTO™ D810 touch rangefinder) (Figure 7-6; Figure 7-7) was used to record geographic locations of the specimens using the SVY21 plane coordinate system. Where there are clusters of specimens of the same species occurring within 1–2 m of each other, all the specimens within the cluster were assessed by certified arborists, but only one specimen was tagged with its location marked using the DGPS. The survey areas are shown in Figure 7-1.

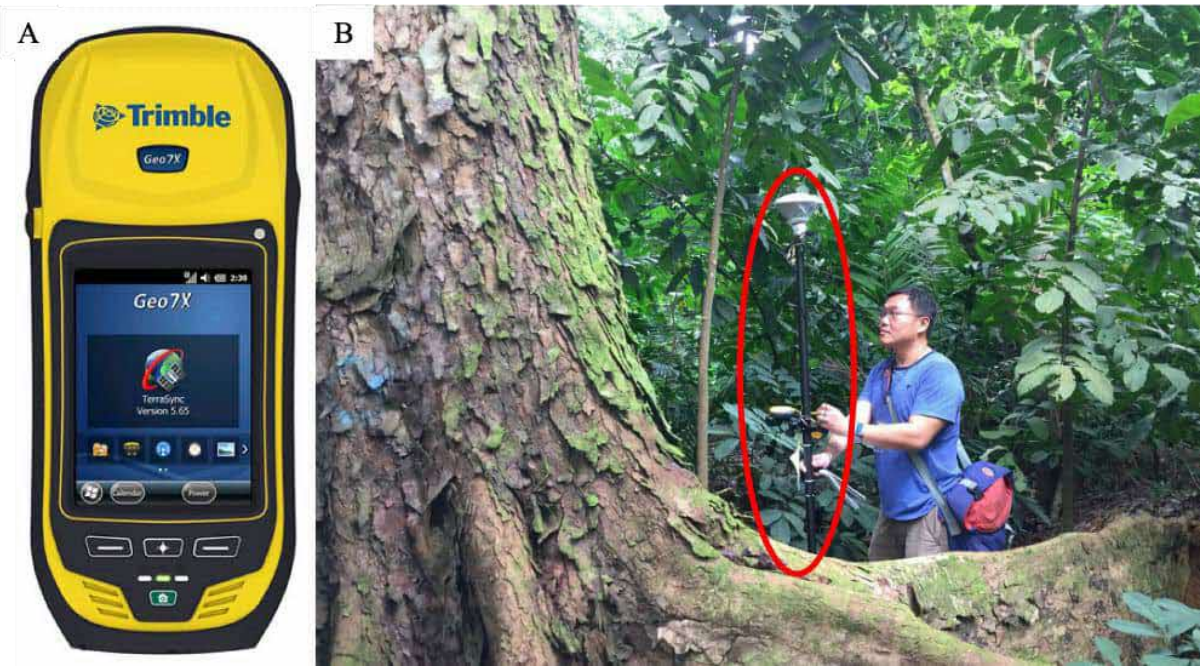


Figure 7-6 Trimble® Geo 7X. (A) Handheld Controller (source: gpsforestry-suppliers.com); (B) How it is Used in the Field.

Figure 7-7 (A) CHC® Navigation HCE320 GNSS Data Controller (Source: Geo-matching.com); (B) How it is Used in the Field.

7.2.5 Faunistic Field Assessment

7.2.5.1 Targeted Field Surveys

Targeted field surveys were carried out for the following taxa: aculeate hymenopterans (bees and stinging wasps, excluding ants), odonates (dragonflies and damselflies), butterflies, freshwater decapod crustaceans, freshwater fish, herpetofauna (amphibians and reptiles), birds, non-volant mammals and bats. These taxa were chosen because they are of general interest to the public, well-documented, generally easy to survey, have important ecological roles in the ecosystem and serve as ecological indicators. Amongst these groups, the aculeate hymenopterans are the least well-studied. Yet, as expertise was available, they were included in the Study to provide a better representation of the site's faunal diversity.

All terrestrial fauna (except bats) were surveyed via visual and/or auditory encounter surveys along terrestrial sampling routes traversing major habitat types within all Study Areas. Four sampling routes measuring 7.3 km in total were identified within the Study Areas (Table 7-4; Table 7-8). At least two surveyors walked along the sampling routes at approximately 1 km/h to search for targeted fauna.

Aquatic fauna were sampled at each aquatic sampling point placed at 100–150-m intervals along each waterbody based on accessibility and availability of water (Table 7-4; Table 7-8). This is with the exception of Maju Forest. At Maju Forest, points were placed at 30-m intervals as the streams were too short to maintain the intervals of 100–150 m.

Locations of all fauna sightings were recorded using a handheld GPS receiver (Garmin GPSMap® 64s). Each diurnal and/or nocturnal surveys were conducted twice for each taxon, including a reverse direction during the second session. Surveys were only conducted once along each sampling route for aculeate hymenopterans. All fauna encountered were identified to species, or the next highest taxonomic level possible. Important observations were also noted down, such as reproductive behaviour (e.g., displaying, guarding, mating, ovipositing), and plant species that butterflies and birds are observed to be feeding on, laying eggs or nesting on, and/or with caterpillars.

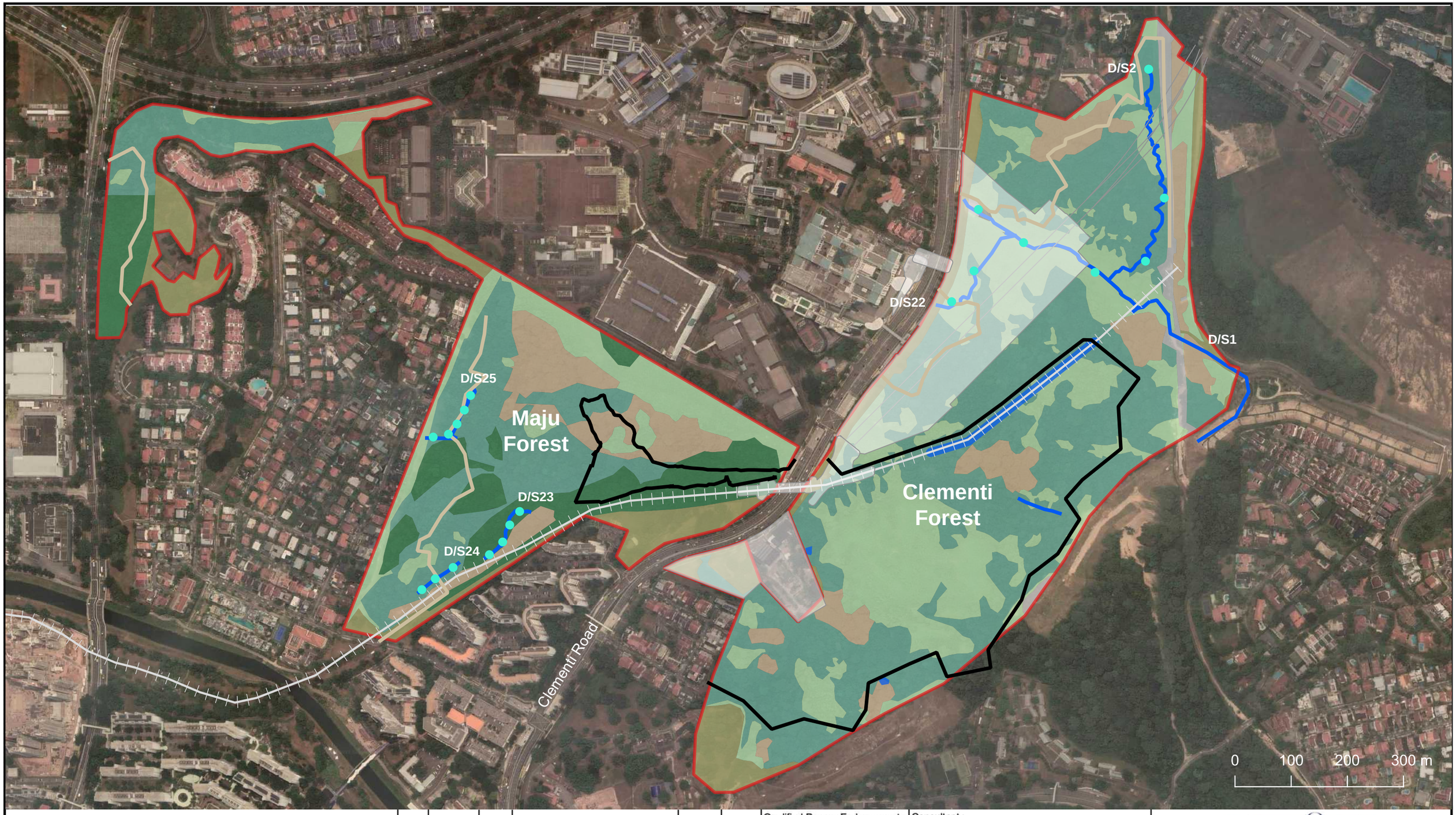
While bat trapping had been initially planned for and was conducted once at Clementi Forest, it was subsequently cancelled in light of the COVID-19 outbreak. Instead, roost emergence surveys for bamboo bats were conducted for bamboo clusters present within worksite areas (if any) to determine if there are potentially conservation significant bamboo bats residing in them. Butterfly trapping was also conducted. In addition, camera trapping was

conducted to complement the documentation of mammal composition within the Study Areas, illustrated in survey methods for non-volant methods below.

A summary of the survey methods for each faunal group is provided in Table 7-4 and further described in the following section.

Table 7-4 Description of Sampling Locations at Each Study Area

Site	Description	Length/No. of Sampling Points)
Maju Forest [33.2 ha]		
T1 (eastern route)	Maju Forest and western part of forest along Clementi Road	1.29 km
T2 (western route)	Eastern part of Maju Forest along Clementi Road	1.14 km
D/S24 (southern stream)	Parallel to canal in the southern end	0.09 km (3 aquatic sampling points)
D/S23 (southern stream)	Parallel to canal in the southern end but not visibly connected to A1	0.15 km (4 aquatic sampling points)
D/S25 (western stream)	Western part of forest along Clementi Road	0.13 km (5 aquatic sampling points)
No. terrestrial camera traps	Deployed on ground/base of tree	6
Clementi Forest [58.3 ha]		
T1 (northern route)	Worksite area (east) & north of Study Area	2.22 km
T2 (southern route)	Old Jurong Railway Corridor & south of Study Area	2.63 km
D/S1 and D/S2 (main stream)	Stream runs in the middle and west (parallel to green corridor) of Study Area	0.50 km (7 aquatic sampling points)
D/S22 (tributary)	Stream runs along Clementi Road	0.20 km (2 aquatic sampling points)
No. terrestrial camera traps	Deployed on ground/base of tree	12



Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area

- Waterbody
- Terrestrial sampling route 1
- Terrestrial sampling route 2
- Aquatic sampling point

N

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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
TERRESTRIAL SAMPLING ROUTES AND AQUATIC SAMPLING POINTS AT MAJU FOREST AND CLEMENTI FOREST

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JW	JAG/NHT	JAG	7-8	-	1 of 1
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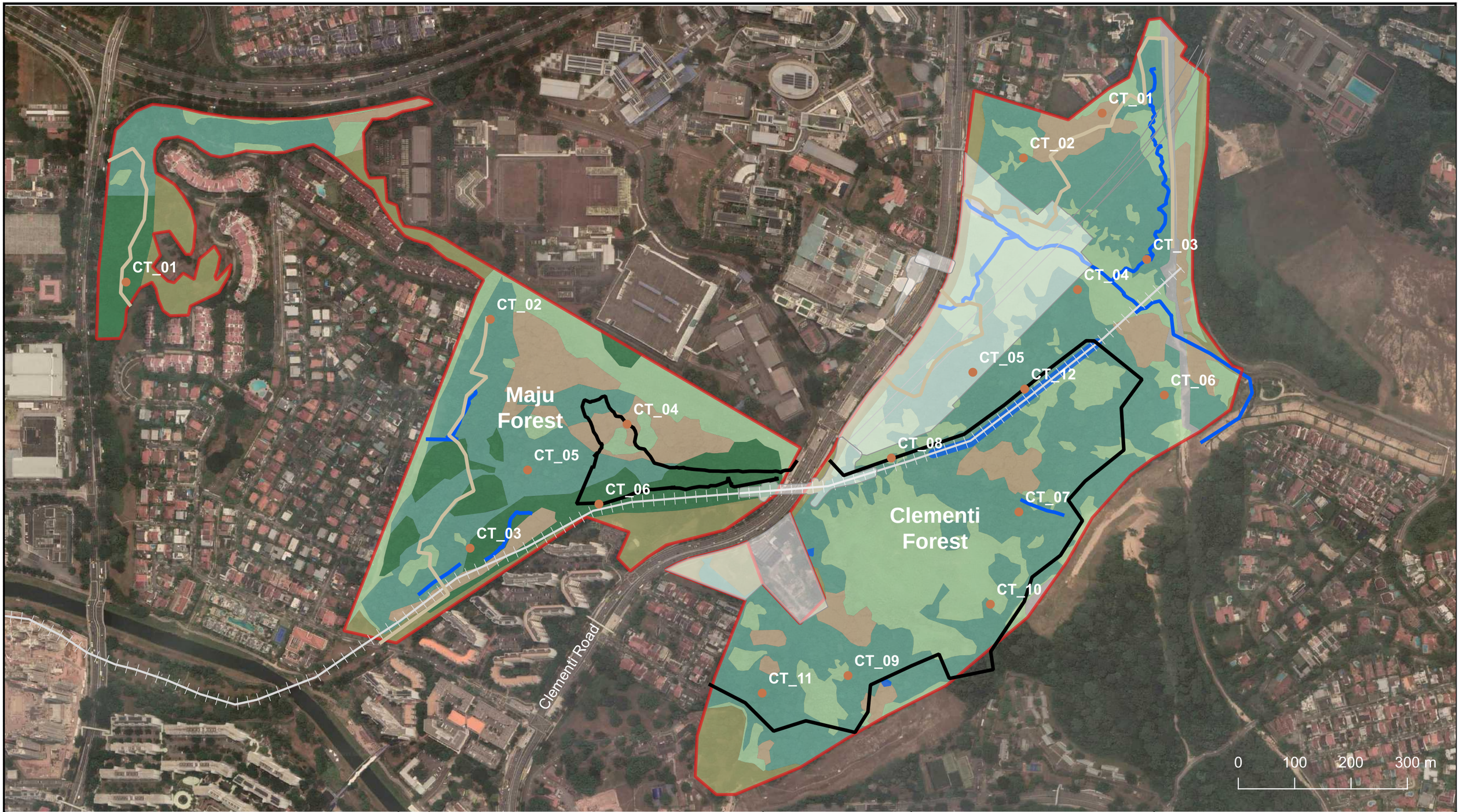

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area

- Waterbody
- Terrestrial sampling route 1
- Terrestrial sampling route 2
- Terrestrial camera trap

N

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-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

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LTA Endorsement :
NA

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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
LOCATIONS OF TERRESTRIAL CAMERA TRAPS IN MAJU FOREST AND CLEMENTI FOREST

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-9	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

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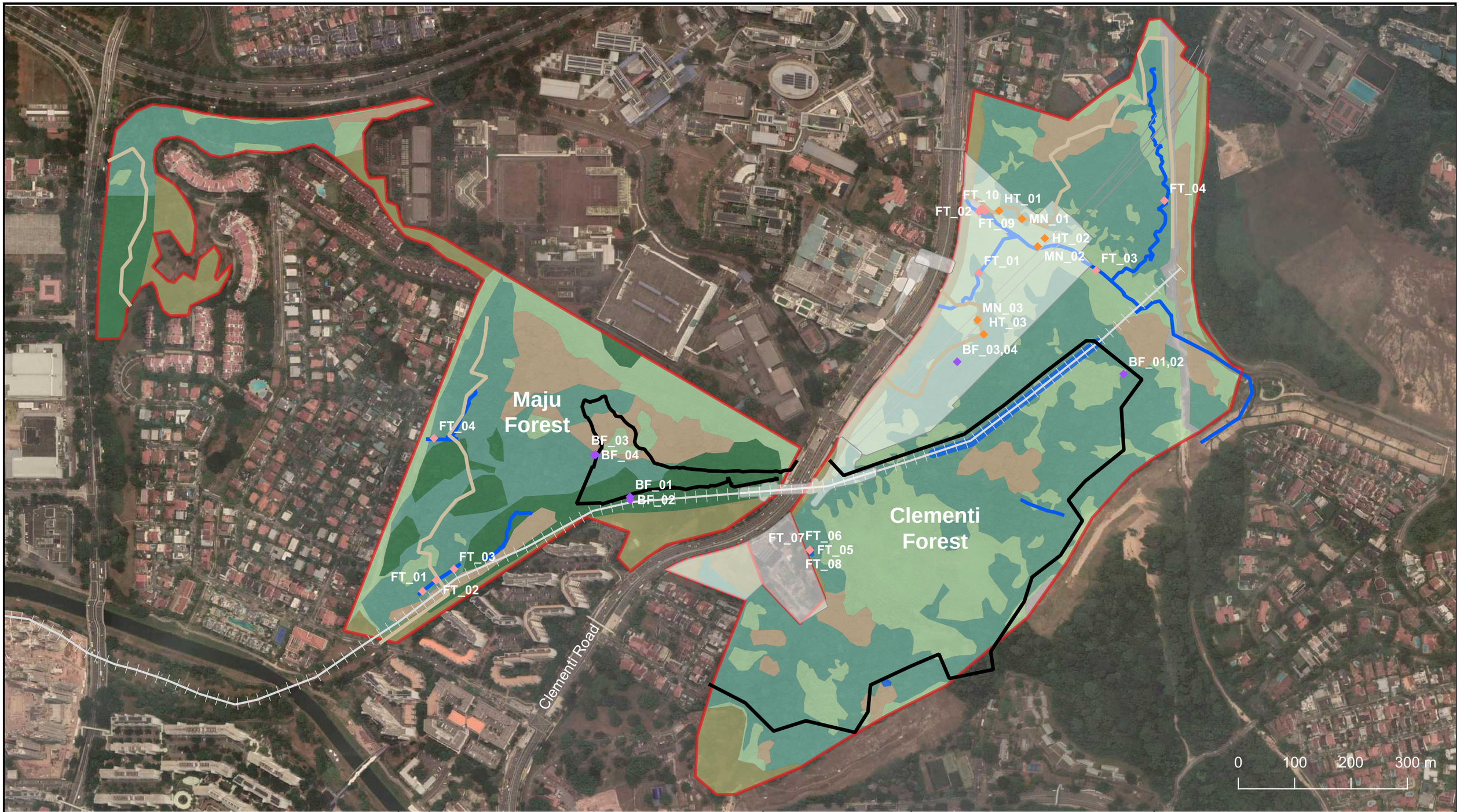

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area

- Waterbody
- Terrestrial sampling route 1
- Terrestrial sampling route 2
- Butterfly trap
- Fish trap
- Bat trap

N

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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
LOCATIONS OF BUTTERFLY, FISH AND BAT TRAPS IN MAJU FOREST AND CLEMENTI FOREST

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-10	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

Table 7-5 Summary of Survey Methods for Each Faunal Group

Faunal Group	Survey Timing (h)	Description
Aculeate Hymenopterans	0900–1600	• Diurnal visual encounter surveys along four terrestrial sampling routes.
Odonates	0900– 1600	• Diurnal visual encounter surveys along four terrestrial sampling routes and diurnal point counts at 20 aquatic sampling points.
Butterflies	0900–1600	• Diurnal visual encounter surveys along four terrestrial sampling routes.
Freshwater Decapod Crustaceans and Fish	0900–1600, 2000–0000	• Diurnal point count surveys with tray-netting at 20 aquatic sampling points • Nocturnal point count surveys with spot-lighting at 20 aquatic sampling points • Minnow trapping at 15 strategic locations along waterbodies (for fish)
Herpetofauna (Amphibians and Reptiles)	0700–1600, 2000–0000	• Diurnal and nocturnal visual and auditory encounter surveys along four terrestrial sampling routes • Diurnal and nocturnal point count surveys at 20 aquatic sampling points
Birds	0700–1000, 2000–0000	• Diurnal and nocturnal visual and auditory encounter surveys along four terrestrial sampling routes
Non-Volant Mammals	0700–1000, 2000–0000	• Diurnal and nocturnal visual and auditory encounter surveys along four terrestrial sampling routes • 18 terrestrial camera traps deployed across the Study Areas
Bats	1830–0000, 2000–0900 (overnight for harp traps only)	• Live-trapping using ground mist nests and ground harp traps + acoustic recording once at Clementi Forest (subsequently, the remaining live trapping sessions were cancelled in light of the Coivd-19 outbreak) • Visual roost emergence surveys conducted between 1830 h and 2100 h for five bamboo clusters within 20 m of worksites

Aculeate hymenopterans (bees and stinging wasps, excluding ants) – Adult bees and stinging wasps, nests, and food plants were visually surveyed along the terrestrial survey route. Surveys were conducted between 0900h and 1600h. Bees and wasps were identified by sight or photography whenever possible. Otherwise, they were captured using handheld insect nets. Individuals were released immediately after identification. When identification in the field was not possible, live specimens were collected and examined *post-hoc* under microscope. The specimens were identified to the lowest taxonomic level possible using relevant references, identification keys, or in consultation with taxonomic experts.

Odonates (dragonflies and damselflies) – Visual encounter surveys were conducted along terrestrial sampling route and five-minute point counts were conducted at each aquatic sampling point between 0900h and 1600h. Owing to the difficulties in sampling and identification, aquatic larvae and exuviae were not surveyed. Adults were identified by sight (with the aid of binoculars where necessary) in flight or while perched. Specimens were also photographed or caught with insect nets if required for species identification. Individuals collected were released immediately after they have been identified.

Butterflies – Visual encounter surveys were carried out for adult butterflies, caterpillars, pupae, eggs, and host plants along terrestrial sampling routes from 0900h to 1600h. Butterflies were identified by sight (with the aid of binoculars where necessary), photographed, or captured using insect nets. In addition, focused trap-sampling was

conducted to target rarer fruit-feeding nymphalid butterflies that are attracted to rotten fruits and decaying matter. The trapping design and method reference a standard butterfly trapping protocol for rapid assessments (Larsen, 2016). Butterfly traps were deployed at two locations at each Study Area, based on presence of palms or habitats deemed favourable for nymphalids. At each location, one pair of butterfly traps were deployed 2 m apart in the understorey at approximately 1.5 m above ground. One trap contained fermented banana bait while the other rotten prawn or sambal bait (Figure 7-12A). The traps were deployed for one day and then retrieved the following day. Captured individuals in the insect nets and traps were released immediately after identification.

Freshwater decapod crustaceans and fish – Surveys comprised diurnal (0900h–1600h) and nocturnal (2000h–0000h) five-minute visual point counts at aquatic sampling points, tray netting and minnow trapping. Point counts involved tray netting using a rigid-frame push net (61 × 49 cm; 5 mm mesh) to capture species within the water column or on the streambed. However, where tray-netting was deemed unsuitable as a result of low water levels, visual surveys were conducted instead. In addition, minnow traps were baited with halal meat (e.g., sausage or liver; Figure 7-11A) and systematically deployed at 15 locations with deeper water (Figure 7-10). Traps were left overnight, then checked and removed the following morning. Nocturnal point counts involved spot-lighting for nocturnal species, especially the walking catfishes (*Clarias* spp.).

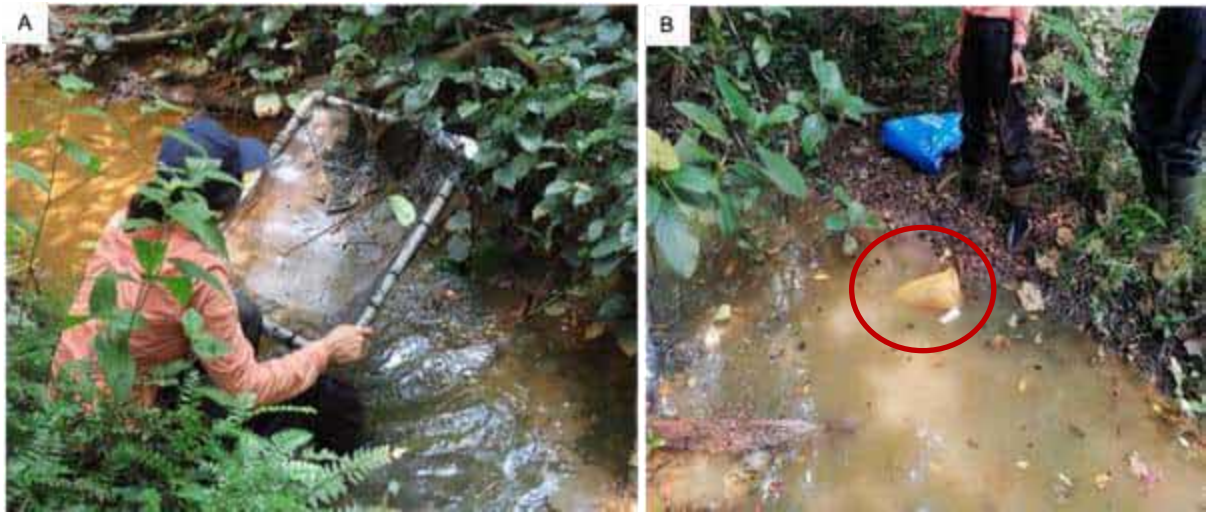


Figure 7-11 Example of (A) Tray Netting and (B) Minnow Trap.

Herpetofauna (amphibians and reptiles) – Diurnal (0700h–1600h) and nocturnal (2000h–0000h) surveys were performed along both terrestrial sampling routes and at aquatic sampling points. As herpetofauna occupy a wide range of habitat types, both surveys involved searching for individuals on the ground, below rocks, logs, leaf litter and debris, in the water, and on vegetation. For nocturnal spotlighting surveys, torches were used to elicit eyeshine. 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. Vocalising geckos and frogs were also located or identified by call recognition, whenever possible.

Birds – Surveys comprised diurnal (0700h–1000h) and nocturnal (2000h–0000h) visual encounter surveys performed along terrestrial sampling routes. All birds were identified by sight (with the aid of binoculars and cameras where necessary) and/or through call recognition. Nocturnal birds (e.g., owls and nightjars) were detected using torches to elicit eyeshine and through call recognition. All surveys were conducted within the bird migratory season (Sep–Mar).

Mammals – Surveys comprised diurnal (0700h–1000h) and nocturnal (2000h–0000h) visual encounter surveys performed along terrestrial sampling routes. Mammals were surveyed on the ground and on vegetation, and in burrows and tree holes. In addition, tracks and scats were also recorded as they can aid in species identification. All mammals were identified by sight (with the aid of binoculars and cameras where necessary). Squirrels were also identified through call recognition. Nocturnal mammals were detected using torches to elicit eye shine, which aids in detection at night.

A total of 18 terrestrial camera traps were deployed – six at Maju Forest and 12 at Clementi Forest (Figure 7-9). The camera traps were distributed equally across the Study Areas, with approximately one camera trap per 4 ha. Each terrestrial camera trap was kept at least 20 m away from terrestrial sampling routes, where possible, to maximise coverage of areas not visible from terrestrial sampling routes.

Each camera trap was deployed at approximately 20–30 cm above ground. They operated 24 h a day and were programmed to record 10-s footage per motion trigger with a 10-s quiet period following each trigger. Each camera trap was deployed for at least 60 nights per location. The two camera trap models used are (1) Browning Recon Force Advantage BTC-7A and (2) Browning Dark Ops HDB Pro X BTC-6HDPX (Figure 7-12B). The former was used only at Maju Forest, and the latter was used at both Maju Forest and Clementi Forest.

Figure 7-12 A Setup of (A) Butterfly Trap and (B) Camera Trap.

Bats – A handheld acoustic detector, the Echo Meter Touch 2 Pro (Wildlife Acoustics, Inc.), connected to a mobile device, was used during nocturnal surveys along terrestrial sampling routes to detect insectivorous bats. Insectivorous bats produce ultrasonic echolocation calls that are unique to each species and can be used to identify bats (Fenton and Bell, 1981). The detector converts the ultrasonic calls to low frequency signals below 20 kilohertz (kHz), a range that is audible to the human ear, which are then streamed on a spectrogram of the Echo Meter Touch app. All bat calls are automatically recorded on the device.

Owing to the difficulty in finding roost sites and the inability to visually identify bats to the species-level in flight, bats were sampled using live-trapping and acoustic detection. However, in light of the COVID-19 outbreak, bat trapping was only conducted once for Clementi Forest, where three harp traps and three mist nets were deployed in each site (Figure 7-10). Live trapping involved the use of mist nets and harp-traps (Figure 7-10). Mist nets target the larger-sized fruit/nectar bats (Megachiroptera), while harp traps target the smaller insectivorous bats (Microchiroptera). At least two ground mist nets and two ground harp traps were deployed for each trapping session. Typically, each ground mist net and harp trap were placed near each other. Traps were set up between 1730h–1930h and trapping lasted from 1930h–2100h, during which traps were repeatedly checked. Mist nets were disassembled by 2100h, while harp traps were left overnight and checked the following morning between 0800h and 0900h and removed. Bats collected in the traps were identified and released immediately.

Roost emergence surveys were conducted at bamboos within 20 m from the worksites to determine the possible residency of bamboo bats. The surveys occurred between 1830h–2100h, during which two to three personnel were stationed around each bamboo to observe for bats flying out from or towards the bamboo, and identified slits that

are at least 1-cm wide and 1-cm long. Active slits and the number of individuals residing within each slit were recorded. An acoustic detector was also used to obtain acoustic recordings.

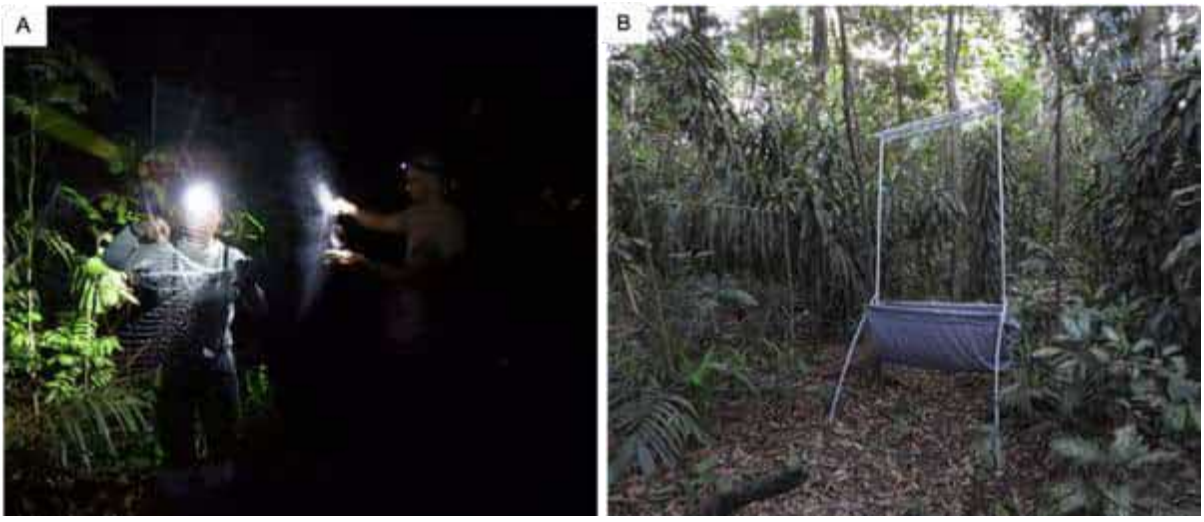


Figure 7-13 A Setup of (A) Mist Net and (B) Harp Trap During Bat Trapping.

7.2.6 Data Analyses

7.2.6.1 Flora

7.2.6.1.1 *Species Accumulation Curves*

All statistical analyses for this Study were carried out in the statistical programming environment R version 3.4.3 (R Development Core Team, 2016). Community data analyses were conducted using the "vegan" package 2.5-6 (Oksanen et al., 2019) and "iNEXT" package 2.0.20 (Hsieh et al., 2019).

Species accumulation curves (SAC) were plotted using data on floristic diversity from the vegetation plots. Species richness was plotted against sample coverage, as opposed to survey effort, to estimate sample completeness/survey adequacy, i.e., how extensively we have sampled the species in the community. According to Chao and Jost (2012), sample coverage refers to "the proportion of the total number of individuals in a community that belong to the species represented in the sample." The curve was extrapolated to provide an estimation of species richness and sample coverage if sample size was doubled. The associated standard error and 95% confidence interval were also computed. Standard error represents the range of uncertainty of the estimate, while 95% confidence interval is the interval in which there is a 0.95 probability of containing the estimated true species richness.

As some species will always remain undetected after sampling all the vegetation plots, total species richness had to be estimated via extrapolation. This was done using the Chao estimator.

7.2.6.1.2 *Forest Regeneration*

The trees were broadly categorised into two main girth-size classes: $\geqslant$ 0.5 m and < 0.5 m. They were first ranked by abundance and examined to see which species made up the larger and smaller trees, respectively. The ten most abundant species present in the vegetation plots were then ranked according to their size-class distribution and examined.

7.2.6.2 Fauna

7.2.6.2.1 *Acoustic Bat Recordings*

Bat recordings were processed using Kaleidoscope v.4.5.4 (Wildlife Acoustics, Inc.) to separate extraneous noise from files with bat echolocation calls. The signal parameters for recognising a potential bat echolocation call were configured as follows: frequency range of 20–200 kilohertz (kHz), duration of 2–500 millisecond (ms), maximum inter-syllable gap of 500 ms and a minimum of 2 pulses. These files were then visually processed to identify bat species based on call structures, peak frequency, minimum frequency and call duration Pottie et al. (2005). They

were identified with reference to those in Pottie et al. (2005), which provides echolocation signatures for bats in Singapore, and other relevant references (Collen, 2012; Hughes et al., 2011).

7.2.6.2.2 *Camera Trapping*

Camera trap location, species identity, and the number of individuals were recorded for each video with a positive capture of faunal species (i.e., with a faunal species recorded on the video). An independent detection constitutes video(s) of one or a group of individuals of the same faunal species occurring within 60 minutes at each camera trap. The number of independent detections were used to calculate detection rate of all mammalian species.

7.2.6.2.3 *Species Accumulation Curves*

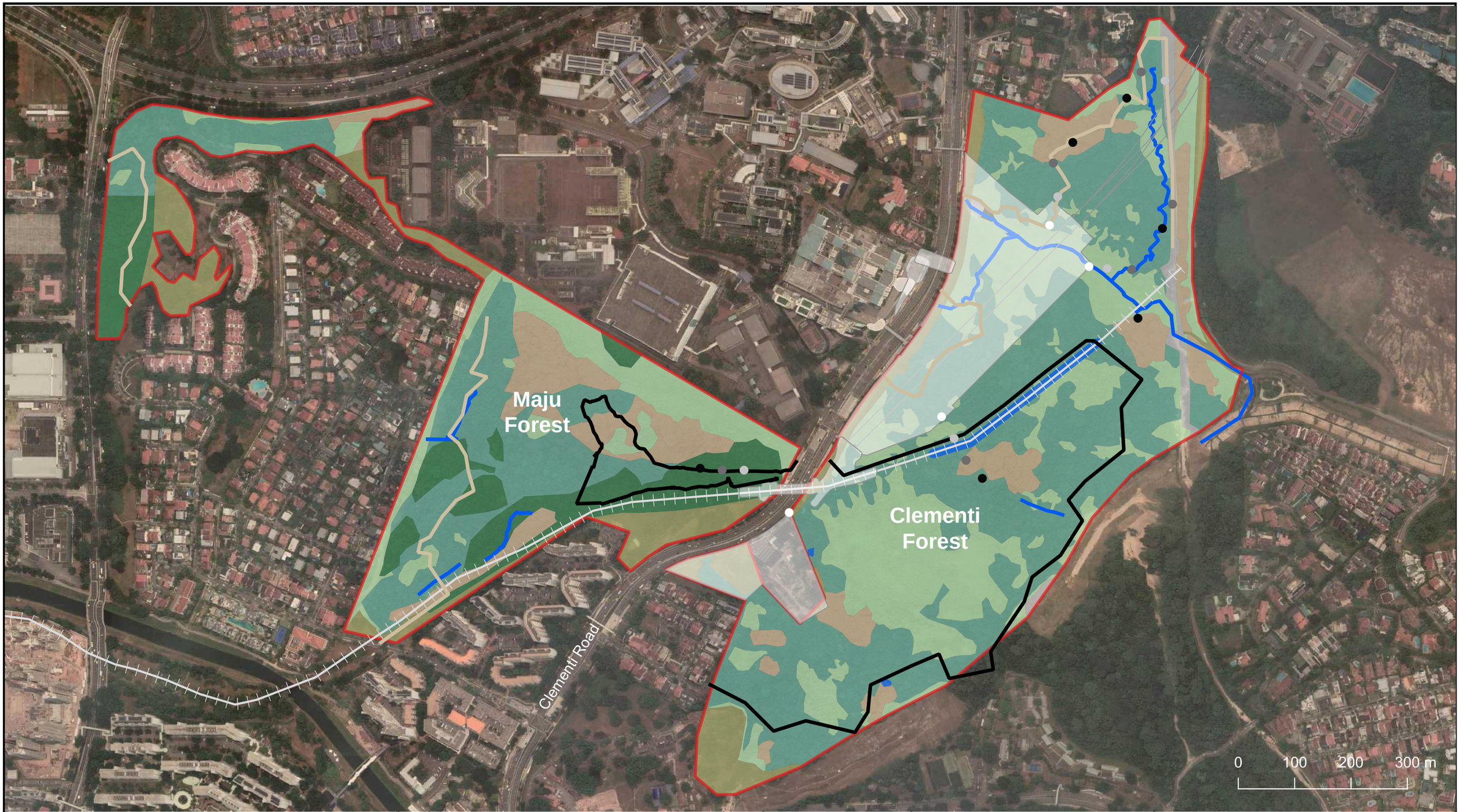
Species accumulation curves (SAC) were plotted for each faunal taxon using data collected along terrestrial sampling routes, aquatic sampling points, and camera traps. The observed sample of incidence data was used to compute estimated coverage and species richness. Similar to that for plants, the associated standard error and 95% confidence interval were computed. The estimated species richness and sample coverage with doubled of sample size were also computed.

7.2.7 Light, Temperature, and Humidity Sampling

Light, temperature and humidity were measured at 0 m (i.e. edge of worksite), 50 m, 100 m and 150 m in four cardinal directions from each worksite, where possible (Figure 7-14; Table 7-6). This information may be used during construction or operational phases to inform mitigation measures. These points were generated using QGIS. Points those lie within non-forested environment were removed. Measurements were done in the day (0800h–1100h) and night (2000h–0000h), and replicated. A handheld Sper Scientific Mini Environmental Quality Meter (850070) was used.

Table 7-6 Number of LTH Sampling Points at Each Interval for Each Worksite

Site (Worksite)	No. of 0-m Interval Sampling Points	No. of 50-m Interval Sampling Points	No. of 100-m Interval Sampling Points	No. of 150-m Interval Sampling Points
Maju Forest (CR16)	4	4	4	4
Clementi Forest (CR16)	4	4	5	5



Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area

- Waterbody
- Terrestrial sampling route 1
- Terrestrial sampling route 2

LTH points (m interval)

- 0
- 50
- 100
- 150

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

Land Transport Authority
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Project Title :
**CONTRACT 2005
ENVIRONMENTAL IMPACT STUDY
(CLEMENTI FOREST AND
MAJU FOREST)**

Figure Title :
LOCATIONS OF LIGHT, TEMPERATURE AND HUMIDITY SAMPLING AT MAJU FOREST AND CLEMENTI FOREST

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-14	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3 Baseline Findings

7.3.1 Local Geographical Context

Study Areas are situated in proximity to the CCNR and BTNR, two important biodiversity hotspots in Singapore. Not only are they important habitats for flora and fauna, the forested areas are also potentially valuable green corridors in the fragmented landscape of Singapore. The ecological connectivity of the areas to other forest fragments is discussed in Section 4.6. Findings from surveys of flora and fauna highlight the importance of the areas as extended habitats where plants and animals disperse and forage, respectively.

7.3.2 Maju Forest

7.3.2.1 Light, Temperature and Humidity

The light levels ranged between 228 to 733 lux in the day with increasing light levels from the forest interior (LTH_1504) to the forest edge (LTH_504), while no light was detected at night. Across the day and night sessions, the humidity ranged between 81.9 to 85.6 rH and the temperature ranged between 29.2 to 31.2°C, with no observable trends within distance to forest edge. The findings are summarised in Table 7-7.

Table 7-7 Light, Temperature and Humidity Levels in Maju Forest

	Light (lux)		Humidity (rH)		Temperature (°C)	
Sampling Point	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
LTH_504	733.0	0.0	85.6	82.8	31.2	29.6
LTH_1004	392.8	0.0	81.9	85.4	30.9	29.2
LTH_1504	228.0	0.0	85.2	85.4	31.1	29.5

7.3.2.2 Habitat and Vegetation Types

There are five vegetation types present in Maju Forest. It is largely occupied by abandoned-land forest (32.8 ha; 32.8%), and native-dominated secondary forest (7.9 ha; 23.7%) (Table 7-8; Figure 7-15). The remaining area is covered by, in descending order, scrubland and herbaceous vegetation (5.5 ha, 16.6%), waste woodland and managed vegetation (both 4.5 ha; 13.6%).

Based on vegetation plot data, total species richness per plot is the highest in abandoned-land forest, followed by native-dominated secondary forest, and scrubland and herbaceous vegetation (Table 7-8). The trend is also observed for native species richness, where more native species were recorded in a plot within abandoned-land forest than that in native-dominated forest (Table 7-8). However, this could, in part, be explained by the higher number of plots in abandoned-land forest than native-dominated forest.

Table 7-8 (ha) and Relative (%) Sizes, Number of Vegetation Plots, and Species Richness of Each Vegetation Type In Maju Forest

Vegetation Type	Area		Plots	Species Richness Per Vegetation Type		
	ha	%		**Total***	Native	Exotic And Cryptogenic
Native-Dominated Secondary Forest	7.9	23.8	2	**44**	37	7
Abandoned-Land Forest	10.9	32.8	3	**55**	43	12
Waste Woodland	4.5	13.6	0	**–**	–	–
Scrubland And Herbaceous Vegetation	5.5	16.6	1	**39**	21	18
Managed Vegetation	4.5	13.6	N.A.	**–**	–	–
Total Spontaneous Vegetation	**28.7**	**86.4**	**6**	**–**	**–**	**–**
Total Area	**33.2**	**100.0**	**–**	**–**	**–**	**–**

Note: *refers to the total number of species recorded across all plots in each vegetation type

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor
- Waterbody
- Vegetation plot

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

Land Transport Authority — We Keep Your World Moving

Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
VEGETATION DISTRIBUTION AND LOCATIONS OF VEGETATION PLOTS IN MAJU FOREST. MAP INLET SHOWS THE WORKSITE, I.E., ACCESS TO CR16 AS BASE SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-15	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.2.2.1 *Native-dominated Secondary Forest*

The quality and stage of succession of the native-dominated secondary forest are not the same throughout the site. The western patch adjacent to Clementi Avenue 6 is in the early successional stage and largely dominated by native pioneer species, such as *Macaranga* and *Mallotus* species (Figure 7-16), which are often associated with disturbance and high light conditions (Yee et al., 2016). On the other side, the eastern patch appears to be in a later successional stage. Trees that form the canopy layer are common native non-pioneer species such as *Cyrtophyllum fragrans*, *Arthrophyllum diversifolium*, *Syzygium lineatum*, *Syzygium grande*, *Ficus fistulosa*, and *Alstonia angustiloba*. Majority of these trees have no larger than 1 m girth. Commonly-encountered plant species in the understorey are *Caryota mitis*, *Dillenia suffructicosa*, and *Melastoma malabathricum* (Figure 7-16). Native climbers found to be widespread across this forest type in Maju Forest include *Ficus apiocarpa* and *Limacia scandens*.

Early-successional forests consisting of light-demanding species will eventually develop into late-successional forests where light-demanding species are replaced (Corlett, 1991). A clear distinction between these two forest sub-types cannot be identified as they occur along a successional gradient (Corlett, 1991; 1997; Turner et al., 1997). Floristically, the native-dominated secondary forest in Maju Forest appears to be an intermediate-successional forest as it consists of both light-demanding native pioneer *Macaranga* and *Mallotus* species (characteristic of early-successional forests), as well as later-stage species from genera such as *Syzygium* (characteristic of late-successional forests), amongst others. If left undisturbed, it would eventually develop into primary forest, albeit very slowly owing to the persistence of pioneer species and the lack of seedling recruitment (Goldsmith et al., 2011; Chua et al., 2013).

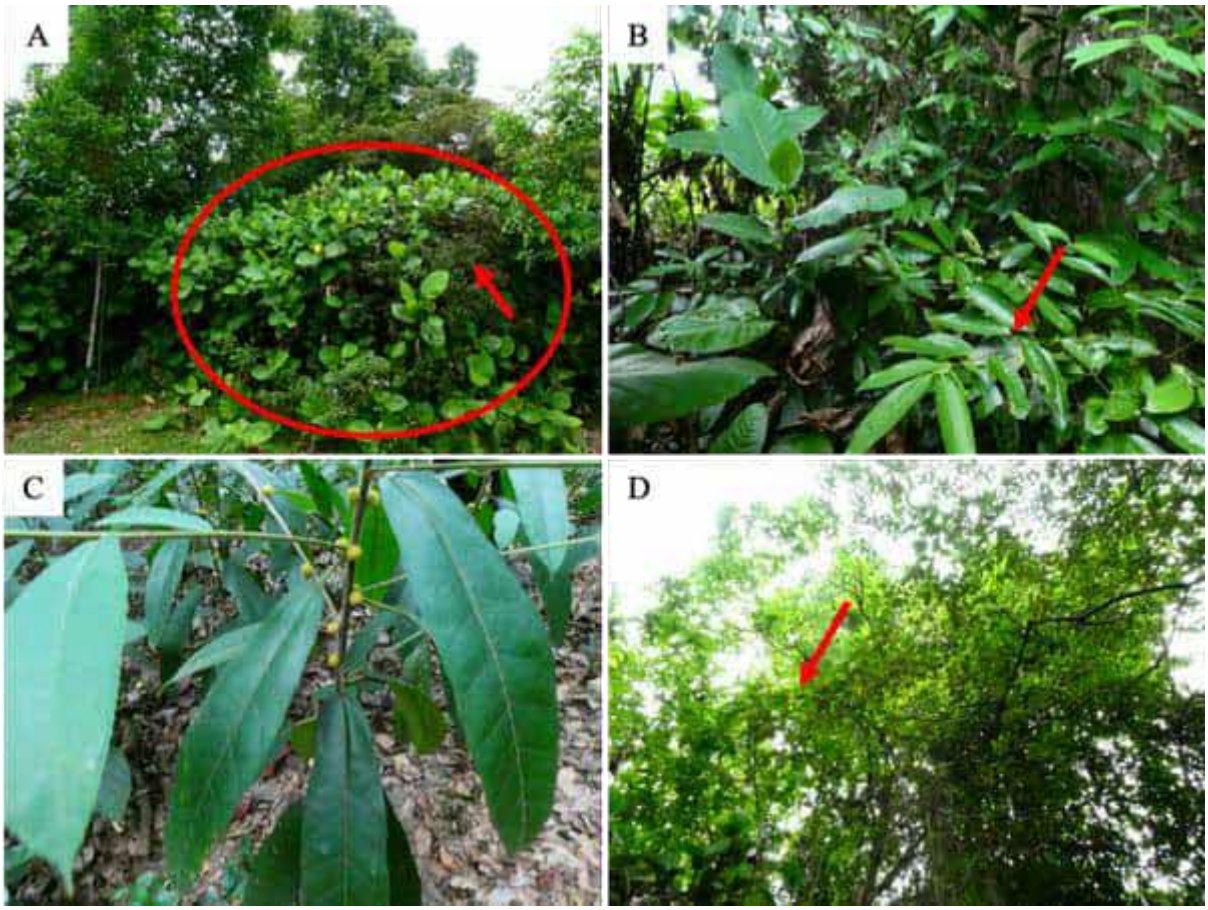

Figure 7-16 Native-Dominated Secondary Forest in Maju Forest. (A) Native Common Shrubs Growing at the Edge of a Forested Patch (Red Circle – *Dillenia suffruticosa*; Red Arrow – *Melastoma malabathricum*); (B) a Common Native Tree Species, *Cinnamomum iners* (Red Arrow); (C) a Native Vulnerable Tree Species, *Ficus aurata* var. *aurata*, that was Producing Figs; (D) a Native Common Pioneer Tree Species, *Mallotus paniculatus*, Occupying the Canopy Layer.

7.3.2.2.2 *Abandoned-land Forest*

Plant species that constitute this vegetation type are mainly exotic fruit trees and crop plants cultivated in the past. Some fruit plant species found in this forest type include durian (*Durio zibethinus*), jackfruit and cempedek (*Artocarpus* species), and banana (*Musa cultivars*) (Figure 7-17). Crop plant species include rubber (*Hevea brasiliensis*) and oil palm (*Elaeis guineensis*) (Figure 7-17). Especially abundant in Maju Forest is the native climber, *Smilax setosa*, which is recorded as Common (Chong et al., 2009). Even though this forest is dominated by exotic plants, there are signs of recruitment of native species, such as *Arthrophyllum diversifolium* and *Ficus aurata* var. *aurata*.

Figure 7-17 Fruit Trees and Crop Plants Found in the Abandoned-Land Forest in Maju Forest. (A) Oil Palm *Elaeis guineensis*; (B) *Artocarpus* sp. Tree; (C) Banana Plants, *Musa* Cultivars; (4) Rubber Tree *Hevea brasiliensis.*

7.3.2.2.3 *Waste Woodland*

While it is generally distributed throughout the site, the largest patch is located in the east of the Study Area, adjacent to patches of scrubland and herbaceous vegetation as well as abandoned-land forest (Figure 7-18). The dominant species here are *Falcataria moluccana* and *Spathodea campanulata* (Figure 7-18). On the other hand, the thin stretch at the northern-most tip of the Study Area, adjacent to the Pan Island Expressway (PIE), is largely dominated by *Acacia auriculiformis* (Figure 7-18). These exotic tree species are fast-growing “with high propagule pressure in (the) surrounding landscape” (Yee et al., 2016), which causes higher rates of establishment than native species with low propagule pressure. In the understorey, the stratum is largely occupied by shrubs, such as *Alocasia macrorrhizos* and *Manihot esculenta*.

Figure 7-18 Waste Woodland in Maju Forest. (A) *Acacia auriculiformis* Trees Forming the Canopy Layer; (B) A Generic Shot of the Forest Beneath the *Acacia auriculiformis* Trees; (C) *Falcataria moluccana* Trees in the Background of a Landscape of Herbaceous Vegetation; (D) *Falcataria moluccana* trees Forming a Continuous Canopy Layer.

7.3.2.2.4 *Scrubland and Herbaceous Vegetation*

Scrubland and herbaceous vegetation are mostly located along the edges of forested areas, where temperature and light levels are higher, as well as scattered patches within the larger forested landscape (Figure 7-15).

These areas are characterised by short vegetation with open canopy (A–B), typically made up of shrubs, climbing/creeping plants, and grasses (Figure 7-19C). Some of these species include the native grass *Ischaemum muticum*, the exotic grass *Imperata cylidrica* (Figure 7-19D)—commonly known as lalang and for its extensive growth in open grasslands via rhizomes underground—and the exotic climber *Mucuna pruriens*.

A noteworthy observation made during floristic surveys was that at least five saplings of the native Vulnerable tree species, *Glochidion zeylanicum* var. *zeylanicum*, were found within the stretch of scrubland and herbaceous vegetation in the east of the Study Area, adjacent to Maju Camp. A mature tree of about 1.75 m in girth was also encountered outside, but very close to the Study Area, approximately 80 m south of the native-dominated secondary forest patch in the west of the Study Area. The locations of these specimens are recorded in Appendix D1. This nationally Vulnerable species is not known to be cultivated locally. Hence, the presence of saplings could be evidence that these species are recruiting.

Figure 7-19 Scrubland and Herbaceous Vegetation in Maju Forest. (A) A Small Patch Occupied Entirely by Herbaceous Plants; (B) Scrubland Occupying a Single Stratum with an Open Canopy; (C) A Mix of Woody Shrub Species, Grasses as well as Climbing and Creeping Plants, Amongst Others; (D) Lalang *Imperata cylindrica*.

7.3.2.2.5 *Managed Vegetation*

Managed vegetation is mostly located along the edges of forested areas (Figure 7-20) and is made up of landscape and streetscape plantings, managed lawns, as well as small community gardens—a make-up typical of urban parks in Singapore (Figure 7-20). Most of the planted trees are exotic species, such as *Podocarpus rumphii*, *Khaya grandifoliola* and *Samanea saman*.

Figure 7-20 Managed Vegetation in Maju Forest.

7.3.2.2.6 *Waterbodies*

Three waterbodies are present within Maju Forest, comprising of semi-open country streams (D/S24 and D/S23), and a forest stream (D/S25 and parts of D/S23) as shown in Figure 7-21. The alignment of the waterbodies is shown in Figure 7-8.

The waterbodies, D/S24 (90 m; Figure 7-21A) and D/S23 (145 m; Figure 7-21B), lie in the southern section of the site. Although presently existing as two discrete waterbodies, they appear to fuse into a single stream during wetter periods of the year (pers. obs.). They were observed to be partially dry at times, often with many sections having no or low water levels. These waterbodies run parallel to a concrete culvert and are characterised by a more open habitat with limited tree canopy cover with edges overgrown by grass and herbaceous shrubs. Some swampy or wet sections are present at or around the waterbodies, and along the Old Jurong Railway Corridor in the eastern part of the Study Area. The forest stream, D/S25 (125 m; Figure 7-21C), is located in the northwest of the site and flows in the north-eastern–southwestern direction. This stream has characteristics of a forest stream (Kwik & Yeo,

2015) with higher canopy cover and large accumulations of leaf litter. However, this stream is very willow and when visited recently was found to be almost entirely dried out.

Figure 7-21 Waterbodies in Maju Forest. (A–B) Semi-Open Country Stream, D/S24; (C) Semi-Open Country And Shaded Forest Stream, D/S23; (D) Shady Forest Stream, D/S25.

7.3.2.3 Floristic Field Findings

7.3.2.3.1 *Overall*

A total of 305 plant species and species groups i.e., plants that could not be identified to species with certainty, belonging to 101 families were recorded from the present Study's floristic surveys at Maju Forest. Eight are listed as species groups: (1) *Acacia* sp., (2) *Archidendron* cf. *jiringa*, (3) *Dalbergia* cf. *junghunii*, (4) *Litsea* cf. *grandis*, (5) *Salacia* cf. *korthalsiana*, (6) *Smilax* cf. *megacarpa*, (7) *Strophanthus* cf. *caudatus*, and (8) *Tectaria* cf. *semipinnata* (Appendix C1).

Even though the species identity of *Dalbergia* cf. *junghunii* could not be confirmed without fertile specimens, the individual could possibly be a native climber that is nationally Critically Endangered based on characters observed from the vegetative specimen we collected (Figure 7-23B). In addition, no other species belonging to the genus *Dalbergia* were recorded at Maju Forest. Similarly, the *Acacia* sp. specimen that we encountered was a climber, a growth habit distinct from that of *Acacia auriculiformis* and *Acacia mangium*, which grow as trees.

All other six species groups that also could not be identified to species with certainty without fertile specimens—but could possibly be nationally threatened species—were also included in the tabulation of total species count in Table 7-9, Appendix C1 as well as Appendix D1.

Of the 305, 161 (52.8%) are native, 120 (39.3%) exotic, and 23 (7.5%) cryptogenic, i.e., of unknown/uncertain origin (Table 7-9). The number of native threatened species makes up 65 (21.3%) of total flora species count at Maju Forest.

For overall findings, however, a distinction is not made as to whether these threatened species are from native wild populations, or are cultivated locally and/or are relics from past cultivation. Species belonging to the latter category may therefore not be of conservation significance even though they have been accorded with a threatened conservation status. This is discussed in greater detail in Section 7.3.2.3.2. This also applies for all other Study Areas.

Table 7-9 Number and Percentage of Plant Species Belonging to Each Status Category in Maju Forest

Origin	Status	Number Of Species	Percentage
Native		**161**	**52.8**
	Common	96	31.5
	Vulnerable	29	9.5
	Endangered	11	3.6
	Critically Endangered	19	6.2
	Presumed Extinct	4	1.3
	Not assessed; recently rediscovered	2	0.7
Exotic		**120**	**39.3**
	Cultivated Only	28	9.2
	Casual	25	8.2
	Naturalised	59	19.3
	Not assessed	8	2.6
Cryptogenic		**23**	**7.5**
Unidentified species (*Acacia* sp.)		**1**	**0.3**
Total		**305**	**100.0**

7.3.2.3.2 *Plant Species of Conservation Significance*

Forty-seven species of plants recorded in Maju Forest are considered of conservation significance (Table 7-10). Locations of 265 individual and/or cluster of specimens belonging to these species were taken (Table 7-11). The specimens were largely in the south of the Study Area (Figure 7-22). Within this area, no obvious patterns of distribution can be observed, though majority (249 out of 265; 94.0%) are distributed within the native-dominated secondary forest and abandoned-land forest (Table 7-11). It is interesting to note that several individuals of stream-associated species were encountered near the waterbodies in Maju Forest, particularly along the Old Jurong Railway Corridor. We note, however, that not the entire Old Jurong Railway Corridor is inundated even though topographically, the railway is situated in lower terrain where water can accumulate. Hence, some of the stream-associated species were found growing along the railway even though waterbodies were not drawn in the map and will be further discussed in the following section. The list of these species as well as locations of specimens belonging to them are in Appendix D1.

The number of specimens and clusters of specimens of conservation significance in abandoned-land forest (126) is comparable to that in native-dominated secondary forest (123) (Table 7-11). The number of species of conservation significance in the abandoned-land forest is higher than that in the native-dominated secondary forest.

Five specimens of conservation significance lie within and very near the boundary of the proposed worksite (base scenario) in Maju Forest (Figure 7-22). They are three nationally Vulnerable tree fern *Alsophila latebrosa* specimens, one nationally Vulnerable fern *Pteris semipinnata* specimens, and one nationally Endangered shrub *Callicarpa longifolia* specimen.

Table 7-10 Number of Plant Species of Conservation Significance in Maju Forest

	VU	EN	CR	RR
Non-Cultivated Threatened Species	18	5	11	2
Cultivated Threatened Species	6	3	2	0
Total Number Of Species Of Conservation Significance	**24**	**8**	**13**	**2**

Note: VU – Vulnerable; EN – Endangered; CR – Critically Endangered; RR – Recently Rediscovered (not assessed).

Table 7-11 Number of Plant Specimens and Species of Conservation Significance in Each Vegetation Type in Maju Forest

Vegetation Type	Number Of Individuals And Clusters					Number Of Species				
	VU	EN	CR	RR	Total	VU	EN	CR	RR	Total
Native-Dominated Secondary Forest	96	20	10	0	**126**	16	4	7	0	**27**
Abandoned-Land Forest	91	19	10	3	**123**	22	4	7	2	**35**
Waste Woodland	1	1	1	0	**3**	1	1	1	0	**3**
Scrubland And Herbaceous Vegetation	11	0	1	0	**12**	4	0	1	0	**5**
Managed Vegetation	1	0	0	0	**1**	1	0	0	0	**1**

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; RR – Recently Rediscovered (not assessed).

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation
- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation

- Waterbody

Stream-associated species
- Vulnerable

Other plant species
- Recently Rediscovered
- Critically Endangered
- Endangered
- Vulnerable

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

Land Transport Authority — We Keep Your World Moving

Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
DISTRIBUTION OF PLANT SPECIMENS OF CONSERVATION SIGNIFICANCE IN MAJU FOREST

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-22	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

Some of the nationally threatened species found at Maju Forest are *Dioscorea orbiculata* var. *tenuifolia*, *Connarus semidecandrus*, *Dalbergia* cf. *junghunii*, *Lomariopsis lineata*, and *Centotheca lappacea* (Figure 7-23; Appendix D1).

Figure 7-23 Nationally Critically Endangered Plant Species Recorded at Maju Forest. (A) *Connarus semidecandrus*; (B) *Dalbergia* cf. *junghunii*; (C) *Lomariopsis lineata*; (D) *Centotheca lappacea*.

Dioscorea orbiculata var. *tenuifolia* was recently rediscovered in Singapore and has not been assigned an updated national conservation status (Singapore Biodiversity Online). It had been recorded in an abandoned-land forest in Admiralty (Neo et al., 2013) as well as the primary and old secondary forests in BTNR (Ho et al., 2019). Previous records show that this species is capable of establishing itself in a range of forest habitats, from the least disturbed primary forests to relatively disturbed abandoned-land forests. Two individuals of this species were encountered in the abandoned-land forest about 100 m into the forested area to the east of Sunset View (Figure 7-24). The locations of these specimens are recorded in Appendix D1. The presence of such species even in relatively disturbed secondary forests justify efforts to conserve such forests that still have important native species of flora that contribute to national biodiversity.

Figure 7-24 *Dioscorea orbiculata* var. *tenuifolia*. (A) Upper Side; (B) Under Side.

7.3.2.3.3 *Large Plant Specimens*

Thirty-five large plant specimens were encountered at Maju Forest (Figure 7-26; Appendix E1). Of these specimens, 23 individuals are large trees (3.0–4.5 m girth), two are stranglers of (3 m and 7 m spread, respectively), while the remaining ten are bamboo clusters (5–12 m spread) (Figure 7-25). The 23 individual large trees belong to nine species and eight families (Table 7-12). There are no large plant specimens that lie within the proposed worksite area in Maju Forest.

Table 7-12 Number of Large Plant Specimens in Maju Forest

Habit	Species	No. of Specimens
Tree	*Alstonia angustiloba*	6
	Cyrtophyllum fragrans	3
	Durio zibethinus	2
	Ixonanthes reticulata	1
	Khaya grandifoliola	2
	Khaya senegalensis	1
	Samanea saman	2
	Syzygium grande	5
	Terminalia catappa	1
Strangler	*Ficus microcarpa*	2
Shrub (Bamboo)	*Bambusa vulgaris*	4
	Schizostachyum brachycladum	6
Total		**35**

Figure 7-25 Large Bamboo Clusters in Maju Forest.

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation
- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Waterbody

Large plant specimens
- Tree
- Strangler
- Bamboo

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
DISTRIBUTION OF LARGE PLANT SPECIMENS IN MAJU FOREST

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-26	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.2.3.4 *Other Plant Specimens of Value*

Three other plant specimens of value were recorded at Maju Forest (Figure 7-28, Appendix F1). They are an *Alstonia aungustiloba* tree (2.8 m girth), a *Bambusa vulgaris* cluster (1 m spread), and a *Falcataria moluccana* tree with an active raptor nest. *Alstonia angustiloba* is a common native tree that could attain a girth size of 5 m and above. It appeared to have good health with little or no structural defects. Hence, it could be incorporated as part of the area to be developed.

The bamboo cluster could be a potential roost site for the nationally Critically Endangered lesser bamboo bats (*Tylonyecteris fulvida*). The presence of bamboo bats and their roost sites was verified during roost emergence surveys.

A changeable hawk-eagle (*Nisaetus cirrhatus*) was seen perching on the nest built on a *Falcataria moluccana* tree on the day of observation (Figure 7-27). This species, an uncommon resident breeder, is nationally Endangered. Sighting of the individual perched on the nest could indicate that the raptors are breeding and the nest is actively used.

Figure 7-27 An Active Changeable Hawk-Eagle (*Nisaetus cirrhatus*) Nest on a *Falcataria moluccana* Tree

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation
- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation

- Waterbody

Other specimens of value
- Tree
- Bamboo
- Raptor nest

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
DISTRIBUTION OF OTHER PLANT SPECIMENS OF VALUE AT MAJU FOREST

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-28	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.2.3.5 *Arboricultural Survey Findings*

Two hundred and forty-one specimens belonging to 40 species and 23 families were tagged at Maju Forest. The seven tree species that make up majority (> 50%) of all specimens assessed during arboricultural surveys are, in descending order, *Syzygium grande*, *Falcataria moluccana*, *Khaya grandifoliola*, *Hevea brasiliensis*, *Elaeis guineensis*, and *Acacia auriculiformis* (Appendix G1). No specimens of conservation significance of ≥ 0.3 m girth were encountered at Maju Forest.

Note that there were more specimens assessed than tagged as some specimens occur in clusters, i.e., within 1–2 m of each other. All the specimens within clusters were assessed, but only one specimen was tagged (Section 7.2.4.4).

7.3.2.3.6 *Forest Regeneration*

There are a total of 44 specimens of ≥ 0.5 m girth belonging to 14 tree species (Figure 7-29) and 1466 specimens of < 0.5 m girth belonging to 44 tree species (Figure 7-30) from vegetation plot sampling in Maju Forest. The top ten most abundant species in the two broad girth-size classes—≥ 0.5 m and < 0.5 m girth, respectively—are listed in descending order in Table 7-13.

Hevea brasiliensis, commonly known as rubber, has the greatest number of stems in the larger girth-size class, with up to 23 stems of ≥ 0.5 m girth (compared to the other species with fewer than five stems of ≥ 0.5 m girth). This species also has the highest recruitment of seedlings and saplings of up to 647 stems, where majority (79%) were of < 0.05 m girth or smaller (Figure 7-30; Figure 7-31). These findings corroborate field observations where majority of Maju Forest is occupied by the abandoned-land forest sub-type. In addition, the presence of early-successional secondary forest tree species, *Adinandra dumosa,* and some species characteristic of late-successional secondary forests, such as *Rhodamnia cinerea* and *Syzygium lineatum*, also corroborates floristic field findings, i.e., intermediate-successional native-dominated secondary forest forms the second largest forest type in Maju Forest.

Acacia auriculiformis, also an exotic naturalised tree species like *H. brasiliensis*, has the second largest number of stems in the larger girth-size class. The remaining eight of the ten most abundant large trees are native species. Of these, seven are common, while *Archidendron jiringa* is the only threatened species listed as nationally Vulnerable. Specimens of the latter, however, are likely to be escapees from local cultivation. As there are very few trees in this class size, no distinct trends can be observed nor conclusive inferences can be drawn from the data gathered, except for that of *H. brasiliensis*. As such, only the girth-size classes of < 0.5 m were further divided and the trends in diameter frequency distribution shown in Figure 7-31.

Second to *H. brasiliensis*, *Arthrophyllum diversifolium* has the next highest level of seedling recruitment; and up to 220 stems belonging to this species were recorded. Similar to *Hevea brasiliensis*, approximately 75% of them are of 0.05 m girth or smaller (Figure 7-30; Figure 7-31). All ten most abundant species of < 0.5 m girth exhibit a typical reverse-J distribution pattern (Figure 7-31). This distribution pattern indicates that there is a high recruitment of small trees. Nine out of the ten most abundance species are native. The only threatened species is rambutan (*Nephelium lappaceum*), which is listed as nationally Critically Endangered, but specimens of this species in the forest are likely to be relics from past cultivation.

Large trees in the forests often act as seed sources. While this trend is clearly evident for *H. brasiliensis*, where the high number of large trees possibly explain the disproportionately higher number of seedlings found in the understorey, the same could not be said for the other species. It is important to note that the absence of large trees within the vegetation plots for the other species with high seedling recruitment does not imply that they are not present in the Study Area, as they may have been opportunistically missed out with random plot sampling.

Table 7-13 The Ten Most Abundant Tree Species in Maju Forest, Listed in Descending Order

S/N	Trees of ⩾ 0.5 m Girth	Trees of < 0.5 m Girth
1.	*Hevea brasiliensis*	*Hevea brasiliensis*
2.	*Adinandra dumosa*	*Arthrophyllum diversifolium*
3.	*Acacia auriculiformis*	*Syzygium grande*

S/N	Trees of ⩾ 0.5 m Girth	Trees of < 0.5 m Girth
4.	*Athrophyllum diversifolium*	*Caryota mitis*
5.	*Cyrtophyllum fragrans*	*Cinamommum iners*
6.	*Rhodamnia cinerea*	*Nephelium lappaceum*
7.	*Syzygium lineatum*	*Ficus fistulosa*
8.	*Vitex pinnata*	*Gynotroches axillaris*
9.	*Alstonia angustiloba*	*Clerodendrum laevifolium*
10.	*Archidendron jiringa*	*Ficus grossularioides* var. *grossularioides*

Figure 7-29 Number of Stems (44 In Total) With ⩾ 0.5 m Girth for All Species Across Vegetation Plots In Maju Forest. Bars in Light Blue Belong to the Ten Most Abundant Species.

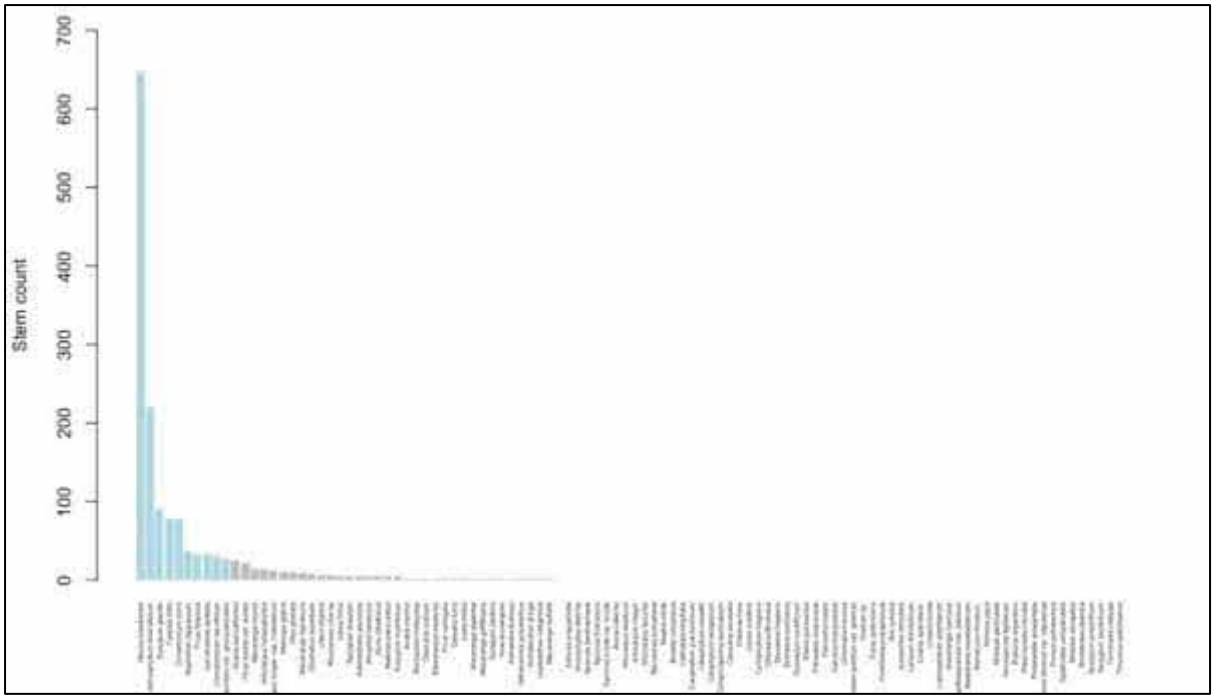

Figure 7-30 Number of Stems (1466) with < 0.5 m Girth for All Species Across Vegetation Plots in Maju Forest. Bars in Light Blue Belong to the Ten Most Abundant Species.

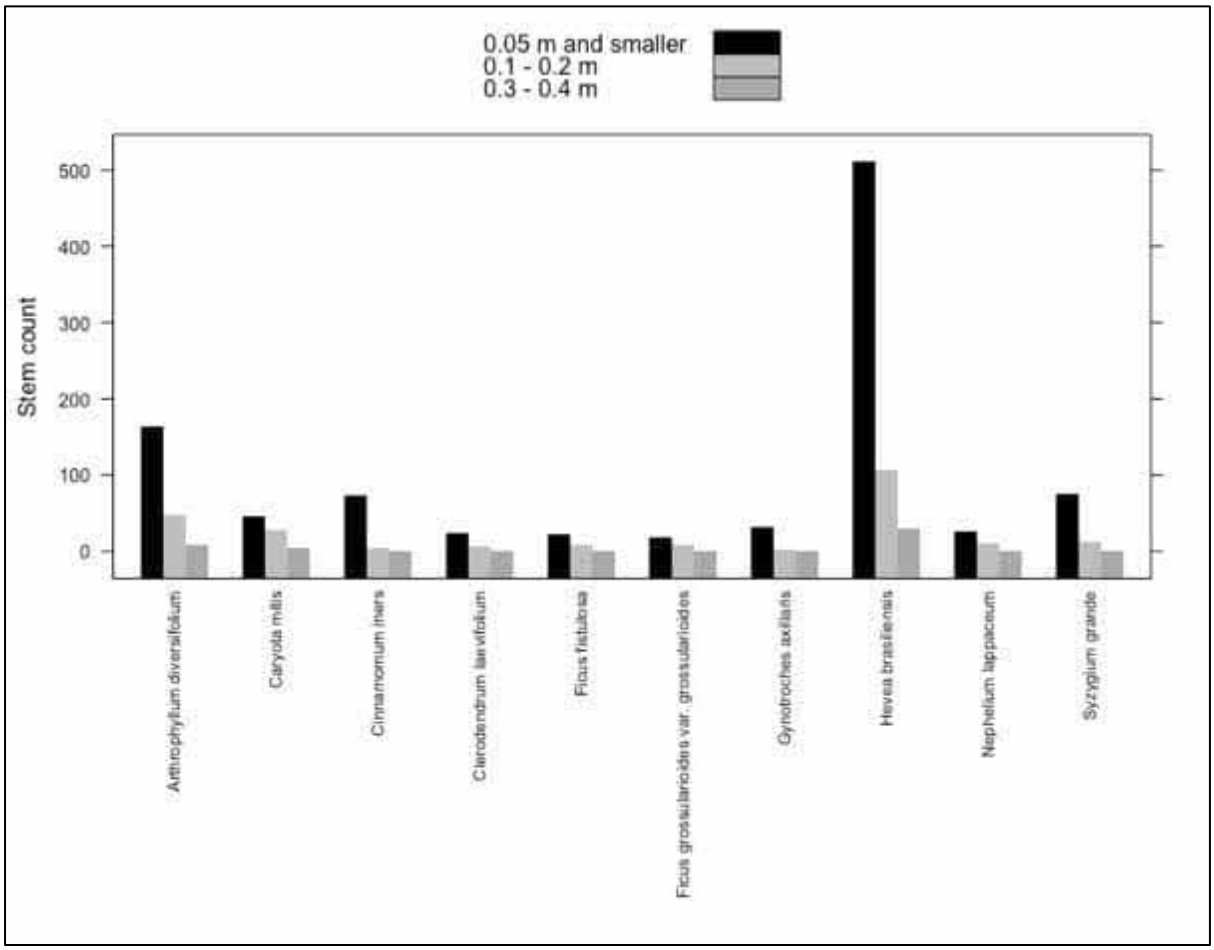

Figure 7-31 Girth-Size Distribution of the Ten Most Abundant Tree Species with < 0.5 m Girth in Maju Forest

7.3.2.4 Faunistic Field Findings

7.3.2.4.1 *Overall*

The desktop assessment identified 535 faunal species of probable occurrence at Maju Forest. The field assessment recorded 130 species with more than half of the recorded assemblage dominated by bird (48 species) and butterfly (34 species) (Table 7-14). A total of 10 species of conservation significance were recorded (Table 7-15). The list of probable and recorded species is in Appendix H1. The faunal survey and camera trap data are provided in Appendix I1 and Appendix J1 respectively.

Table 7-14 Summary of Probable and Recorded Faunal Species at Maju Forest

Faunal Group	Total No. of Probable Species		Total No. of Recorded Species	
	All Species	CS Species	All Species	CS Species
Aculeate hymenopterans	78	1	6	0
Bees	39	1	3	0
Stinging wasps	39	0	3	0
Odonates	43	1	10	0
Dragonflies	33	0	8	0
Damselflies	10	1	2	0
Butterflies	178	17	34	1
Freshwater decapod crustaceans	1	0	1	0
Freshwater fish	9	0	2	0
Herpetofauna	47	1	18	0
Amphibians	16	0	8	0
Reptiles	31	1	10	0
Birds	152	19	48	7
Mammals	26	5	11	2
Non-Volant mammals	15	2	6	2
Bats	11	3	5	0
Total	**534**	**44**	**130**	**10**

Note: 'CS species' refers to species of conservation significance.

Species of conservation significance were distributed across the Study Area with no distinct hotspot (Figure 7-32).

The assemblage recorded here was dominated by butterflies (34 species) and birds (48 species). The mixture of vegetation types (e.g., waste woodlands and abandoned-land forest) supports fauna species with different habitat requirements across the Study Area. Some species may be more active in the open country habitats (e.g., scrubland and herbaceous vegetation) and forest edges for foraging in the day. Furthermore, species tend to be more visible in open habitats than in the forest. Along the waterbodies, records of aquatic fauna were poor and comprised largely of odonate species. The poor records may be attributed to the ephemeral nature of the streams, which were often dry with disconnected willow pools of water. However, tadpoles of the uncommon copper-cheeked frog (*Chalcorana labialis*) were recorded along the western stream (D/S25). Past studies by Camphora Pte Ltd (2018) also recorded adult individuals of the copper-cheeked frog.

Table 7-15 List of Faunal Species of Conservation Significance Recorded in Maju Forest

Faunal Group	Species	Common Name	Local Status	Global Status
Butterfly	*Neptis harita*	Chocolate sailor	Vulnerable	Not Assessed

Faunal Group	Species	Common Name	Local Status	Global Status
Bird	*Accipiter trivirgatus*	Crested goshawk	Critically Endangered	Least Concern; CITES protected (Appendix II)
Bird	*Nisaetus cirrhatus*	Changeable hawk-eagle	Endangered	Least Concern; CITES protected (Appendix II)
Bird	*Gallus gallus*	Red junglefowl	Endangered	Least Concern
Bird	*Loriculus galgulus*	Blue-crowned hanging-parrot	Endangered	Least Concern; CITES protected (Appendix II)
Bird	*Pycnonotus zeylanicus*	Straw-headed bulbul	Endangered	Critically Endangered; CITES protected (Appendix II)
Bird	*Rallina fasciata*	Red-legged crake	Vulnerable	Least Concern
Bird	*Psittacula longicauda*	Long-tailed parakeet	Not Assessed	Vulnerable; CITES protected (Appendix II)
Mammal	*Manis javanica*	Sunda pangolin	Critically Endangered	Critically Endangered; CITES protected (Appendix II)
Mammal	*Macaca fascicualris*	Long-tailed macaque	Least Concern	Vulnerable; CITES protected (Appendix II)

The proximity of the Study Area to the green corridor and the connection to an adjacent larger forest patch (i.e. Clementi Forest) might allow for the detection of uncommon or rare species. The field assessment shows that the Study Area supports local populations of species of conservation. Singapore is also a stronghold to two globally threatened species, namely the straw-headed bulbul (*Pycnonotus zeylanicus*) and Sunda pangolin (*Manis javanica*) that were recorded, emphasizing the importance of conserving forest patches where these species reside in, as discussed in Sections 7.3.2.4.10 and 7.3.2.4.11 respectively. The Study Area also supports local populations of forest-dependent species and/or species of restricted distribution that are increasingly threatened by habitat loss. This further illustrates the importance of maintaining connectivity with surrounding forest patches for the persistence of these species. The ecological connectivity of the Study Area is also illustrated in Section 4.6

Native-dominated secondary forest, such as that present within the Study Area, provides resources and habitats for fauna. This is particularly important for forest butterflies that are dependent on a few specific native flower species for feeding (Jain et al., 2016).

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Waterbody

- Terrestrial sampling route 1
- Terrestrial sampling route 2

Faunal species of conservation significance

- Non-volant mammal
- Bird
- Butterfly

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
LOCATIONS OF FAUNAL SPECIES OF CONSERVATION SIGNIFICANCE FROM SURVEYS AND CAMERA TRAPS AT MAJU FOREST

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-32	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.2.4.2 *Sampling Coverage*

Along the terrestrial sampling routes, the sample coverage for faunal groups was above 70%, with the exception of aculeate hymenopterans (48.0%) and odonates (52.7%). At aquatic sampling points, coverage of odonates was 83.4% but that for amphibians was only 54.2%. A higher sampling coverage obtained for odonates at aquatic sampling points may be due to odonates being more easily observed near waterbodies. Sample coverage was not calculated for mammals or freshwater fish since fewer than two species were recorded.

Doubling the sampling effort will result in a marginal increase of richness for most groups (one to four species), although nine additional species may be detected for aculeate hymenopterans and butterflies. Camera trapping obtained a relatively high coverage of 91.2%. A summary is provided in Table 7-16.

Table 7-16 Result Summary of Taxon Sampling Analysis for Maju Forest

Faunal Group	Sample Coverage (%)	Observed Richness	Estimated Richness (± Standard Error)	95% Confidence Interval for Estimated Richness	Estimated Coverage with Doubled Effort (%)	Estimated Richness (And Additional Species) with Doubled Effort
Terrestrial Sampling Routes						
Aculeate Hymenopteran	48.0	14	71 ± 68.1	23.3–373.8	57.0	23 (+9)
Odonate	50.9	7	18 ± 16.4	8.6–97.0	67.5	11 (+4)
Butterfly	77.4	26	46 ± 15.8	31.2–104.1	88.0	35 (+9)
Amphibian	92.9	5	5 ± 1.3	5.0–13.1	99.0	5 (+0)
Reptile	83.8	9	14 ± 6.8	9.9–45.2	91.8	11 (+2)
Bird	94.3	43	47 ± 3.8	44.0–62.2	99.2	46 (+3)
Non-Volant Mammal	N.A.	2	N.A.	N.A.	N.A.	N.A.
Bat	N.A.	2	N.A.	N.A.	N.A.	N.A.
Aquatic Sampling Points						
Odonate	83.4	7	6.8 ± 4.0	7.5–44.7	91.8	9 (+2)
Freshwater Fish	N.A.	2	N.A.	N.A.	N.A.	N.A.
Amphibian	54.2	4	11.1 ± 6.6	4.3–26.2	83.9	5 (+1)
Reptile	N.A.	0	N.A.	N.A.	N.A.	N.A.
Camera Trapping						
Non-Volant Mammal	91.2	6	7 ± 3.2	6.1–24.8	97.1	7 (+1)

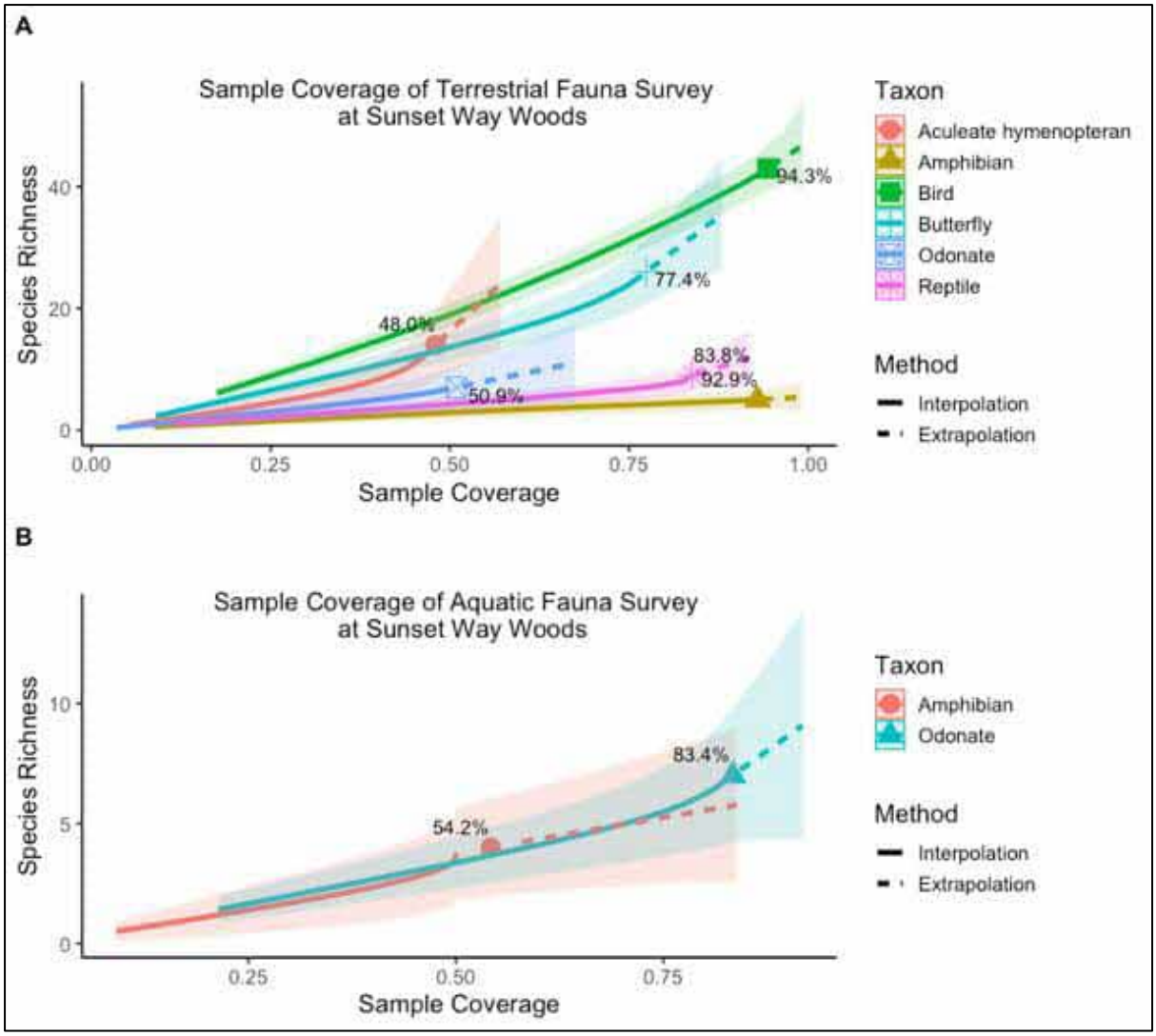

Figure 7-33 Taxon Sampling Curves for the Respective (A) Faunal Terrestrial Sampling Routes and (B) Aquatic Sampling Points at Maju Forest

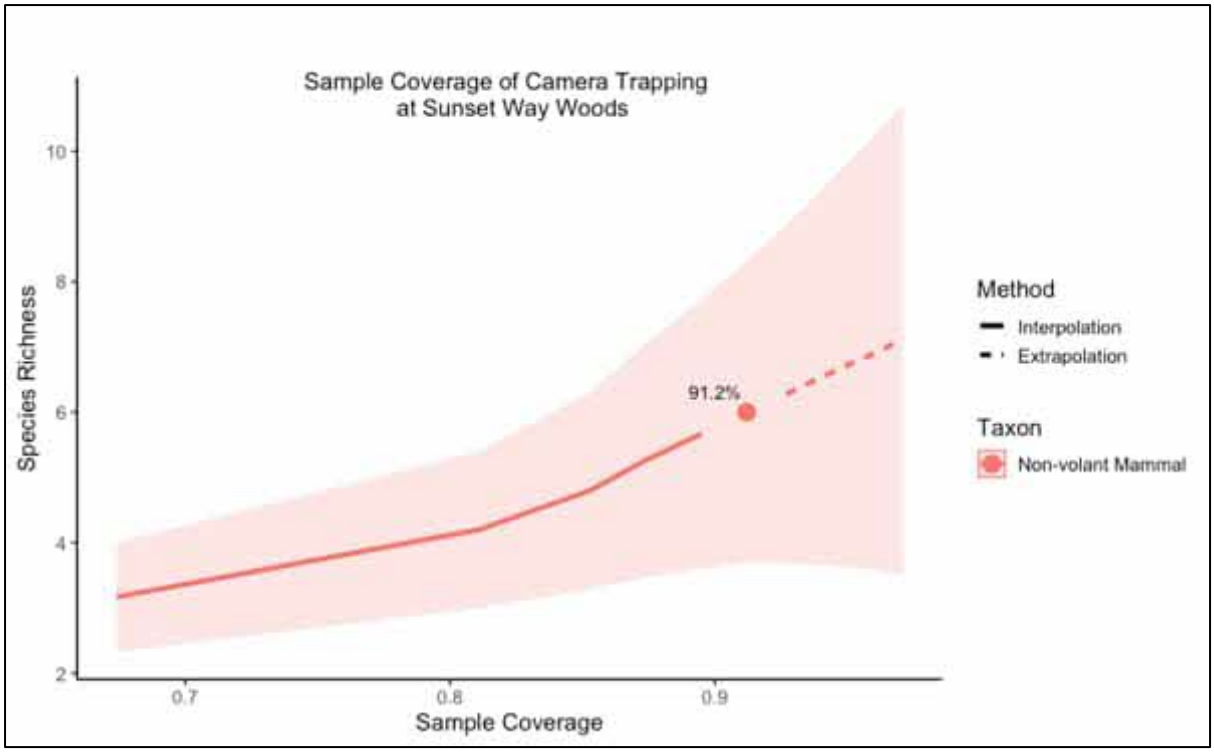

Figure 7-34 Taxon Sampling Curve for Camera Trapping at Maju Forest

7.3.2.4.3 *Aculeate Hymenopterans*

A total of six species of aculeate hymenopterans were recorded, comprising of three wasp and three bee species (Table 7-14; Appendix H1). All species recorded were common native species, none can be defined as forest specialists.

However, while individuals of the paper wasp *Ropalidia sumatrae* have been recorded in a wide range of habitats possibly due to a large flight range, nests and larger numbers are usually found in areas with good mature vegetation, so the presence of this species in large numbers might serve as an indication of the health of the habitat. A large, thriving nest of this species was also observed within the Study Area.

In view of the diversity of bees and stinging wasps present in Singapore, the numbers and abundance of species at all sites proved to be much lower than expected. However, this does not necessarily mean the habitat is poor in terms of biodiversity; the abundance of bees and stinging wasps in general has been observed to be lower than normal in many parts of Singapore throughout 2017 and 2018, and this trend continued into 2019, although no studies have been done to verify this (Lee JXQ, pers. comm.). The habitat along the southern edge has nectaring plants, such as the Simpoh Air (*Dillenia suffructicosa*) and *Leea indica*, which appears to attract a wide variety of bees and wasps. An individual of the stingless bee *Tetragonula valdezi* and five individuals of the Eastern honeybee (*Apis cerana*) were recorded here. Along the western route, two patches of habitat were also considered of interest. The palms and bamboos and fruit trees can provide nest sites and food sources for a wide diversity of species respectively (JXQ Lee, pers obs.).

7.3.2.4.4 *Odonates*

Within the Study Area, 43 species (34.7% of local extant species) were deemed of probable occurrence (Table 7-14; Appendix H1). Most species expected in the Study Area are widespread and common, except one that are restricted and rare – variable featherlegs (*Copera vittata*). This species was expected owing to the presence of small, willow muddy pools on site which are uncommon habitats locally. The variable featherlegs (*Copera vittata*) is nationally Critically Endangered.

The field assessment recorded 10 odonate species and none are of conservation significance (Table 7-14; Appendix H1). Most are common and widespread in Singapore, with a tolerance for disturbed and open habitats, except for the dingy duskhawker (*Gynacantha subinterrupta*) which is uncommon.

Three odonate species, the blue skimmer (*Orthetrum glaucum*), white-barred duskhawk (*Tholymis tillarga*), and grenadier (Agrionoptera insignis), were observed along the Old Jurong Railway Corridor of the eastern terrestrial route. This may be attributed to ephemeral water puddles present along the route, but all are expected to be able to use the entire Study Area. The dingy duskhawker is usually recorded in forested areas, and was seen in the western forest patch beside Clementi Park. Along the southern (D/S24) and western (D/S25) waterbodies, the more commonly recorded species were the common parasol (*Neurothemis fluctuans*), grenadier (*Agrionoptera insignis*) and variable wisp (*Agriocnemis femina*).

7.3.2.4.5 *Butterflies*

Within the Study Area, 178 species of butterflies (53.0% of local extant species) were deemed of probable occurrence and 17 are of conservation significance (Table 7-14; Appendix H1). About one-third (28%; 50 species) is moderately rare or rare. The field assessment recorded 34 butterfly species in the Study Area, and one was of conservation significance (Table 7-14; Appendix H1) – nationally Vulnerable chocolate sailor (*Neptis harita harita*). This butterfly is usually confined to the forested areas in nature reserves and is rare locally (Khew, 2015). It was also recorded near the native-dominated secondary forest in the east of the Study Area, although its host plant, *Poikilospermum suaveolens*, was not observed. Native-dominated secondary forest, an increasingly uncommon habitat in Singapore, is important in providing habitats for forest-dependent butterflies and caterpillars that feed on native plant species (Jain et al., 2016). This shows the value of the Study Area in providing habitats for these species.

Butterfly traps recorded six individuals from three species – plain nawab (*Polyura hebe plautus*), common palmfly (*Elymnias hypermnestra agina*) and palm king (*Amathusia phidippus phidippus*). The most butterfly species (13 species) recorded were in the south, adjacent to the Old Jurong Railway Corridor. It is located on the forest edge and surrounded by a mixture of vegetation types (e.g., waste woodlands and abandoned-land forest) which may support species with different habitat requirements. In addition, butterflies tend to be active in the open habitats and forest edges when foraging in the day, although forest-dependent species are largely restricted within the forest. Furthermore, some species tend to be more visible in open habitats than in the forest.

Most of the recorded species are common to moderately common. Many of the species occur in both urban parks and gardens as well as forested areas where their host plants may be found, e.g., small branded swift (*Pelopidas mathias mathias*), painted Jezebel (*Delias hyparete metarete*) and orange awlet (*Burara harisa consobrina*).

Another notable record is the ultra snow flat (*Tagiades ultra*). It is rare and largely restricted to the CCNR (Khew, 2015), although a sighting was reported at Singapore Botanic Gardens on iNaturalist (Teo, 2017). The host plant, *Dioscorea glabra*, was not recorded within the Study Area, thus the butterfly was not considered likely to occur. Yet, it was recorded within the native-dominated secondary forest in the east of the Study Area.

Figure 7-35 The Rare Ultra Snow Flat (*Tagiades ultra*) Recorded in Maju Forest.

7.3.2.4.6 *Freshwater Decapod Crustaceans*

The desktop assessment only includes a single decapod species, the maculate freshwater crab (*Parathelphusa maculata*), as probable occurrence (Table 7-14; Appendix H1). This species is one of only a few native decapods found beyond Singapore's forest reserves (Ng 1997) and its presence at some parks (e.g., Bukit Batok Nature Park) points to a capacity for dispersal. However, given the presence of only ephemeral waterbodies at Maju Forest, it is likely this species does not have a permanent presence in the site and only appears during wetter periods. It was recorded once in the naturalised drain along the Old Jurong Railway Corridor (Figure 7-36).

Legend

- Study Area
- Old Jurong Railway Corridor

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Waterbody

- Worksites and alignment
- Terrestrial sampling route 1
- Terrestrial sampling route 2
- P. maculata

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

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LTA Endorsement :
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Consultant : AECOM

Land Transport Authority
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Project Title :
CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
LOCATION OF MACULATE FRESHWATER CRAB (PARATHELPHUSA MACULATA)

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-36	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name :		A3

Note: Source of basemap - Google Earth Map

7.3.2.4.7 *Freshwater Fish*

The desktop assessment identified nine species of probable occurrence at the Study Area (Table 7-14; Appendix H1). Species of probable occurrence consist mainly of common, native species that are tolerant of disturbance such as the whitespot (*Aplocheilus armatus*) and capable of limited locomotion overland such as the climbing perch (*Anabas testudineus*). A number of adaptable alien species from the family Poecilidae (guppies, mollies, mosquitofish) are also on the list. These species are likely escapees; commonly found in the aquarium trade and capable of subsisting in a wide range of conditions – from low oxygenated or hypersaline environments, meagre pockets of water, ditches and vegetated canals (Tan et al., 2020). This adaptability gives them an advantage in the more open waterways of Maju Forest that often become fragmented and smaller during dry periods.

Two species were recorded. The guppy (*Poecilia reticulata*) was recorded at the southern waterbody (D/S24) and an ephemeral pool of water along eastern terrestrial route. In addition, one individual of the Asian swamp-eel (*Monopterus javanensis*) was recorded downstream of the western waterbody (D/S25).

The largely ephemeral conditions of the waterbodies in Maju Forest could preclude the long-term presence of freshwater fish at these sites due to the lack of water for parts of the dry season. Over the course of our surveys, the waterbodies (D/S23-25) were observed during dry periods with disconnected small pools, which may be insufficient for long-term establishment of freshwater fishes, although fish species capable of limited overland dispersal (e.g., *Monopterus javanensis*) are likely to utilise the habitat during wetter periods.

7.3.2.4.8 *Amphibians*

A total of 16 amphibians were deemed of probable occurrence (Table 7-14; Appendix H1). The field assessment recorded eight amphibian species (Table 7-14; Appendix H1). Records along the eastern route are likely contributed by temporary willow pools of water during the monsoon season. Along the waterbodies, records were also poor, but the tadpoles of the copper-cheeked frog (*Chalcorana labialis*) were recorded along the western waterbody (D/S25). The poor records may be due to the waterbodies being partially dry, or having low water levels.

Of the eight amphibians recorded, two were non-native frogs, namely the banded bull frog (*Kaloula pulchra*) and East Asian ornate chorus frog (*Microhyla mukhlesuri*). The latter was heard once along the southern stream (D/S24).

The Study Area also provides habitats for forest-dependent species and those with restricted distribution, thus supporting these populations locally. The waterbodies are also used by amphibians for breeding. Two tadpoles of the copper-cheeked frog (*Chalcorana labialis*) were recorded along the western waterbody (D/S25). Not documented in this Study, adult individuals of the copper-cheeked frog and Malesian frog (*Limnonectes malesianus*) were previously recorded in the western and southern waterbodies from past studies by Camphora Pte Ltd (2018). These species are known to be confined to the CCNR (Baker & Lim, 2012), therefore are noteworthy. The former prefers forest streams with running water while the latter prefers mature swampy forest which are both present in the Study Area. The Malayan giant frog (*Limnonectes blythii*) was seen twice along Old Jurong Railway Corridor of the eastern route. This species is also known to require flowing forest stream (Baker & Lim, 2012). The presence of these forest-dependent species suggests the value of the site (forest and stream) in supporting these populations locally.

7.3.2.4.9 *Reptiles*

The probable species list has 31 reptilian species comprising three terrapins, 12 lizards and 16 snakes (Table 7-14; Appendix H1). The field assessment recorded ten reptiles (Table 7-14; Appendix H1).

A notable record of the dwarf reed snake (*Pseudorabdion longiceps*) was recorded once in the leaf litter in the western part of the Study Area during a night survey. This species is known to be confined to the CCNR (Baker & Lim, 2012 and is considered widespread but rare. Specimen recorded within Study Area could have travelled via the Old Jurong Railway Corridor. The green crested lizard (*Bronchocela cristatella*) was also recorded along both sampling routes. It is increasingly uncommon as it faces competition from the non-native changeable lizard (*Calotes versicolor*).

7.3.2.4.10 *Birds*

A total of 152 bird species were deemed of probable occurrence, comprising 98 resident (14 introduced), 53 migrant and one non-resident introduced species (Table 7-14; Appendix H1). The field assessment recorded 48 species, made up of 40 residents (nine introduced), one introduced non-resident and four migrant species (Table 7-14;

Appendix H1). The remaining three species were identified only to genus level. Three bird species were recorded only from camera traps – Malayan night heron (*Gorsachius melanolophus*) at CT04, flycatcher sp. (*Terpsiphone* sp.) at CT06 and laced woodpecker (*Picus vittatus*) at CT_01 to CT_03.

Species recorded are largely common to uncommon, except for the rare migrant, Malayan night heron (*Gorsachius melanolophus*). The three migratory species recorded are Arctic warbler (*Phylloscopus borealis*), grey wagtail (*Motacilla cinerea*), and Malayan night heron (*Gorsachius melanolophus*). The Arctic warblers are common visitors and frequently seen in forested sites. The grey wagtail is considered as an uncommon migrant. The Malayan night heron is rare and documented once by camera trap.

Of the 19 probable conservation significant species, seven were recorded. Records of species of conservation significance were also distributed across the Study Area with no distinct patterns (Figure 7-37). Most of these species were previously regarded as rare but have since increased in range and numbers such as the changeable hawk-eagle (*Nisaetus cirrhatus*) and the blue-crowned hanging-parrot (*Loriculus galgulus*). A nest of the changeable hawk-eagle was recorded in the middle of the site (near transect 2) indicating breeding activity.

Unlike the rest of the conservation significant species recorded, the straw-headed bulbul (*Pycnonotus zeylanicus*) is both nationally and globally threatened. It was heard several times mainly along the eastern terrestrial sampling route, including the Old Jurong Railway Corridor and western forest patch beside Clementi Park. It was recorded across several habitat types (native-dominated secondary forest, abandoned-land forest and waste woodlands). The straw-headed bulbul is threatened by the songbird trade and loss of forest habitats. Its global conservation status was recently revised from Endangered to Critically Endangered as populations experience rapid decline (BirdLife International, 2018). According to Yong et al. (2017), the estimated population size in Singapore is slightly over 200 birds, possibly making up one-third of the global population (Neo, 2016). This species experiences low poaching pressure in Singapore, and has thus shown a stable trend on the main island of Singapore and a slightly increasing trend on Pulau Ubin. However, in Singapore, habitat loss to development remains as a primary threat to the straw-headed bulbul. The nationally Critically Endangered crested goshawk (*Accipiter trivirgatus*) was also seen once flying overhead the western forest patch near Clementi Park.

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor
- Terrestrial sampling route 1
- Terrestrial sampling route 2

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Waterbody

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

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Consultant : AECOM

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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
BIRD SPECIES OF CONSERVATION SIGNIFICANCE WITHIN MAJU FOREST, INCLUDING INCIDENTAL RECORDS

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-37	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.2.4.11 *Non-volant Mammals*

A total of 15 species of non-volant mammals were deemed of probable occurrence, including the conservation significant Sunda pangolin (*Manis javanica*) and long-tailed macaque (*Macaca fascicularis*) (Table 7-14; Appendix H1). The lack of connectivity to mature forests and the absence of suitable habitat quality suggests that rarer mammalian species with stricter habitat requirements are unlikely to occur. Most species of probable occurrence are widespread, common, and tolerant of disturbance, except the Sunda pangolin. Visual surveys and camera trapping documented six species of non-volant mammals Table 7-14 ; Appendix H1). The nationally Critically Endangered Sunda pangolin (*Manis javanica*) was recorded once on camera trap (Figure 7-38). It has been recorded from the nature reserves and degraded forest fragments in Singapore (Nash et al., 2020). Notably, Singapore is potentially a stronghold for the Sunda pangolin populations and is crucial in contributing to the conservation of pangolin populations globally. Unlike other countries where it ranges, it faces low poaching pressure in Singapore (Lee et al., 2018; Nash et al., 2020). Yet, habitat loss, degradation and fragmentation, and road kills threaten the viability of Sunda pangolin population in Singapore (Lee et al., 2018).

The nationally widespread and common long-tailed macaque (*Macaca fascicularis*) was recently up-listed as a globally vulnerable species as a result of human persecution across the rest of Southeast Asia (Eudey et al., 2020). This species was only recorded on camera traps (CT_02 and CT_05). It is unclear if it is a resident troop as detections are low (Table 7-17).

Only the plantain squirrel (*Callosciurus notatus*) and rats (*Rattus* spp.) were observed visually, while the rest were only documented by camera traps as shown in the following figures. Species not recorded were largely comprised of murids, which are difficult to identify from camera trapping and visual surveys. Typically, live-trapping is used but it is invasive and labour-intensive, thus not considered in this Study. The wild pig (*Sus scrofa*) was also not recorded. This species is widespread across Singapore and able to persist in large patches of mixed secondary forest-abandoned plantation (Yong et al., 2010).

Figure 7-38 A Sunda Pangolin Recorded on Camera Trap CT_05 in Maju Forest.

The six camera traps yielded 104 independent detections and seven species of mammals (including one bat) over 378 trap-nights (Table 7-17; Table 7-18). The list of camera trap data is available in Appendix J1.

Table 7-17 Locations and Number of Independent Detections of Recorded Faunal Species from Camera Traps at Maju Forest

Faunal Group	Species	Common Name	CT Location No.	No. Of Independent Detections
Mammal	*Callosciurus notatus*	Plantain squirrel	All (01–06)	19

Faunal Group	Species	Common Name	CT Location No.	No. Of Independent Detections
Mammal	*Macaca fascicularis**	Long-tailed macaque	02, 05	2
Mammal	*Manis javanica**	Sunda pangolin	05	1
Mammal	*Paradoxurus musangus**	Common palm civet	02	1
Mammal	*Rattus* sp.	Rat	All (01–06)	49
Mammal	*Tupaia glis**	Common treeshrew	01, 02, 05, 06	31
Mammal	N.A.	Unidentified bat	06	1
Total				**104**

Note: * indicates species only recorded via camera traps.

The long-tailed macaque (*Macaca fascicularis*), common treeshrew (*Tupaia glis*), Sunda pangolin (*Manis javanica*) and common palm civet (*Paradoxurus musangus*) were only recorded from camera traps. The most commonly recorded mammalian species were the rats (*Rattus* spp.), with 49 independent detections across all camera traps. The common treeshrew (*Tupaia glis*) was also frequently recorded with 31 independent detections. On the other hand, the nationally Critically Endangered Sunda pangolin (*Manis javanica*) was detected at CT_05, with only one independent detection. Similarly, the common palm civet (*Paradoxurus musangus*) was only recorded once at CT_02. The highest mammal richness (5 species) was recorded at CT_02 situated within the abandoned-land forest in the north-western part of the Study Area (Figure 7-39). The highest mammal detection rate was also recorded at CT_02 (0.42 independent detections per trap-night).

Table 7-18 Number of Species and Detection Rate of Mammals Recorded at Each Camera Trap at Maju Forest

Station	No. Of Trap Nights	No. Of Mammalian Species Recorded	Detection Rate Of Mammals
CT_01	71	3	0.42
CT_02	62	5	0.63
CT_03	62	2	0.08
CT_04	61	1	0.02
CT_05	61	5	0.23
CT_06	61	3	0.23
Total	**378**	**7**	**N.A**

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Waterbody

- Terrestrial sampling route 1
- Terrestrial sampling route 2

Mammalian species of conservation significance

- M. javanica
- M. fascicularis

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
MAMMALIAN SPECIES OF CONSERVATION SIGNIFICANCE WITHIN MAJU FOREST

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	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.2.4.12 *Bats*

Only 11 bats were deemed of probable occurrence within the Study Area and five were recorded (Table 7-14; Appendix H1). Only the lesser dog-faced fruit bat (*Cynopterus brachyotis*) was recorded visually and the rest were recorded via acoustic sampling (Figure 7-40). While the glossy horseshoe bat (*Rhinolophus lepidus*) is not a threatened species, it is a forest-dependent species and uncommon outside of the CCNR (Pottie et al., 2005). Therefore, it is of conservation interest. It was recorded via acoustic recording (Figure 7-40) near the Old Jurong Railway Corridor, suggesting usage of the Corridor.

One species of conservation significance not recorded but considered noteworthy is the nationally Critically Endangered lesser bamboo bat (*Tylonycteris fulvida*). While not recorded in this field assessment, bamboo bats (*Tylonycteris* spp.) were found residing within bamboos located in the north-western tip of the Study Area during a survey by Camphora Pte Ltd in 2018 (Camphora Pte Ltd, unpublished data). However, as the morphometric measurements and acoustic signature of the lesser bamboo bat overlap with those of locally widespread and common greater bamboo bat (*Tylonycteris malayana*), we were unable to distinguish their identities of our records. Nevertheless, both species are known to reside in bamboo internodes and are especially susceptible to injury or mortality if their roosts are removed/damaged during developments. Therefore, the bamboo bat is regarded as a notable record in the Study Area. The black-bearded tomb bat may be found in forested or urban areas, and is considered widespread but rare (Baker & Lim, 2012).

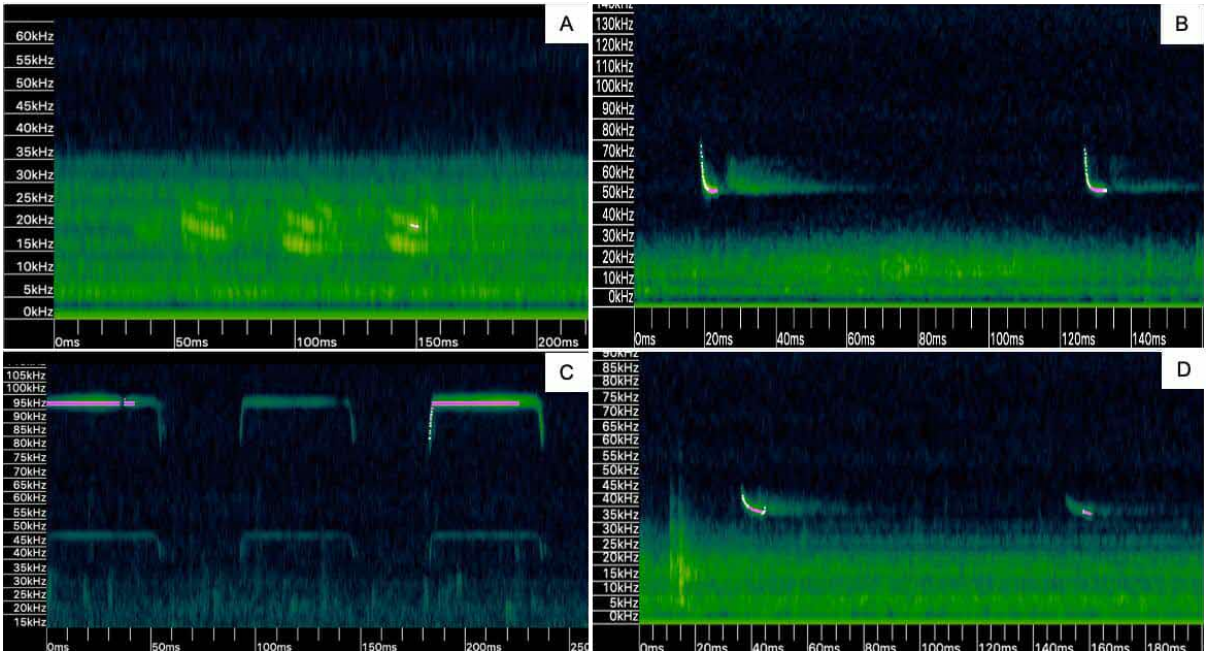


Figure 7-40 Spectrogram of Echolocations Calls from Bat Species. (A) Pouch-Bearing Bat (*Saccolaimus saccolaimus*); (B) Whiskered Myotis (*Myotis muricola*); (C) Glossy horseshoe bat (*Rhinolophus lepidus*); (D) Asiatic Lesser Yellow House Bat (*Scotophilus kuhlii*).

7.3.3 Clementi Forest

7.3.3.1 Light, Temperature and Humidity

The light levels ranged between 200.3 to >20000 lux in the day. Locations in open areas at the forest edges (LTH_02, LTH_04, LTH_502, LTH_505, LTH_1006 and LTH_1502) had higher light levels above 3000 lux. Locations within the forest had lower light levels below 650 lux. Across the day and night sessions, the humidity ranged between 80.6 to 90.6 rH and the temperature ranged between 28.5 to 32.0°C, with no observable trends within distance to forest edge. The findings are summarised in Table 7-19.

Table 7-19 Light, Temperature and Humidity Levels at Clementi Forest

	Light (lux)		Humidity (rH)		Temperature (°C)	
Sampling Point	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
LTH_01	217.3	0.0	87.2	86.7	29.7	29.8
LTH_02	>20000	0.0	82.2	86.7	31.6	28.5
LTH_03	377.0	0.8	80.6	85.1	31.0	30.5
LTH_04	9857.5	1.0	80.6	85.1	30.7	29.8
LTH_501	372.0	0.0	88.1	85.9	29.7	29.9
LTH_502	17122.5	0.0	84.7	85.7	31.2	29.4
LTH_503	1163.8	0.0	88.4	87.6	30.8	29.9
LTH_505	8212.5	0.0	81.0	86.3	30.3	29.0
LTH_1001	360.3	0.0	86.3	82.5	29.8	29.9
LTH_1002	426.8	0.0	86.0	88.8	30.4	28.9
LTH_1003	256.8	0.0	87.2	86.4	30.6	29.9
LTH_1005	646.8	0.0	87.1	84.3	29.4	29.8
LTH_1006	3260.0	0.0	86.7	90.6	29.7	29.1
LTH_1501	200.3	0.0	86.7	83.3	29.4	29.7
LTH_1502	6452.5	0.0	87.6	82.7	32.0	31.3
LTH_1503	506.8	0.0	88.5	84.8	30.8	30.0
LTH_1505	227.8	0.0	90.5	86.0	30.2	29.6
LTH_1506	372.0	0.0	89.3	89.6	30.7	29.2

7.3.3.2 Habitat and Vegetation Types

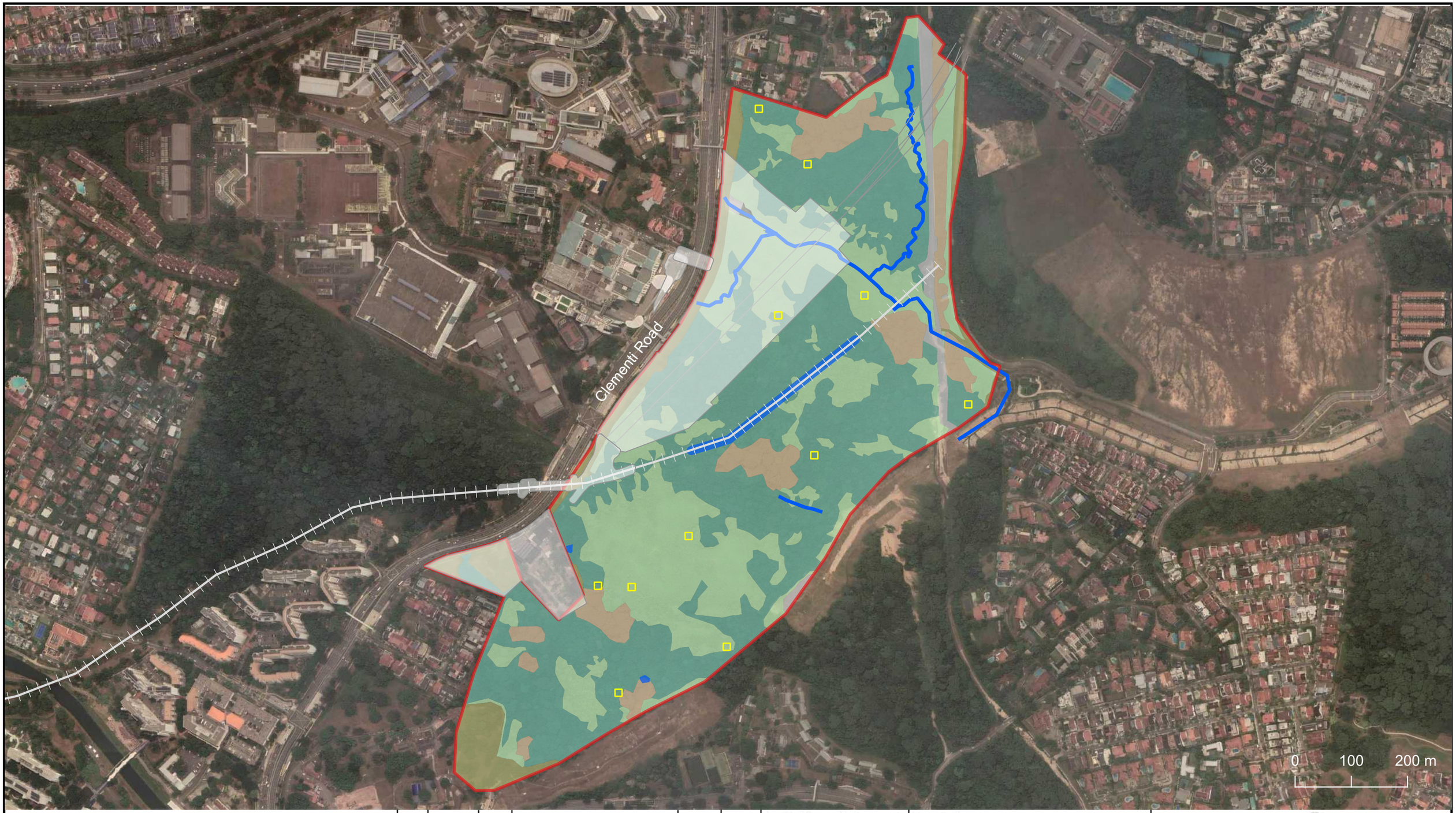
There are four vegetation types present in Clementi Forest, dominated by abandoned-land forest Area (Table 7-20; Figure 7-41). Following this is 18.5 ha (31.7%) of scrubland and herbaceous vegetation, and 4.8 ha (8.2%) of waste woodland. The Study Area also has 4.4 ha (7.5%) of managed vegetation and 1.4 ha (2.4%) of cleared area. Approximately 0.2 ha (0.3%) of space in Clementi Forest was not drawn out in the vegetation distribution map; this is the waterbody that is represented by a line on the map.

Vegetation plot data indicate that species richness is the highest in abandoned-land forest, with up to 93 species in total within a plot, followed by 38 in a scrubland and herbaceous vegetation plot, and 22 in a waste woodland plot (Table 7-20). This trend is also the same for native species richness, where plots within abandoned-land forest record the highest count (Table 7-20).

It was observed that vegetation along the Old Jurong Railway Corridor is relatively distinct, vegetated with several plants of the stream-associated species, *Alsophila latebrosa* and *Blechnum finnlaysonianum*, in the understorey. The native *Campnosperma auriculatum* trees and saplings were also found growing along the track. This stretch of vegetation was not featured as a distinct vegetation type on the map as it lies within the larger forested landscape with predominantly abandoned-land tree species in the canopy layer.

Table 7-20 Absolute (ha) and Relative (%) Sizes, Number of Vegetation Plots, and Species Richness of Each Vegetation Type in Clementi Forest

				Species Richness Per Vegetation Type		
	ha	%	Plots	Total*	Native	Exotic And Cryptogenic
Abandoned-Land Forest	29.0	49.7	6	**93**	66	27
Waste Woodland	4.8	8.2	1	**22**	20	2
Scrubland And Herbaceous Vegetation	18.5	31.7	4	**38**	23	15
Managed Vegetation	4.4	7.5	N.A.	–	–	–



Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor
- Vegetation plot

Vegetation

- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

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NA

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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
VEGETATION DISTRIBUTION AND LOCATIONS OF VEGETATION PLOTS IN CLEMENTI FOREST

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JW	JAG/NHT	JAG	7-41	-	1 of 1
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Note: Source of basemap - Google Earth Map

7.3.3.2.1 *Abandoned-land Forest*

Abandoned-land forest occupies the largest area in this Study Area. This finding corroborates with that in Neo et al. (2012) and can be explained by the previous land use at the site. Previously a rubber plantation between the 1920s and 1940s (Surveyor-General, Federated Malay States and Straits Settlements, 1924; Survey Production Centre, Southeast Asia, 1945, Neo et al. 2012) estimated that the area was abandoned during the Second World War between 1941–1945, and not re-established thereafter. Sundry cultivation of food crops and fruit trees subsequently developed as small settlements were established in low-density within the forest after the railway line was constructed.

Hence, many species found in this forest type are mainly fruit trees and crop plants cultivated in the past. Some of these plants persist through time and grow into large woody trees after the plantation area was abandoned and the forest regenerates as spontaneous vegetation took over. The crop plant species found to be occurring the most frequently in the Clementi Forest is, expectedly, rubber *Hevea brasiliensis*, and followed by the oil palm *Elaeis guineensis* (Figure 7-42A–B). Other dominant fruit tree species are rambutan *Nephelium lappaceum* and mango *Mangifera indica* (Figure 7-42C–D), amongst others. While the floristic composition is mostly comprised of exotic species, there is a number of threatened species found here. Hence, the forest is still valuable for the conservation of native flora.

Figure 7-42 Fruit Trees and Crop Plants Found in Abundance in the Abandoned-Land Forest of Clementi Forest. (A) Rubber *Hevea brasiliensis*; (B) Oil Palm *Elaeis guineensis*; (C) Rambutan *Nephelium lappaceum*; (D) Mango *Mangifera indica*.

7.3.3.2.2 *Waste Woodland*

While majority of the forested area in Clementi Forest is covered by fruit trees and crop plants that still persist from past cultivation (refer to section above), some patches are likely to have been cleared or highly disturbed, thus allowing fast-growing exotic tree species to establish themselves in the area. These trees, mostly belonging to the naturalised species, *Falcataria moluccana* and *Spathodea campanulata*, often occupy the canopy and occasionally

the emergent layers of the forest (Figure 7-43C–D). In these areas where succession has occurred, the growth of shrubs and herbs in the understorey is often suppressed (Yee et al., 2016). Some of the plants observed in the understorey are *Aphanamixis polystachya* and *Piper sarmentosum* (Figure 7-43A–B).

Figure 7-43 Waste Woodland in Clementi Forest. (A, B) Large *Spathodea campanulata* Trees (Orange Arrows) And Herbs and Shrubs Growing in the Understorey (AP – *Aphanamixis polystachya*; PS – *Piper sarmentosum*); (C, D) *Falcataria moluccana* Trees Forming the Canopy Layer.

7.3.3.2.3 *Scrubland and Herbaceous Vegetation*

Scrubland and herbaceous vegetation are characterised by short vegetation with uniform stratum and/or open canopy (Figure 7-44). In this area, a variety of herbaceous plant and woody shrub species form this habitat type, including shrubs (e.g., *Manihot esculenta*, *Dieffenbachia sanguine*, and *Dillenia suffruticosa*) and climbing and/or creeping plants (e.g., *Paederia foetida* and *Synogonium podophyllum*).

Figure 7-44 Scrubland and Herbaceous Vegetation in Clementi Forest. (A–C) Areas Covered by Herbaceous Vegetation and have a Relatively Uniform Stratum and Open Canopy; (D) Area Beneath a Scrubland Densely Covered by *Dillenia suffruticosa* Shrubs.

7.3.3.2.4 *Managed Vegetation*

Managed vegetation consists of a mix of managed lawns and park areas. Managed lawns are mainly found along the forest edge adjacent to Clementi Road (Figure 7-45), while the park areas are predominantly at two locations near the southern tip of the Study Area – one is adjacent to the Corona Florist and Nursery, while the other is at the southern-most end of the Study Area, near Ulu Pandan Road.

Figure 7-45 Managed Lawn Adjacent to Clementi Road (Red Arrow) and Along the Edge of the Forested Area in Clementi Forest

7.3.3.2.5 *Waterbodies*

Within Clementi Forest, waterbodies, ponds and swampy sections are present (Figure 7-46). The locations and alignment of the waterbodies is shown in Figure 7-8.

One major stream system (D/S1), with D/S22 flowing from the west into DS/1 and DS/2 flowing from the north, (1.38 km; Figure 7-46A), runs across the Study Area. It encompasses both forest streams characterised by higher canopy cover, lower temperatures and higher accumulations of leaf litter (D/S2), and open-country streams characterised by lower canopy cover, higher temperatures and smaller leaf litter accumulations (D/S2 and D/S22). D/S2 begins at the northern boundary of the site in forest before flowing out and heading southwest along the central grassland area of the site and draining into the culvert. The pH of D/S2 stream is approximately 6.68 to 7.05 (Section 8.5.1.2). D/S22 flows in a north-easterly direction along the western boundary through scrubland before joining D/S1. It appears to be relatively more disturbed than the main stream running in the middle of the site. The pH of D/S22 stream is approximately 7.61 (Section 8.5.1.2). While A3 is a small stretch of waterbody, that was observed to be waterlogged (Figure 7-46B).

There are two large ponds present. A 20 m by 20 m artificial pond is situated within the Corona Florist (A5; Figure 7-46E) and another smaller pond of 10 m by 10 m is located in the southern forest (A4; Figure 7-46F). The latter appears to only be filled up during wetter periods. Within the site, waterlogged sections were also observed at multiple locations, particularly along Old Jurong Railway Corridor and forest to its south. Along the Old Jurong Railway Corridor, the water level in the middle section can get up to 1.0 m deep when it is flooded during wet periods (Figure 7-46C–D). The waterlogged sections along Old Jurong Railway Corridor do not seem connected to a larger waterbody source and appears to be ephemeral, filling up only during the wet periods.

Figure 7-46 Waterbodies in Clementi Forest. (A–B) Open Country Stream Across Grassland; (C–D) Waterlogged Sections Along Old Jurong Railway Corridor that are Occasionally Flooded Along T2, (E) Large Pond in Corona Florist; (F) Large Pond in Southern Portion of Clementi Forest Along T2 Which Gets Filled Up During Wet Season.

7.3.3.3 Floristic Field Findings

7.3.3.3.1 *Overall*

A total of 303 plant species and species groups, i.e., plants that could not be identified to species with certainty, belonging to 97 families were recorded at Clementi Forest (Appendix C2). Specimens in the six species groups could not be identified with certainty, but comprised (1) *Chisocheton* cf. *patens*, (2) *Neoscortechinia* cf. *sumatrensis*, (3) *Sterculia* cf. *cordata*, (4) *Ruellia* cf. *blechnum*, (5) Burseraceae, and (6) unknown. All species groups were included in the tabulation of total species count in Table 7-21. While specimens from the three species groups could not be identified with certainty in the field, they are likely to be native threatened species.

Of the species recorded at Clementi Forest, 158 (52.1%) are native, 125 (41.3%) are exotic, and 18 (5.9%) are cryptogenic (Table 7-21).

Table 7-21 Number and Percentage of Species Belonging to Each Status Category in Clementi Forest

Origin	Status	Number of Species	Percentage
Native		**158**	**52.1**
	Common	87	28.7
	Vulnerable	34	11.2
	Endangered	12	4.0
	Critically Endangered	21	6.9
	Presumed Extinct	4	1.3
Exotic		**125**	**41.3**
	Cultivated Only	25	8.3
	Casual	38	12.5
	Naturalised	54	17.8
	Not assessed	8	2.6
Cryptogenic		**18**	**5.9**
Unidentified species		**2**	**0.7**
Total		**303**	**100.0**

7.3.3.3.2 *Plant Species of Conservation Significance*

A total of 52 plant species in Clementi Forest are considered of conservation significance (Table 7-22). Altogether, 364 specimens and/or clusters of specimens belonging to these species of conservation significance were recorded. Most specimens are concentrated along the Old Jurong Railway Corridor as well as the patch of abandoned-land forest in the northern area (Figure 7-47). Some rare and noteworthy species recorded from these two areas of concentration are discussed below. The list of species of conservation significance as well as the locations of specimens belonging to these species are in Appendix D2.

Same as in Maju Forest, many specimens and species of conservation significance were found in the abandoned-land forest patches of Clementi Forest; of the 364 individuals and clusters, 302 (83.0%) are distributed within the abandoned-land forest patches alone. While these patches constitute high concentrations of threatened species, the forest canopy layers were dominated by rubber trees (*Hevea brasiliensis*) that have persisted from past cultivation practices (Section 4.4.2). Hence, the forested patches were still classified as “abandoned-land forest.” As forest succession is an on-going process, some forests may bear features that overlap with various forest types.

A total of 33 individuals and clusters of specimens of conservation significance lie within the proposed worksites (22 in abandoned-land forest, nine in scrubland and herbaceous vegetation, and two in managed vegetation) (Table 7-23).

Table 7-22 Number of Plant Species of Conservation Significance in Clementi Forest

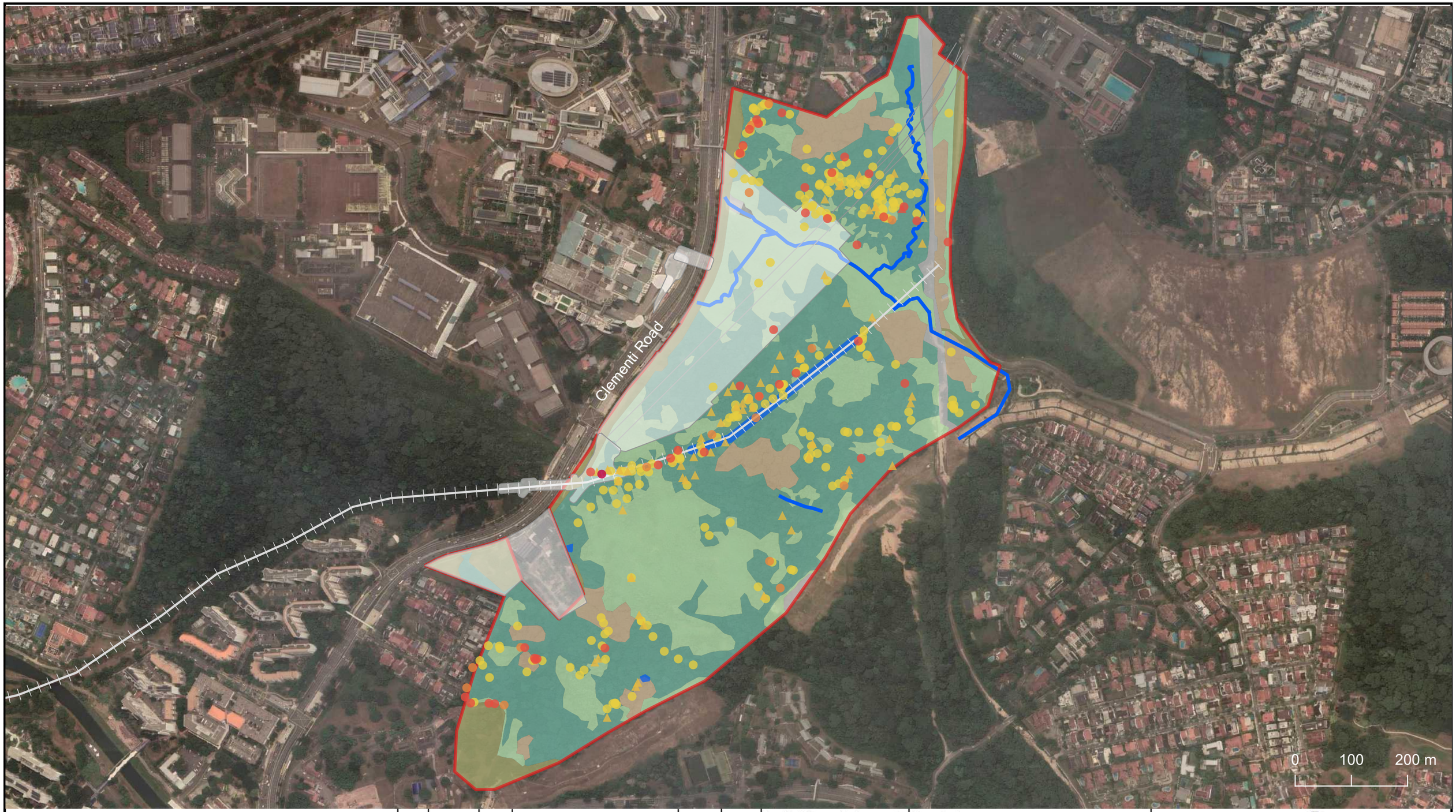
	VU	EN	CR	EX
Non-Cultivated Threatened Species	18	6	11	1
Cultivated Threatened Species	10	3	3	0
Total Number Of Species Of Conservation Significance	**28**	**9**	**14**	**1**

Note: VU – Vulnerable; EN – Endangered; CR – Critically Endangered; EX – Presumed Extinct.

Table 7-23 Number of Plant Specimens and Species of Conservation Significance in Each Vegetation Type in Clementi Forest. Numbers in Parentheses are those that Fall Within the Proposed Worksites

	Number Of Individuals And Clusters					Number Of Species				
	VU	**EN**	**CR**	**EX**	**Total**	**VU**	**EN**	**CR**	**EX**	**Total**
Abandoned-Land Forest	259 (19)	15 (0)	27 (2)	1 (0)	**302 (21)**	25 (7)	6 (0)	11 (1)	1 (1)	**43 (9)**
Waste Woodland	32	3	7	0	**42**	13	3	5	0	**21**
Scrubland And Herbaceous Vegetation	13 (7)	0 (1)	3 (1)	0 (0)	**16 (9)**	8 (4)	0 (0)	3 (1)	0 (0)	**11 (2)**
Managed Vegetation	1 (1)	0 (0)	3 (1)	0 (1)	**4 (3)**	1 (1)	0 (0)	1 (1)	0 (0)	**2 (2)**

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; EX – Presumed Extinct.



Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody

Stream-associated species
- Vulnerable
- Critically Endangered

Other plant species
- Recently Rediscovered
- Critically Endangered
- Endangered
- Vulnerable

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

Land Transport Authority
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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
DISTRIBUTION OF PLANT SPECIMENS OF CONSERVATION SIGNIFICANCE IN CLEMENTI FOREST

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-47	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

The only species that is nationally Presumed Extinct and not cultivated locally recorded at Clementi Forest is *Asplenium nitidum*. Some of the rarer nationally Critically Endangered species are *Chisocheton* cf. *patens*, *Neoscortechinia* cf. *sumatrensis*, *Dienia ophrydis*, *Ficus villosa*, *Macaranga hullettii*, *Memecylon floridum*, *Selaginella argentea*, *Sterculia* cf. *cordata*, *Sterculia parviflora*, and *Syzygium oblatum* var. *oblatum* (Figure 7-48; Appendix D2).

Figure 7-48 Nationally Critically Endangered Plant Species Recorded at Clementi Forest. (A) *Agelaea macrophylla*; (B) *Ficus villosa*; (C) *Macaranga hullettii*; (D) *Selaginella argentea*.

The *Asplenium nitidum* fern specimen was first encountered on 27th November 2019 (Figure 7-49). It was growing on the trunk of an *Elaeis guineensis* palm, near the entrance to Clementi Forest via the Old Jurong Railway Corridor and adjacent to Clementi Road. The geographic coordinates of the specimen are in Appendix D2.

The fronds were approximately 20–30 cm and there were some spores observed on the fronds below (Figure 7-49B). We did not collect any voucher specimens as no other individuals were seen growing in the vicinity. Instead, photographs were taken and used to match against identification keys and books. Characters observed in the photographs match those in Piggott (1996). A second visit was made to the same individual a month later on 27 Dec 2019, but there were no spores observed.

This species is listed as nationally Extinct in Davison et al. (2008), Chong et al. (2009), and Ho et al. (2019). Three specimens catalogued in the Singapore Herbarium date all the way back to the 19th century, where specimens were collected between 1906 and 1907. Thereafter, no voucher specimens were collected until about a century later, in 2012, where one specimen was collected from Jalan Jelutong at Pulau Ubin. A checklist of vascular plants on Pulau Ubin published by the NParks in 2014 listed this species, but there were no details about its population size in the account. This species may have been under-detected and thus thought to be nationally extinct. Its presence at Clementi Forest is evidence that the population may still be persisting on mainland Singapore. More studies on this species is needed to assess and determine its national conservation status as well as to put in place measures to conserve it as part of our natural heritage.

Figure 7-49 A Specimen of *Asplenium nitidum*—A Fern that is Nationally Presumed Extinct—Encountered Along the Old Jurong Railway Corridor in Clementi Forest. (A) It Was Growing on the Trunk of an *Elaeis guineensis* Palm; (B) Close-Up of the Frond Below with Some Spores (Red Arrows).

Another species of note is the rare terrestrial orchid species, *Dienia ophrydis*, thought to be extinct in Singapore. Prior to its rediscovery at Clementi Forest in January 2011, specimens of this species were last collected in the 19th century (Hassan Ibrahim et al., 2011). During floristic surveys in this present Study, two individuals growing in the relatively shaded forest understorey along the Old Jurong Railway Corridor were encountered (Figure 7-50). Steep vegetated slopes flank both sides of the railway track, along which some sections were waterlogged and/or inundated during the monsoon season in December 2019.

According to Hassan Ibrahim et al. (2011), a population of less than 50 mature individuals were encountered "in a valley, beside a clear-water stream in humid conditions with bright but indirect sunlight amidst a wooded area that is abounded with introduced plants like rubber trees and oil palms." Descriptions of the location coincide with that where the two individuals were recorded in the present Study.

Individuals of this species were encountered again by Neo et al. in 2012, but there was no mention of how many and where they were seen. Considering that the orchids are still present almost a decade after it was first rediscovered, it is likely that the population of this self-pollinating orchid species is persisting. Ex-situ efforts to propagate and conserve this species are on-going (Hassan Ibrahim et al., 2011). In addition, the actual size of the population is not yet known, though it was estimated to be less than 50 mature individuals (Hassan Ibrahim et al., 2011). There could be more or less individuals growing in the area. More detailed studies of the population are required to inform measures to conserve this species in-situ.

Figure 7-50 Two specimens of *Dienia ophrydis*—A Terrestrial Orchid Species that was Thought to be Nationally Extinct but was Rediscovered in Recent Years—Encountered on 27th December 2019 Along the Old Jurong Railway Corridor in Clementi Forest. Both Individuals were About 0.15 m in Height.

One specimen determined as *Neoscortechinia* cf. *sumatrensis* measuring < 0.05 m in girth and 1.5 m in height was encountered. Based on vegetative characters seen on photographs of this specimen, the serrated leaf margins, leaf blade shape, leaf venation pattern, and double kneed petioles match that of *Neoscortechinia sumatrensis* (Figure 7-51). One of the key characters, though, i.e., two glands at the base of the leaf blade, could not be observed in the photographs. Hence, the species identity could not be confirmed with certainty.

This species is rare and nationally Critically Endangered (Ang et al., 2010). It is known to inhabit predominantly freshwater swamp and peat swamp forests, though it can also grow in lowland, dryland primary and secondary forests up to 250 m altitude (Corner, 1978). Dried specimens deposited in the SING were mostly from or near the Nee Soon Swamp Forest; the few specimens collected outside the Nee Soong Swamp Forest were from Seletar Reservoir and Old Upper Thomson Road. No specimens of this species had been collected from Clementi Forest and this species was also not recorded in the checklist of vascular plants by Neo et al. (2012).

The specimen at Clementi Forest was found near a stream waterbody in the northern part of the Study Area (Figure 7-54). While the species identity is not certain, its vegetative characters and location indicate a possibility that this could have been previously overlooked and is the first record at Clementi Forest.

Figure 7-51 A Specimen of *Neoscortechinia* cf. *sumatrensis*.

In addition, it was observed that the slopes which flank both sides of the Old Jurong Railway Corridor are populated with numerous individuals of the stream-associated species, *Alsophila latebrosa* and *Blechnum finnlaysosianum*, in both Maju Forest and Clementi Forest (Figure 7-52; Figure 7-53; Figure 7-54). Both species are nationally Vulnerable and are considered of conservation significance in this Study. Several *Campnosperma auriculatum* trees and saplings were also found growing along the railway track, predominantly within Clementi Forest. While it is a common native tree species, *Campnosperma* is one of the genera usually found in later-stage native-

dominated secondary forests (Yee et al., 2016). Floristically, the stretch of vegetation along the railway is relatively distinct from the larger forested landscape of largely abandoned-land forest, albeit a small patch.

Sterculia parviflora is nationally Critically Endangered in the wild, but is known to be cultivated locally in some nurseries. Propagules found in many secondary forests in Singapore could have spread from cultivation. In this Study, a cluster of specimens, including one of 0.8 m girth, was encountered near the southern tip of the Study Area (Appendix D2). Considering the size of the specimen, there is a likelihood that it is a young parent tree belonging to the local native stock. Hence, a more conservation approach was adopted and this species was considered of conservation significance in Clementi Forest (Appendix D2).

Figure 7-52 Two Stream-Associated Plant Species with Several Individuals Found Growing Along the Old Jurong Railway Corridor in Clementi Forest. (A) The Frond Underside of *Alsophila latebrosa*; (B) The Frond Upperside of *Blechnum finnlaysonianum*.

Figure 7-53 Specimens of Alsophila latebrosa Growing on the Steep Slopes that Flank Both Sides of the Old Jurong Railway Corridor, which can be Seen in the Background (A) When it was Dry And (B) When it was Inundated. Note that Both Photographs were Taken at Different Sections Along the Railway.

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody

Stream-associated species

- Neoscortechinia cf. sumatrensis (CR)
- Alsophila latebrosa (VU)
- Blechnum finlaysonianum (VU)

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

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Project Title :
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(CLEMENTI FOREST AND
MAJU FOREST)**

Figure Title :
DISTRIBUTION OF PLANT SPECIMENS OF NATIONALLY THREATENED STREAM-ASSOCIATED SPECIES IN MAJU FOREST AND CLEMENTI FOREST

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-54	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.3.3.3 *Large Plant Specimens*

At Clementi Forest, 81 large plant specimens were recorded – 27 trees (3.0–5.6 m girth), 22 stranglers (3–20 m spread), and 32 bamboo clusters (3–20 m spread) (Table 7-24; Figure 7-55; Figure 7-56; Appendix E2). The 27 large trees belong to eight species and eight families.

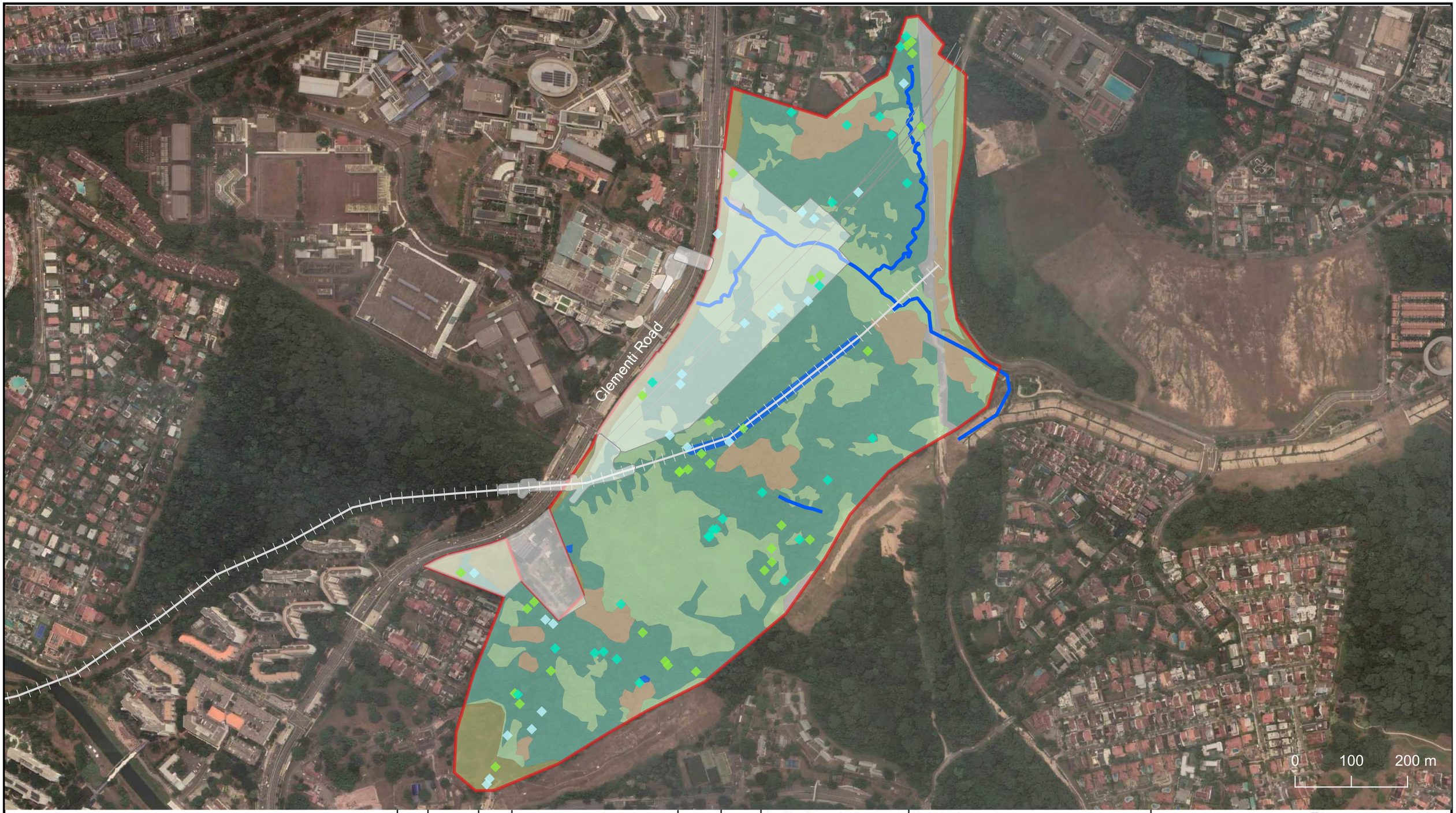
Table 7-24 Number of Large Plant Specimens in Clementi Forest

Habit	Species	No. of Specimens
Tree	*Alstonia angustiloba*	7
	Cyrtophyllum fragrans	1
	Durio zibethinus	2
	Ficus variegata	3
	Hevea brasiliensis	2
	Pterocarpus indicus	5
	Syzygium grande	3
	Terminalia catappa	4
Strangler	*Ficus benjamina*	6
	Ficus elastica	5
	Ficus microcarpa	11
Shrub (Bamboo)	*Bambusa heterostachya*	5
	Bambusa vulgaris	26
	Thyrsostachys siamensis	1
Total		**81**

Figure 7-55 Large Plant Specimens in Clementi Forest. (A) Strangling Fig, *Ficus elastica*; (B) Strangling Fig *Ficus microcarpa*; (C, D) Large Tree *Alstonia angustiloba*; (E) Large Bamboo Cluster *Bambusa vulgaris*; (F) Close-Up of a Fallen Sheath from the Bamboo Cluster.

Eighteen large plant specimens lie within the proposed worksites and alignment at Clementi Forest (Figure 7-56). Of these, 11 are stranglers – five *Ficus microcarpa* (3–20 m spread), four *Ficus benjamina* (4–5 m spread), and two *Ficus elastica* (3–5 m spread); two are large trees – *Syzygium grande* (3.2 m girth) and *Pterocarpus indicus* (4.6 m girth); and five are bamboo *Bambusa vulgaris* clusters (3–8 m spread).

Faunistic surveys near the bamboo clusters that lie within the proposed worksites and alignment were carried out to determine if there are bamboo bats residing within the clusters.



Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody

Large plant specimens
- Tree
- Strangler
- Bamboo

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement : NA

LTA Endorsement : NA

Consultant : AECOM

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Project Title : **CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)**

Figure Title : **DISTRIBUTION OF LARGE PLANT SPECIMENS IN CLEMENTI FOREST**

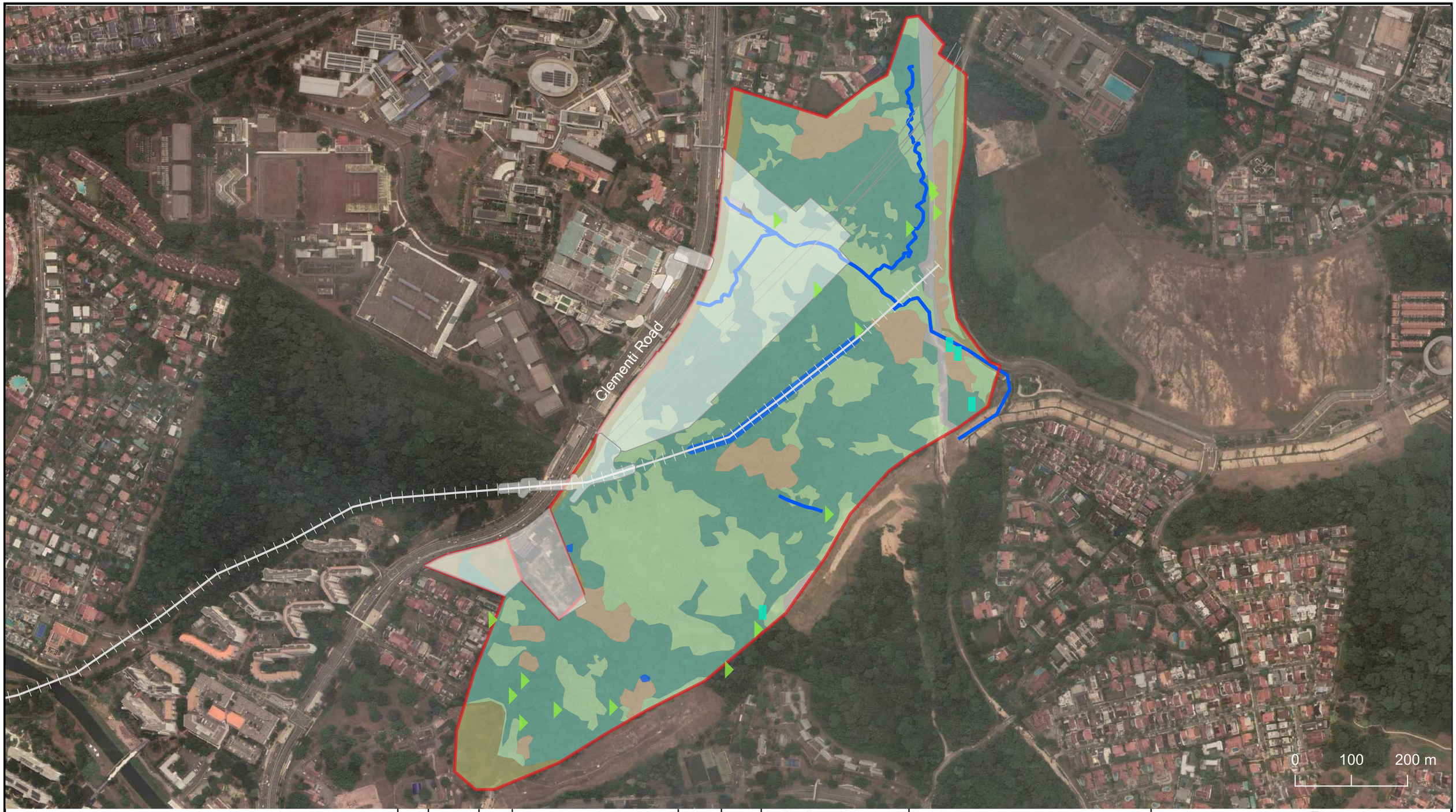
Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-56	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.3.3.4 *Other Plant Specimens of Value*

Nineteen other plant specimens of value were recorded at Clementi Forest, four of which are trees with nests and 15 are bamboo clusters (Figure 7-57; Figure 7-58; Appendix F2). It is not known whether the nests are actively used, but they could potentially be raptor nests. Even though the bamboo specimens do not meet the minimum size requirement to qualify as 'large plant specimens' defined in this study, they may still be important sources of food and shelter for fauna communities. Of the 19 specimens, two small bamboo clusters of < 3 m spread fall within the proposed worksites in Clementi Forest (Figure 7-58).

Figure 7-57 Trees with Nests in Clementi Forest. (A, D) *Falcataria moluccana*; (B) *Vitex pinnata*; (C) *Spathodea campanulata*



Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation

- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody

Other specimens of value

- Bamboo
- Nest

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement : NA

LTA Endorsement : NA

Consultant : AECOM

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Project Title : **CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)**

Figure Title : **DISTRIBUTION OF OTHER PLANT SPECIMENS OF VALUE IN CLEMENTI FOREST**

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-58	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.3.3.5 *Arboricultural Survey Findings*

In Clementi Forest, there were 1500 specimens belonging to 58 species and two species groups tagged during arboricultural surveys. One specimen could not be identified and was indicated as "Unknown" (Appendix G2). Another specimen was identified as *Chisocheton* cf. *patens* based on vegetative characters of a leafy specimen collected during surveys. Altogether, the species belong to 27 families.

In descending order, *Hevea brasiliensis*, *Elaeis guineensis*, *Falcataria moluccana*, and *Spathodea campanulata* trees make up majority (> 50%) of all the specimens assessed during arboricultural surveys (Appendix G2). Eighty-two specimens belong to seven species of conservation significance, namely, *Alsophila latebrosa*, *Calophyllum tetrapterum*, *Chisocheton* cf. *patens*, *Litsea firma*, *Oncosperma tigilaria*, and *Symplocos fasciculata*. Majority (81.7%) of these specimens were *Alsophila latebrosa* tree ferns that had a median girth range of 0.3–0.5 m.

Note that there were more specimens assessed than tagged as some specimens occur in clusters, i.e., within 1–2 m of each other. All the specimens within clusters were assessed, but only one specimen was tagged (Section 7.2.4.4).

7.3.3.3.6 *Forest Regeneration*

The ten most abundant species for trees found in the vegetation plots in two broad girth-size classes—≥ 0.5 m girth and < 0.5 m girth—are listed in descending order in Table 7-25. The girth-size classes were further divided and the trends in diameter frequency distribution are shown in Figure 7-59 and Figure 7-60.

More than half of the trees in the larger size class (≥ 0.5 m girth) belong to the species *Hevea brasiliensis*, a naturalised exotic species that was heavily cultivated locally in the past. This reflects the site's past land use as a rubber plantation. Not only are trees of this species large in size and established in the vegetation plots, they also exhibit high seedling recruitment potential, being the most abundant species in the smaller size class (< 0.5 m girth) (Figure 7-60; Figure 7-61); the presence of both large mature trees, which are seed sources, and high understory seedling counts is indicative of this species' ability to successfully recruit in the forest. Naturalised species form "self-replacing, usually sexually-reproducing populations" (Chong et al., 2009). Hence, the population of this species is likely to continue persisting in the forest if it is left undisturbed without human intervention.

There are very few trees individuals recorded for the remaining nine species in the larger size class (≥ 0.5 m girth), where the maximum stem count for each species is fewer than five. Amongst them, four species are considered crop plants. *Elaeis guineensis*, commonly known as oil palm, is a crop plant species while *Spathodea campanulata* was cultivated in the past as an ornamental plant. *Nephelium lappaceum*, commonly known as rambutan, is listed as nationally Critically Endangered (Chong et al., 2009), but it is likely to have persisted from past cultivation and *Artocarpus heterophyllus*, commonly known as jackfruit, is likely to have persisted from past cultivation as well. The remaining five species consist of a mix of exotic tree species (*Falcataria moluccana* and *Adenanthera pavonina*) and native species (*Ficus variegata, Cinnamomum iners* and *Aphanamixis polystachya*) (Figure 7-59).

There are numerous seedings and saplings found in the lower forest strata. All ten most abundant species of < 0.5 m girth generally exhibit a typical reverse-J distribution pattern (Figure 7-61), indicating that there is a high recruitment of small trees. Four out of the ten abundant species are crop plants that are likely to have persisted from past cultivation (*Hevea brasiliensis, Lansium domesticum, Dimocarpus longan* ssp. *malesianus* and *Nephelium lappaceum*). It is interesting to note that the remaining six out of ten most abundant species are native, of which *Aphanamixis polystachya* is listed as nationally Endangered while *Ficus aurata* var. *aurata* is listed as nationally Vulnerable. While most *Aphanamixis polystachya* seedlings are likely escapees from cultivation and not of the native genetic stock, having native species in the forests is still preferred to have their exotic counterparts.

The high saturation of seedlings belonging to both native and exotic tree species occupying the same forest strata is indicative that there could be inter- and intra-specific competition for space, nutrients, light, and other resources. Should the native seedling species successfully outcompete the exotic seedling species when there are forest canopy openings, e.g., from natural tree falls, the forest may slowly recover into a native secondary forest over a long period of time if left undisturbed. However, if the exotic seedlings persist, seedling competition between the exotic and native species is likely to continue. Native species those are unable to outcompete the exotic counterparts would eventually be shaded out. In such scenarios, the forest would continue to be dominated by exotic species.

However, it should be noted that these conclusions are drawn based on the assumption that the data gathered from the vegetation plots is representative of the entire site.

Table 7-25 The Ten Most Abundant Tree Species in Clementi Forest, Listed in Descending Order

S/N	Trees Of ≥ 0.5 m Girth	Trees Of < 0.5 m Girth
1.	*Hevea brasiliensis*	*Hevea brasiliensis*
2.	*Elaeis guineensis*	*Cinnamomum iners*
3.	*Falcataria moluccana*	*Lansium domesticum*
4.	*Ficus variegata*	*Dimocarpus longan* ssp. *malesianus*
5.	*Spathodea campanulata*	*Nephelium lappaceum*
6.	*Cinnamomum iners*	*Arthrophyllum diversifolium*
7.	*Nephelium lappaceum*	*Aphanamixis polystachya*
8.	*Adenanthera pavonina*	*Syzygium grande*
9.	*Aphanamixis polystachya*	*Ficus aurata* var. *aurata*

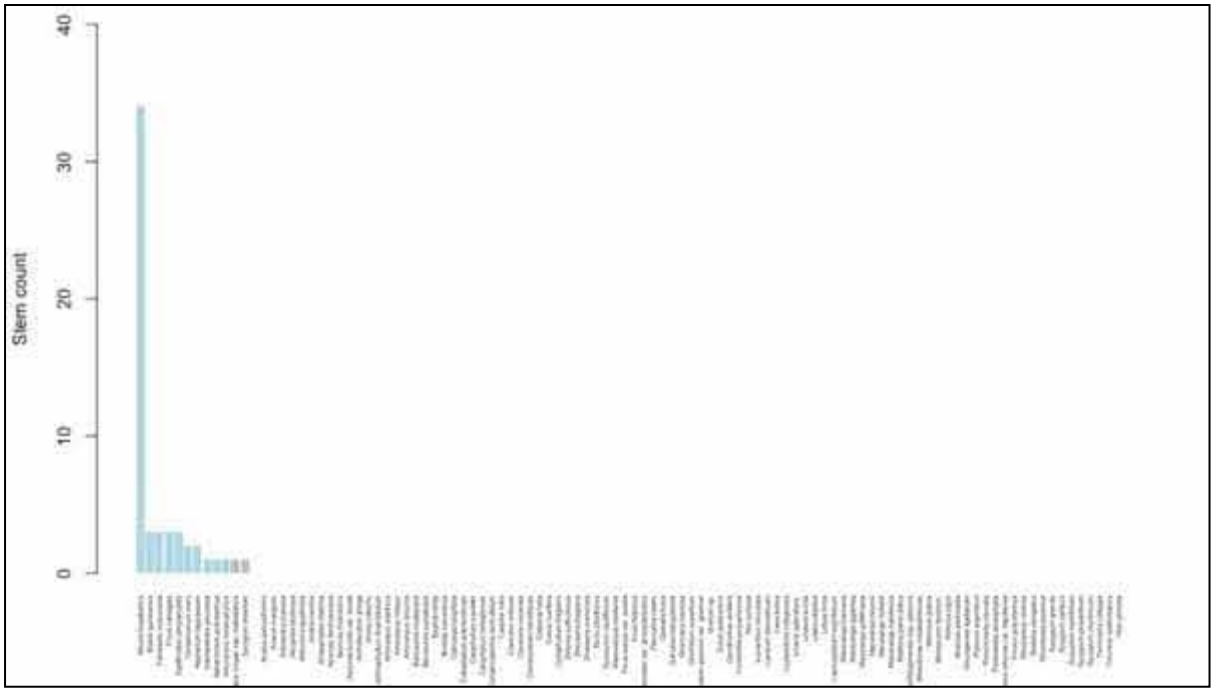


Figure 7-59 Number of Stems (55 In Total) With ⩾ 0.5 m Girth for all Species Across Vegetation Plots in Clementi Forest. Bars in Light Blue Belong to the Ten Most Abundant Species.

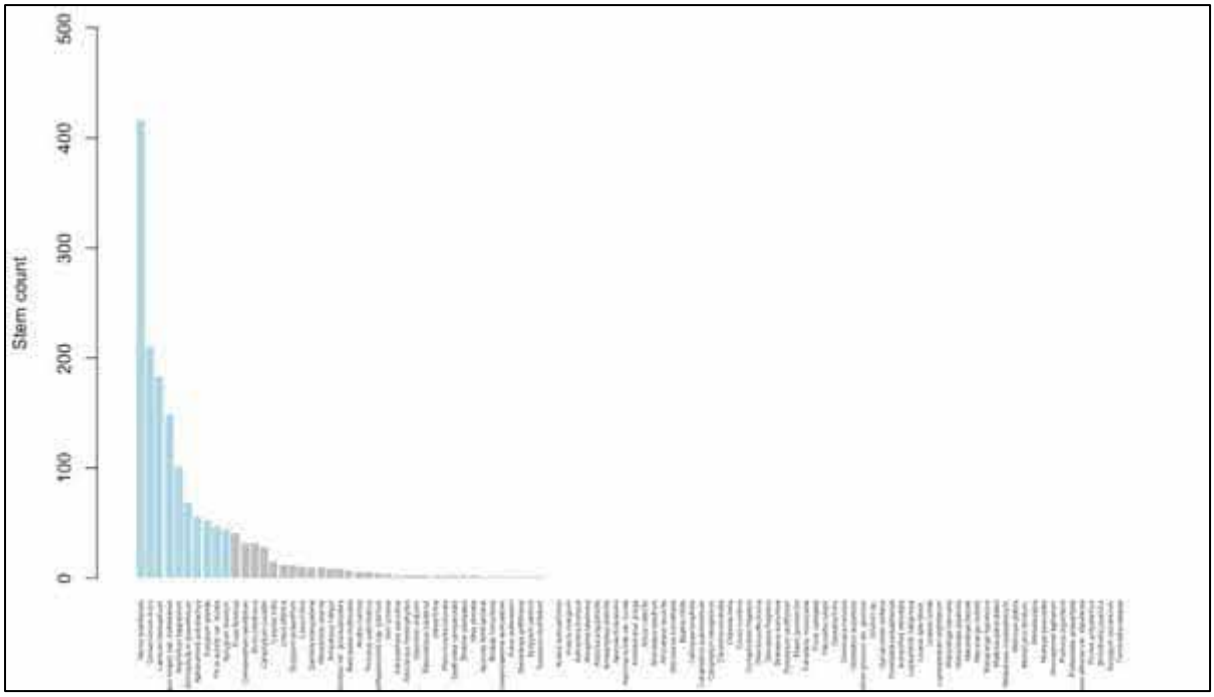


Figure 7-60 Number of Stems (1594 In Total) with < 0.5 m Girth for all Species Across Vegetation Plots in Clementi Forest. Bars in Light Blue Belong to the Ten Most Abundant Species

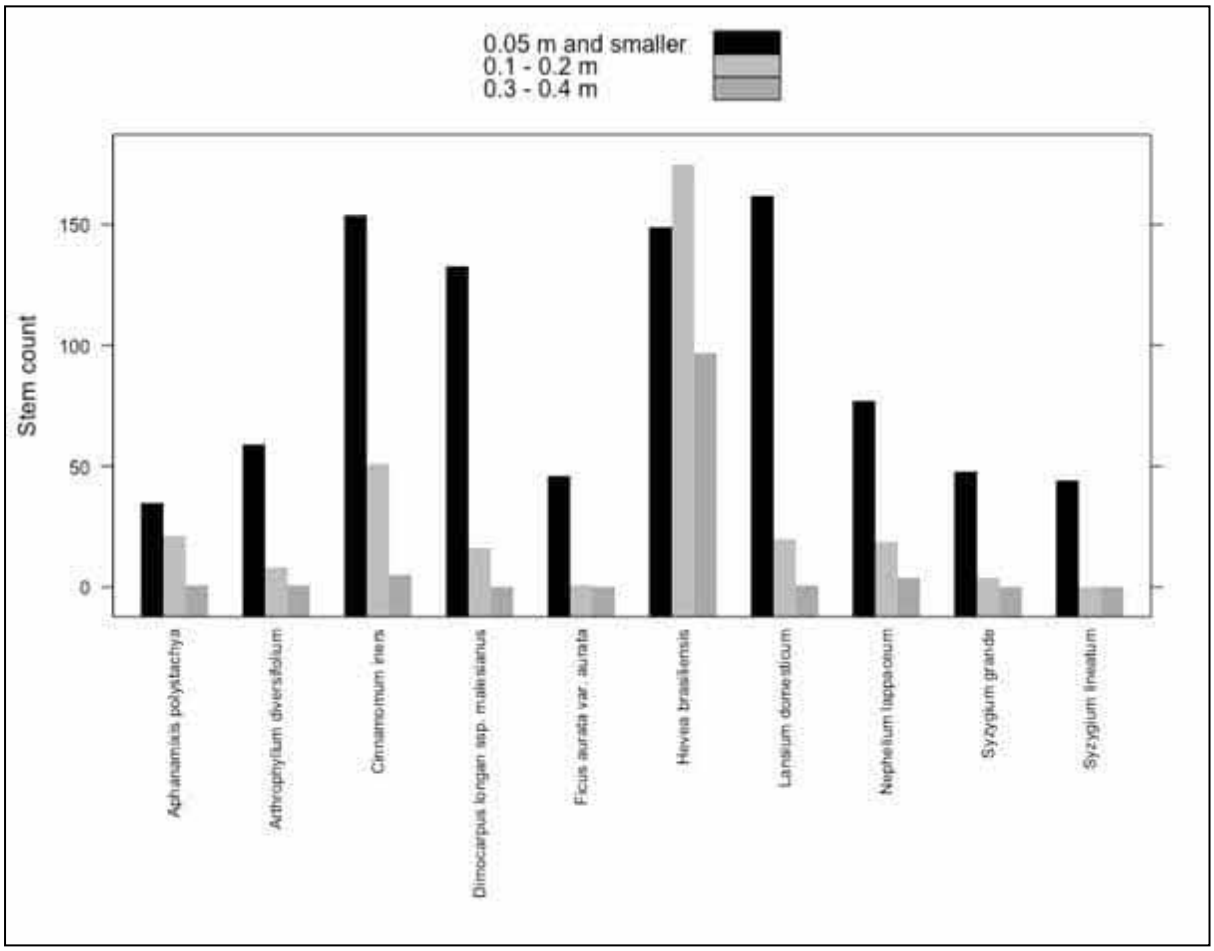


Figure 7-61 Girth-Size Distribution of the Ten Most Abundant Tree Species with < 0.5 m Girth in Clementi Forest

7.3.3.4 Faunistic Field Findings

7.3.3.4.1 *Overall*

The desktop assessment identified 560 species of probable occurrence at Clementi Forest, including 49 species of conservation significance.

The field assessment documented 210 species, which was dominated by bird (75) and butterfly (49) species. Amongst these, 18 species of conservation significance were also recorded, including two species of non-probable occurrence (Table 7-27). The findings for each faunal group are described in the following sections. The list of probable and recorded species is available in Appendix H2, and summarised in Table 7-26. The list of faunal species of conservation significance and their conservation statuses is available in Table 7-27. The faunal survey and camera trap data are provided in Appendix I2 and Appendix J2 respectively.

Table 7-26 Summary of Probable and Recorded Faunal Species at Clementi Forest

Faunal Group	Total No. of Probable Species		Total No. of Recorded Species	
	All Species	CS Species	All Species	CS Species
Aculeate Hymenopterans	81	1	18	1
Bees	41	1	8	1
Stinging Wasps	40	0	10	0
Odonates	52	2	25	2
Dragonflies	41	1	18	1
Damselflies	11	1	7	1
Butterflies	175	16	49	2
Freshwater Decapod Crustaceans	2	0	0	0
Freshwater Fish	14	0	8	0
Herpetofauna	48	2	25	1
Amphibians	16	0	11	0
Reptiles	32	2	14	1
Birds	161	20	75	10
Mammals	27	6	10	2
Non-Volant Mammals	16	3	5	1
Bats	11	3	5	1
Total	**560**	**47**	**210**	**18**

Note: 'CS species' refers to species of conservation significance.

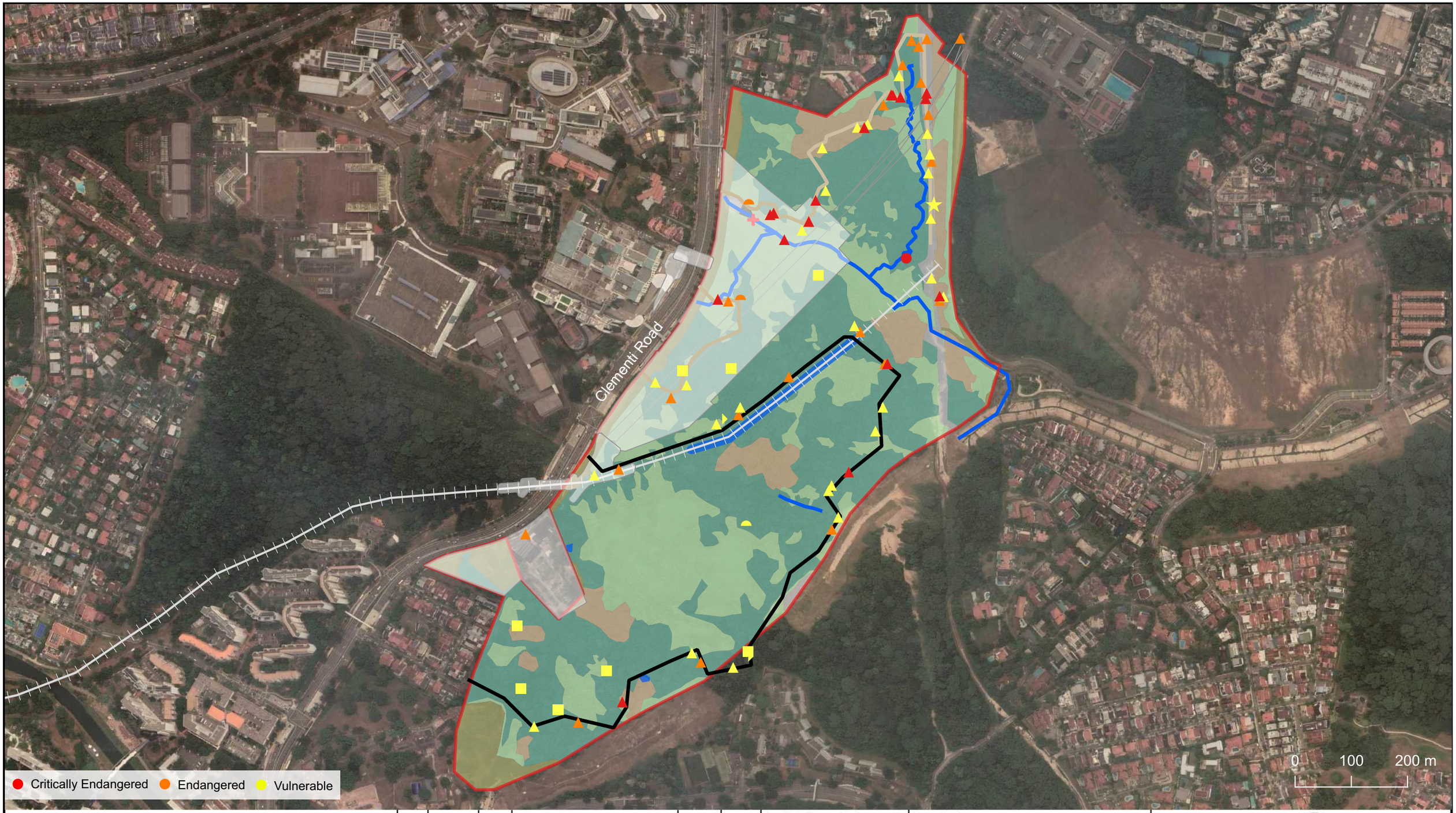
Table 7-27 List of Faunal Species of Conservation Significance Recorded in Clementi Forest

Faunal Group	Species	Common Name	Local Status	Global Status
Aculeate Hymenopteran	*Lipotriches takauensis*	N.A.	Vulnerable	Not Assessed
Odonate	*Gynacantha bayadera*	Small duskhawker	Vulnerable	Least Concern
Odonate	*Copera vittata*	Variable featherlegs	Vulnerable	Least Concern
Butterfly	*Borbo cinnara*	Formosan swift	Endangered	Not Assessed
Butterfly	*Troides helena cerberus*	Common birdwing	Vulnerable	Not Assessed; CITES protected (Appendix II)
Reptile	*Dogania subplana*	Malayan softshell turtle	Critically Endangered	Least Concern; CITES protected (Appendix II)

Faunal Group	Species	Common Name	Local Status	Global Status
Bird	*Nisaetus cirrhatus*	Changeable hawk-eagle	Endangered	Least Concern; CITES protected (Appendix II)
Bird	*Spilornis cheela*	Crested serpent eagle	Critically Endangered	Least Concern; CITES protected (Appendix II)
Bird	*Anthracoceros albirostris*	Oriental pied hornbill	Critically Endangered	Least Concern; CITES protected (Appendix II)
Bird	*Vanellus indicus*	Red-wattled lapwing	Endangered	Least Concern
Bird	*Chrysococcyx xanthorhynchus*	Violet cuckoo	Endangered	Least Concern
Bird	*Gallus*	Red junglefowl	Endangered	Least Concern
Bird	*Loriculus galgulus*	Blue-crowned hanging-parrot	Endangered	Least Concern; CITES protected (Appendix II)
Bird	*Psittacula longicauda*	Long-tailed parakeet	Not Assessed	Vulnerable; CITES protected (Appendix II)
Bird	*Pycnonotus zeylanicus*	Straw-headed bulbul	Endangered	Critically Endangered; CITES protected (Appendix II)
Bird	*Rallina fasciata*	Red-legged crake	Vulnerable	Least Concern
Non-Volant Mammal	*Macaca fasciuclaris*	Long-tailed macaque	Least Concern	Vulnerable; CITES protected (Appendix II)
Bat	*Tylonycteris* sp.	Bamboo bat	Vulnerable	Least Concern

Both the forested areas and waterbodies provide habitats to species of conservation significance which were distributed across the Study Area (Figure 7-62). Similar as Maju Forest, the Study Area contributes to the conservation of two globally threatened species, the straw-headed bulbul (*Pycnonotus zeylanicus*) and Sunda pangolin (*Manis javanica*).

Within the proposed worksite area, most recorded species were common and widespread. However, several species recorded are uncommon to moderately rare, or with restricted distribution such as the Malesian frog (*Limnonectes malesianus*). Notably, a stream system lies within the worksite area. Such natural stream habitats are uncommon in Singapore and have value in supporting aquatic fauna.



Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody

- Terrestrial sampling route 1
- Terrestrial sampling route 2

Faunal species of conservation significance
- ★ Aculeate hymenopteran
- ◗ Odonate
- ◓ Butterfly
- \+ Fish
- ● Reptile
- ▲ Bird
- ■ Non-volant mammal and bat

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
LOCATIONS OF FAUNAL SPECIES OF CONSERVATION SIGNIFICANCE FROM SURVEYS AND CAMERA TRAPPING CONDUCTED AT CLEMENTI FOREST

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-62	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.3.4.2 *Sampling Coverage*

The sample coverage for each faunal group along terrestrial sampling routes and aquatic sampling points were all above 80%, except for aculeate hymenopterans at only 37.4%. Sample coverage was not calculated for faunal groups with less than two species were recorded. Camera trapping also attained a coverage of 100%. With doubled sampling effort, a marginal increase in richness is expected for most groups, but more than 10 species may be detected for aculeate hymenopterans, odonates, butterflies and birds. A summary is provided in Table 7-28.

Table 7-28 Result Summary of Taxon Sampling Analysis for Clementi Forest

Faunal Group	Sample Coverage (%)	Observed Richness	Estimated Richness (± Standard Error)	95% Confidence Interval for Estimated Richness	Estimated Coverage with Doubled Effort (%)	Estimated Richness (And Additional Species) with Doubled Effort
Terrestrial Sampling Routes						
Aculeate Hymenopteran	37.4	15	50 ± 32.5	22.5–179.1	55.5	25 (+10)
Odonate	90.3	18	23.8 ± 6.3	19.0–50.7	97.1	22 (+4)
Butterfly	84.6	39	59.1 ± 13.1	45.2–103.6	93.7	50 (+11)
Amphibian	96.9	8	8 ± 2.2	8.1–21.5	99.6	8 (+0)
Reptile	85.8	9	11 ± 3.4	9.4–27.4	96.9	11 (+2)
Bird	93.4	58	83 ± 15.7	66.1–135.5	96.9	71 (+13)
Non-Volant Mammal	N.A.	2	N.A.	N.A.	N.A.	N.A.
Bat	N.A.	2	N.A.	N.A.	N.A.	N.A.
Aquatic Sampling Points						
Odonate	84.1	13	24 ± 15.3	14.5–96.7	89.8	16 (+3)
Freshwater Fish	82.2	4	5 ± 3.4	4.2–23.9	93.8	5 (+1)
Amphibian	83.9	7	9 ± 3.1	7.2–24.2	96.0	8 (+1)
Reptile	N.A.	0	N.A.	N.A.	N.A.	N.A.
Camera Trapping						
Non-Volant Mammal	100.0	5	5 ± 0.5	5.0–6.5	N.A.	N.A.

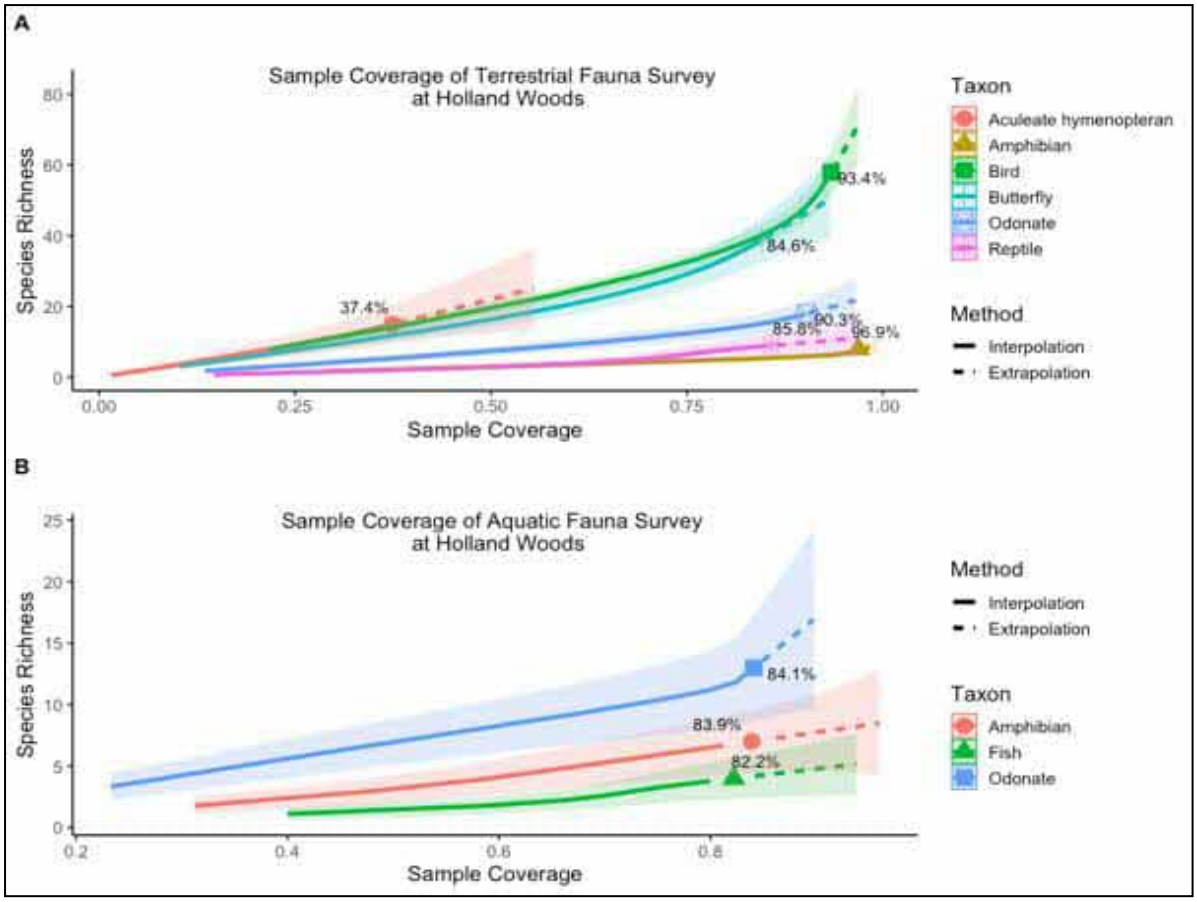


Figure 7-63 Taxon Sampling Curves for Respective Faunal Groups Along (A) Terrestrial Sampling Routes And (B) Aquatic Sampling Points at Clementi Forest

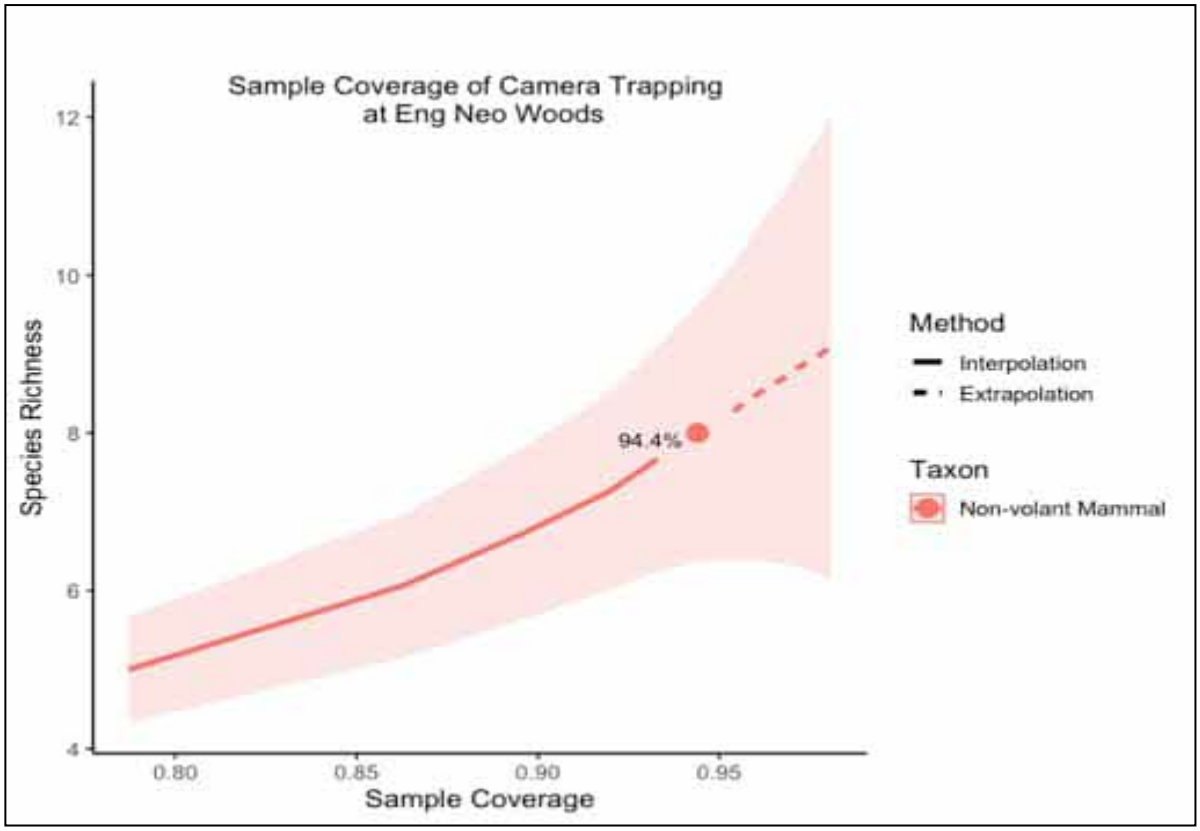


Figure 7-64 Taxon Sampling Curve for Camera Trapping at Clementi Forest.

7.3.3.4.3 *Aculeate Hymenopterans*

A total of 18 species of aculeate hymenopterans were recorded, from five families – Apidae (4 species), Crabronidae (1 species), Halictidae (3 species), Megachilidae (1 species) and Vespidae (9 species) (Table 7-26; Appendix H2).

While the majority of these were common native species, the halictid bee *Lipotriches takauensis* is considered nationally Vulnerable by Ascher et al. (in prep), thus far known from less than five sites, consisting largely of forest or forest fragments. It was recorded once along the Rail Corridor. An individual of the lesser paper wasp (*Parapolybia varia*) was also observed. It is an uncommon species that is usually found in places with at least some mature scrub forest, mangrove or secondary forest.

Records of aculeate hymenopterans were present in open areas with flowering grasses and shrubs which may be attractive for these species. Most species were observed in low numbers with up to three individuals. The more frequently recorded species were the Eastern honeybee (*Apis cerana*), carpenter bee (*Xylocopa latipes*) and the halictid bee (*Lipotriches ceratina*), where three individuals were recorded for each species. An individual of the leafcutter bee (*Megachile conjuncta*) was observed feeding on the nectar of *Mimosa pudica*. The giant honeybee (*Apis dorsata*) and paper wasp (*Ropalidia sumatrae*) were incidental records.

7.3.3.4.4 *Odonates*

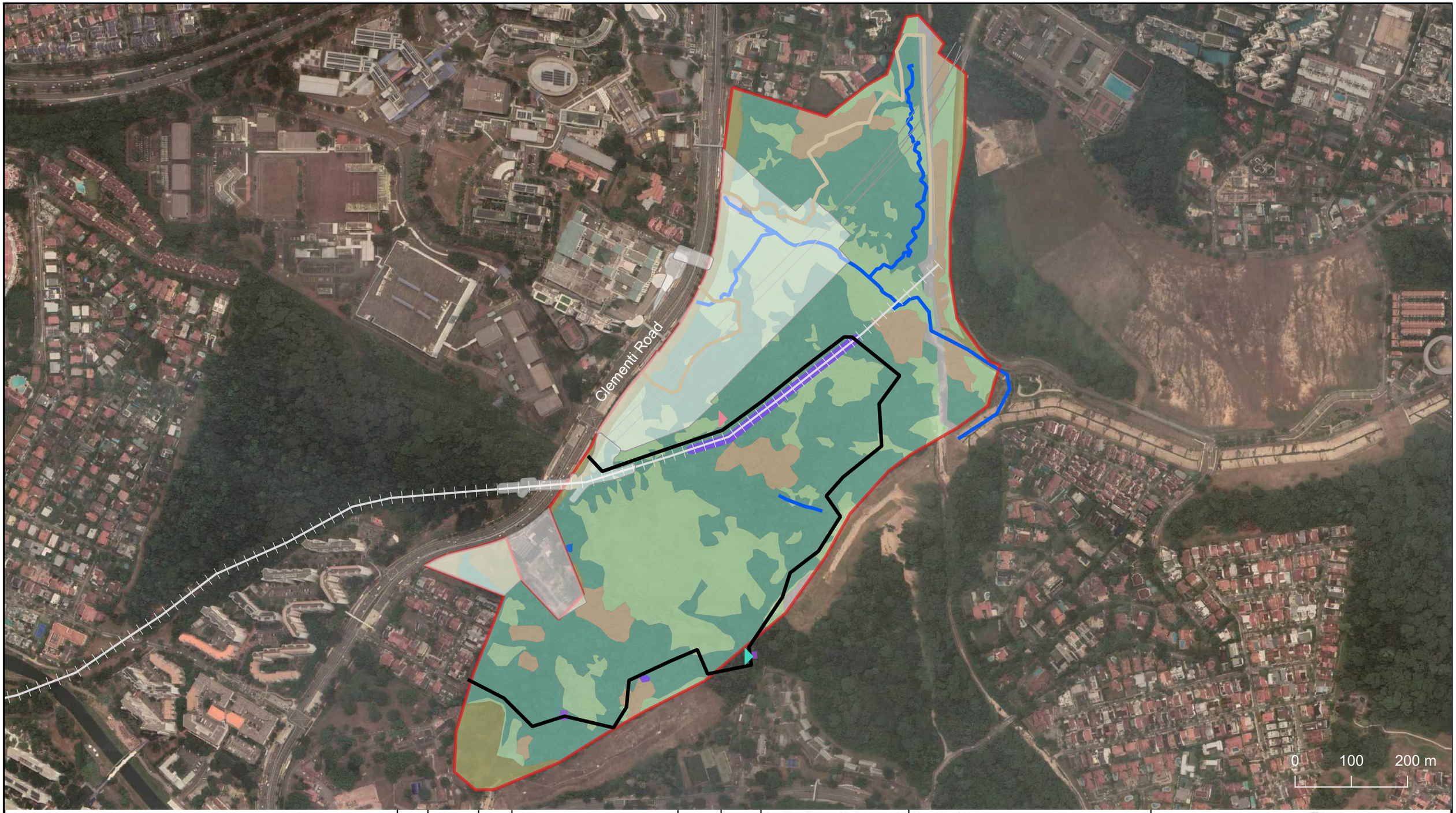
A total of 52 species (41.9% of nationally extant species) were deemed of probable occurrence and two are of conservation significance (Table 7-26; Appendix H2). The field assessment recorded 25 species, two of which are of conservation significance. The nationally Vulnerable small duskhawker (*Gynacantha bayadera*) has only been recorded from Mandai, Rifle Range, Pulau Semakau and Nanyang Technological University (Tang et al., 2010). One individual was observed in the southern forest of the Study Area (along transect 2). Notably, four exuviae of *Gynacantha* spp. were observed nearby at a large pond approximately 200m to the east (A3). Several individuals of the uncommon dingy duskhawker (*Gynacantha subinterrupta*), including a teneral, were also observed in the southern part of the Study Area (along transect 2). The presence of exuviae at the small stretch of waterbody, that was observed to be waterlogged (A3) and sightings of *Gynacantha* spp. suggest the importance of this area, particularly the pond habitat, for the breeding of *Gynacantha* spp.

Similarly, the nationally Vulnerable variable featherlegs (*Copera vittata*) inhabits sluggish channels and willow pools in swamp forest (Tang et al., 2010). Five individuals were recorded adjacent to the waterlogged sections along Old Jurong Railway Corridor (Figure 7-66)). This shows the value of the Study Area in supporting species favouring swampy or waterlogged habitats, an increasingly uncommon habitat in Singapore.

Also recorded at this location is the red-tailed sprite (*Teinobasis ruficollis*) which has similar habitat requirements. It is widespread but rare, and considered near-threatened. It was also recorded in the southern forest, where a small waterlogged section lies (Figure 7-65;Figure 7-66). This shows the value of the Study Area in supporting species favouring swampy or waterlogged habitats, an increasingly uncommon habitat in Singapore.

Figure 7-65 Odonates Recorded In Clementi Forest. (A) Small Duskhawker (*Gynacantha bayadera*), (B) Variable Featherlegs (*Copera vittata*) And (C) Red-Tailed Sprite (*Teinobasis ruficollis*).

The proposed worksite area occupies half of the identified stream system (D/S22, D/S1 and D/S2) in Clementi Forest. This includes the downstream portion of the main stream (D/S1) and the entire western stream tributary (D/S22). Species recorded here are largely those widespread and common such as the blue sprite (*Pseudagrion microcephalum*), ornate coraltail (*Ceriagrion cerinorubellum*) and variegated green skimmer (*Orthetrum sabina*). Yet, such natural stream habitats are uncommon in Singapore. Given that this stream system is considered relatively extensive, it has value in supporting local populations of common to uncommon odonate species.



Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation

- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody

- Terrestrial sampling route 1
- Terrestrial sampling route 2

Odonate species of conservation significance

- C. vittata
- G. bayadera
- Habitat of interest

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
LOCATIONS OF ODONATE SPECIES OF CONSERVATION SIGNIFICANCE AND HABITATS OF INTEREST FOR ODONATES

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-66	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.3.4.5 *Butterflies*

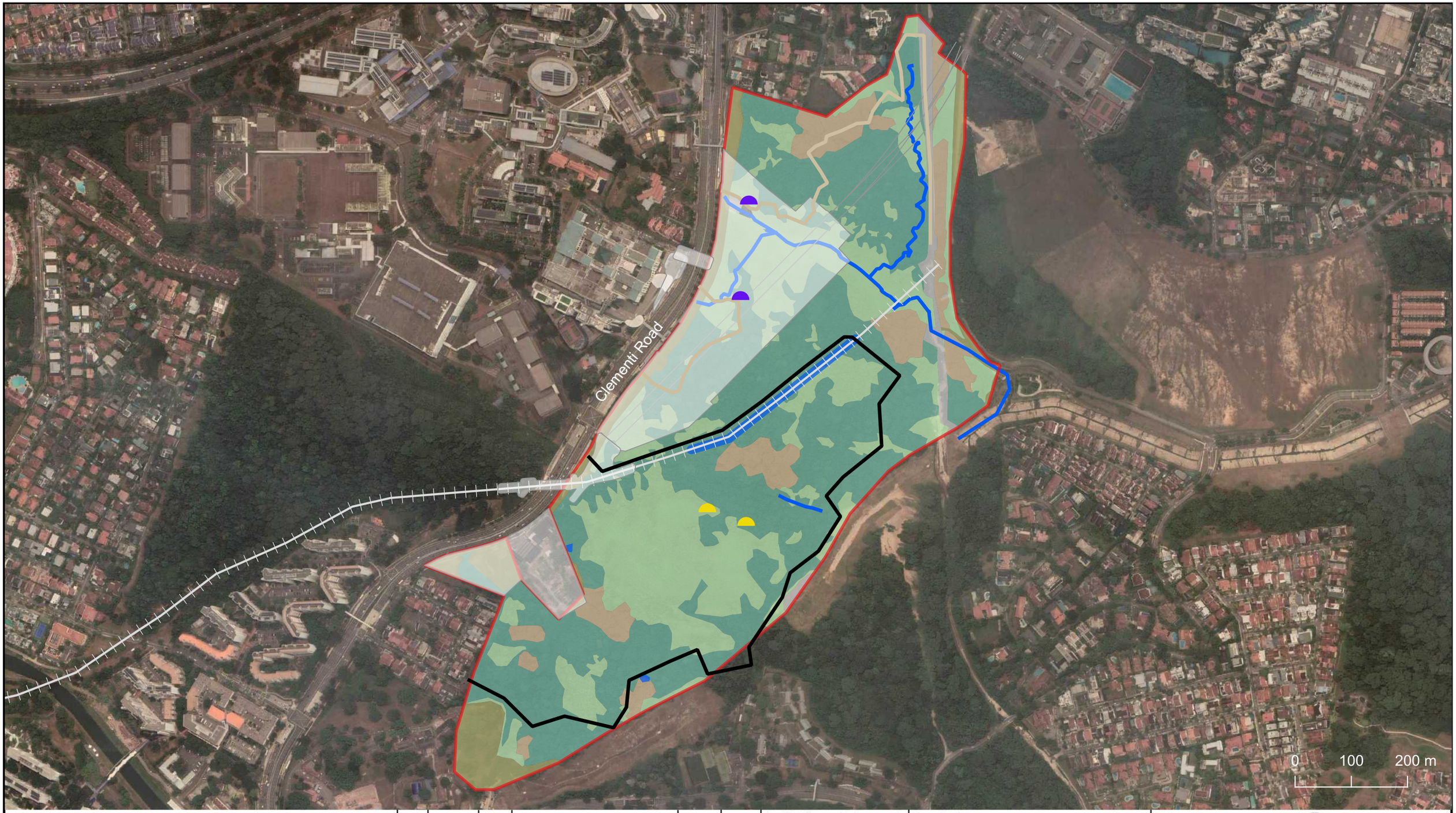
A total of 175 species were deemed of probable occurrence within the Study Area, with 16 species of conservation significance (Table 7-26; Appendix H2). Most species are common or moderately common throughout Singapore (71.4%; 125 species). Yet, one-third is considered moderately rare to rare (28%; 49 species) due to rarity of host plants or sightings. The field assessment recorded 49 species, including two species of conservation significance (Table 7-26; Appendix H2).

The butterfly traps only recorded one individual of the common palmfly (*Elymnias hypermnestra agina*).

The two species of conservation significance, the Formosan swift (*Bornbo cinnara*) and common birdwing (*Troides helena cerberus*), are now listed as moderately common. The Formosan swift can be found in parks, gardens and forest, and was recorded on the forest edge in the northwest (Figure 7-67). The common birdwing was recorded in the south, where a mating pair was also observed (Figure 7-67). Its host plant, *Aristolochia acuminata*, was recorded on site.

Seven moderately rare species were also recorded. The Malay tailed Judy (*Abisara savitri savitri*) usually inhabits forested areas within nature reserves. It was observed several times in the north, along transect 1 and once in the south, along transect 2. Its host plant, *Embelia ribes*, a common native climber, was documented in the Study Area. Additionally, the bamboo tree brown (*Lethe europa malaya*) was observed once in the southern forest (along transect 2). These records may suggest the value of the Study Area in supporting uncommon to rare butterfly species. The presence of native flora species within the Study Area (Section 7.3.3.3.1) also suggests its potential to support forest-dependent butterfly species that require native plant species (Jain et al., 2016).

Within the proposed worksite area, species recorded are largely common (e.g., grass yellows and bush browns), but the moderately rare Malay tailed Judy (*Abisara savitri savitri*) was also observed here.



Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation

- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody

- Terrestrial sampling route 1
- Terrestrial sampling route 2

Butterfly species of conservation significance

- B. cinnara
- T. h. cerberus

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
LOCATIONS OF BUTTERFLY SPECIES OF CONSERVATION SIGNIFICANCE IN CLEMENTI FOREST

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-67	-	1 of 1
	Drawn: JW	Date: JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.3.4.6 *Freshwater Decapod Crustaceans*

Given the lack of connectivity between the streams at Clementi Forest to the more biodiverse freshwaters of the CCNR and poor dispersal capability of most freshwater decapods, only two species, the native maculate freshwater crab (*Parathelphusa maculata*) and the non-native ghost shrimp (*Macrobrachium lanchesteri*), are considered of probable occurrence (Table 7-26; Appendix H2).

No decapod crustaceans were encountered in Clementi Forest, suggesting poor habitat suitability for these species.

7.3.3.4.7 *Freshwater Fish*

The desktop assessment identified 14 species of probable occurrence within the Study Area, with no species of conservation significance (Table 7-26; Appendix H2). Species of probable occurrence consist mainly of common, native species that are tolerant of disturbance such as whitespot (*Aplocheilus* armatus) and common snakehead (*Channa striata*). A number of adaptable alien species from the family Poecilidae (guppies, mollies, mosquitofish) are on the list. The deeper water present around the concrete culvert on the western portion likely provides habitat for larger-bodied species that are adaptable in terms of water chemistry. As such, the desktop assessment also includes some of the more common cichlid species (Mayan and Midas cichlids).

Eight species of freshwater fishes were encountered in Clementi Forest – three of these are native while five are introduced (Table 7-29; Appendix H2). The most number of species was recorded downstream DS/1 where the stream broadened just before entering the culvert. This larger and deeper channel allows for the presence of larger-bodied species such as the cichlids, including the Mozambique tilapia (*Oreochromis mossambicus*), which the narrower channels upstream would not be able to support. The Mozambique tilapia was recently accorded a global Vulnerable status by the IUCN as population reductions have been observed due to hybridisation and compeition with mainly the Nile tilapia. However, the Mozambique tilapia is an introduced species in Singapore and is hence not considered a species of conservation significance.

Subsequently, the presence of the common walking catfish (*Clarias* cf. *batrachus*) in this site is a notable record. Three individuals were recorded downstream of the main stream system (D/S1) and at D/S2 stream. Though a previously widespread species in the non-forested waterways of Singapore, it has seen a marked decline in its populations outside of the CCNR due to competition and displacement from the invasive African sharptooth catfish (*Clarias gariepinus*) (Ng et al., 2014).

The threespot gourami (*Trichopodus trichopterus*) was recorded along the main stream (D/S1) and along waterlogged areas of Old Jurong Railway Corridor. The dense vegetation that forms an overhang into the stream in these areas provides the cover that this species needs to survive. The Sunda swamp-eel (*Monopterus javanensis*) was recorded in the western stream (D/S22) and along waterlogged areas of Old Jurong Railway Corridor. Though such observations might make it appear to be highly restricted in Clementi Forest, it is unlikely to be the case. This species is largely nocturnal and cryptic making it difficult to observe during surveys. In addition, it is a generalist species that is not specialised to a type of habitat. Its ability to breathe air and to move overland affords it a heightened capacity for dispersal and makes it likely to occur broadly across most freshwater habitats in the area.

Table 7-29 Summary of Fish Species from the Waterbodies in Clementi Forest

Species	Common Name	Origin	D/S1 and D/S2	D/S22
Channa striata	Ghost shrimp	Native	Yes	No
Clarias cf. *batrachus*	Common walking catfish	Native	Yes	Yes
Monopterus javanensis	Asian swamp-eel	Native	No	Yes
Amphilophus citrinellus	Midas cichlid	Introduced	Yes	No
Poecilia reticulata	Guppy	Introduced	Yes	Yes
Cichlasoma uropthalmum	Mayan cichlid	Introduced	Yes	No
Oreochromis mossambicus	Mozambique tilapia	Introduced	Yes	No

Species	Common Name	Origin	D/S1 and D/S2	D/S22
Trichopodus trichopterus	Threespot gourami	Native	Yes	No

7.3.3.4.8 *Amphibians*

A total of 16 amphibians were deemed of probable occurrence (Table 7-26; Appendix H2). The field assessment recorded 11 amphibian species (Table 7-26; Appendix H2). Three of these species, while not threatened, are considered to be forest-dependent species with restricted distribution.

The copper-cheeked frog (*Chalcorana labialis*) and Malesian frog (*Limnonectes malesianus*) are known to be confined to the CCNR (Baker & Lim, 2012). The copper-cheeked frog prefers forest streams with running water. One individual was observed during a night survey at the forested stream parallel to Rail Corridor (D/S2). A total of 37 tadpoles were also observed along the same stream, confirming that stream serves as a breeding habitat for the species (Figure 7-68). The Malesian frog prefers mature swampy forest and was recorded along both waterbodies. The masked rough-sided frog (*Pulchrana laterimaculata*) was heard once along the Old Jurong Railway Corridor in Clementi Forest. It was also recorded previously by Siow et al. (2014) along the Old Jurong Railway Corridor. The presence of these forest-dependent species suggests the value of the Study Area, both forest and stream, in supporting such uncommon or rare forest species outside of nature reserves. Of the eight frogs recorded, one was the non-native greenhouse frog (*Eleutherodactylus planirostris*) which is widespread across Singapore. It was recorded in abundance across the Study Area, including the Old Jurong Railway Corridor and Rail Corridor.

Within the proposed worksite area, amphibian richness was low and sightings were largely of widespread and common species such as the dark-sided chorus frog (*Microhyla heymonsi*) and four-lined tree frog (*Polypedates leucomystax*). The forest-dependent Malesian frog (*Limnonectes malesianus*) was also found here albeit in low numbers.

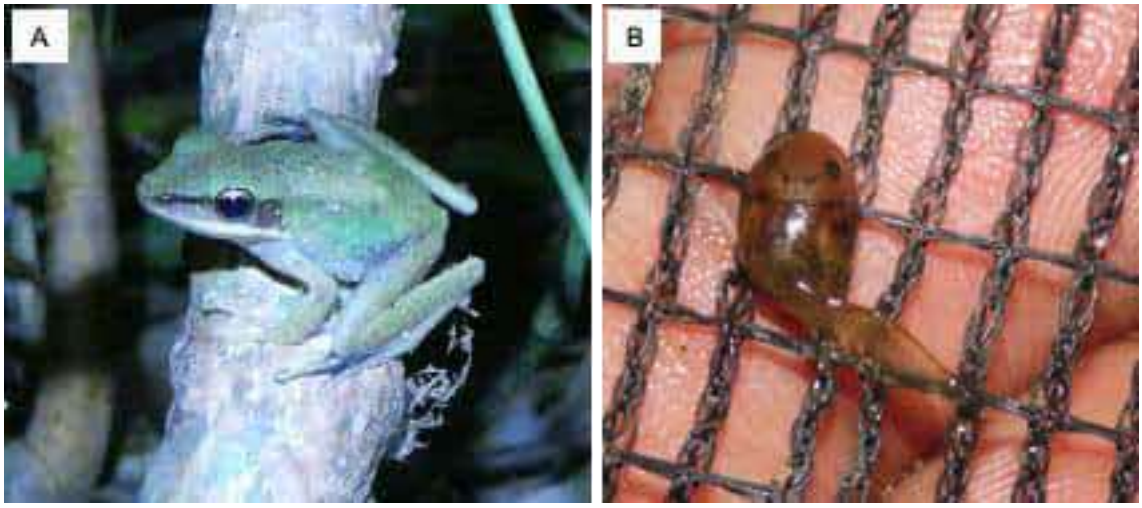


Figure 7-68 An (A) Adult and (B) Tadpole of the Copper-cheeked Frog (*Chalcorana labialis*) at Clementi Forest.

7.3.3.4.9 *Reptiles*

The probable species list amounted to 32 reptiles comprising three terrapins, 12 lizards and 17 snakes (Table 7-26; Appendix H2). Of these, three species (one snake one turtle and one terrapins) were of conservation significance. The field assessment recorded 14 reptiles, including the Malayan softshell turtle (*Dogania subplana*) (Table 7-26; Appendix H2). The nationally Critically Endangered Malayan softshell turtle (*Dogania subplana*), which was previously thought to be confined to the CCNR (Baker & Lim, 2012), was recorded in the stream (D/S2; Figure 7-62) parallel to Rail Corridor during night survey. Most reptilian species recorded were widespread and common, such as the painted bronzeback (*Dendrelaphis pictus*), but uncommon species such as the green crested lizard (*Bronchocela cristatella*) were also recorded.

Within the proposed worksite area, species richness of reptiles was low and sightings were largely of widespread and common species such as the spotted house gecko (*Gekko monarchus*) and changeable lizard (*Calotes versicolor*). However, it overlaps with the main stream running across the site, in which the Malayan softshell turtle (*Dogania subplana*) was recorded further upstream.

7.3.3.4.10 *Birds*

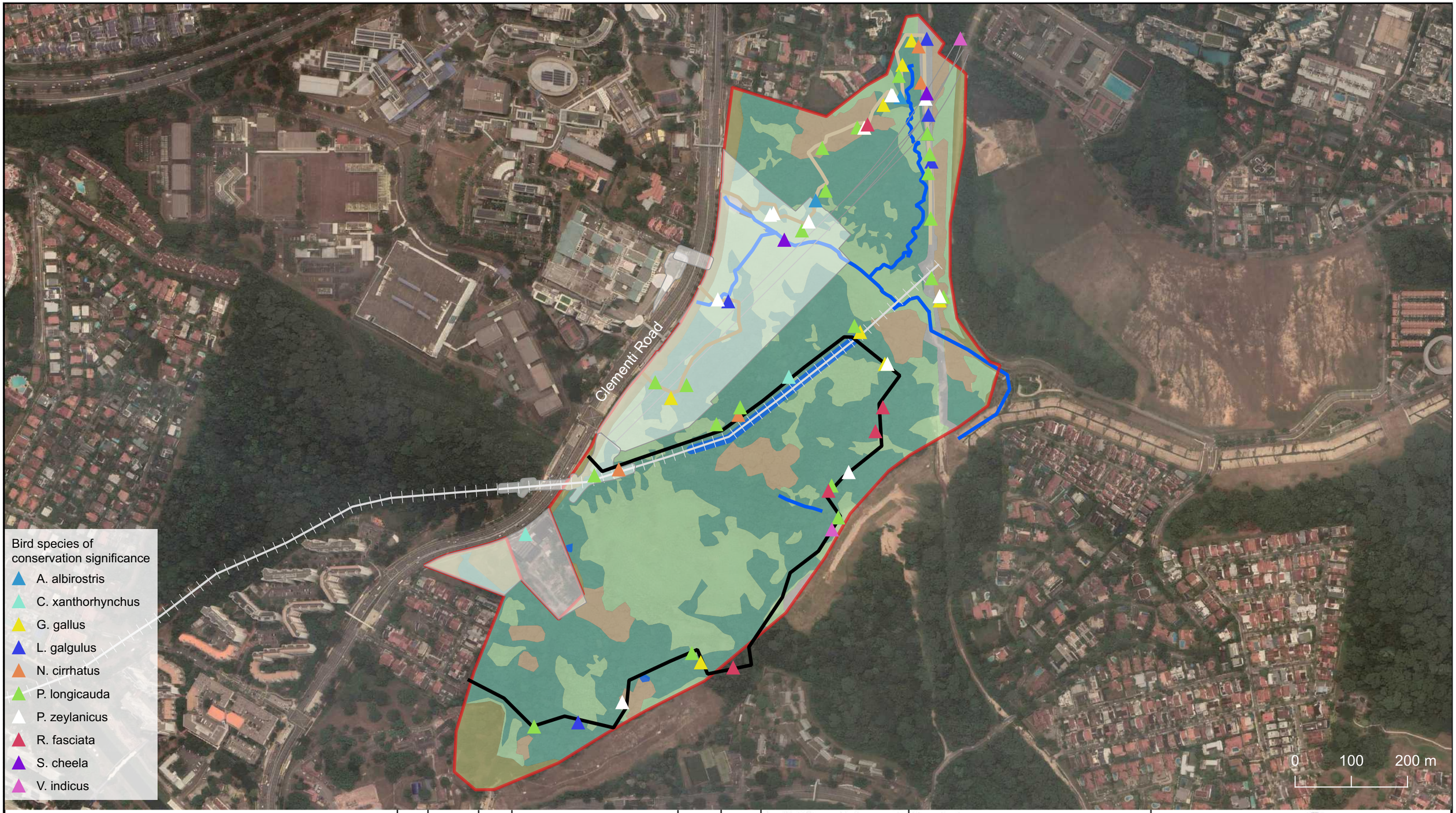
A total of 161 species of birds were deemed of probable occurrence, comprising 104 resident (14 introduced), one introduced non-resident and 56 migrant/visitor species (Table 7-26; Appendix H2). The field assessment recorded 75 species, of which 61 residents (11 introduced), one introduced non-resident and 12 are migrant/visitor species. One species (*Aerodramus* sp.) was only identifiable to genus level thus not classified by its native status (Table 7-26; Appendix H2). Three birds were only documented via camera traps – common emerald dove (*Chalcophaps indica*), black-throated laughingthrush (*Pterorchinus chinensis*) and orange-headed thrush (*Geokichla citrina*). The orange-headed thrush was recorded once along Old Jurong Railway Corridor.

Migratory species recorded include uncommon species such as the Indian cuckoo (*Cuculus micropterus*) and orange-headed thrush (*Geokichla citrina*). The latter was only recorded once on camera trap along the Old Jurong Railway Corridor. Also recorded on this camera trap was the introduced black-throated laughingthrush (*Pterorhinus chinensis*), which was not listed as a probable species due to lack of known distribution records and status. The slaty-breasted rail (*Lewinia striata*) was also not considered as a probable species, and was recorded at D/S22 stream.

Ten species of conservation significance were recorded within the Study Area (Table 7-27). They were distributed across the Study Area (Figure 7-70). Most of these species were previously regarded as rare but has since increased in range and numbers such as the changeable hawk-eagle (*Nisaetus cirrhatus*) and the blue-crowned hanging-parrot (*Loriculus galgulus*). The Critically Endangered crested serpent eagle (*Spilornis cheela*) is still considered moderately rare in Singapore. The population was reported to remain stable with no increase or decrease in range and abundance (Lim & Yong, 2013). It was observed twice flying overhead the northern forest (Figure 7-69; Figure 7-70). Also, the globally and nationally threatened straw-headed bulbul (*Pycnonotus zeylanicus*; Figure 7-69; Figure 7-70) was seen or heard several times across Clementi Forest.

Within the proposed worksite area, most bird species recorded here were also recorded in other parts of the Study Area. For example, the pin-striped tit-babbler (*Mixornis gularis*) and greater racket-tailed drongo (*Dicrurus paradiseus*) were recorded at multiple locations across the Study Area. However, it provides habitats for uncommon species associated with waterbodies, e.g., the straw-headed bulbul (*Pycnonotus zeylanicus*) and ruddy-breasted crake (*Porzana fusca*).

Figure 7-69 Bird Species of Conservation Significance Recorded at Clementi Forest – (A) Crested Serpent Eagle (*Spilornis cheela*) and (B) Straw-Headed Bulbul (*Pycnonotus zeylanicus*).



Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation

- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody

- Terrestrial sampling route 1
- Terrestrial sampling route 2

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

Land Transport Authority
We Keep Your World Moving

Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
LOCATIONS OF BIRD SPECIES OF CONSERVATION SIGNIFICANCE IN CLEMENTI FOREST, INCLUDING INCIDENTAL RECORDS

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-70	-	1 of 1
	Drawn: JW	Date: JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.3.4.11 *Non-volant Mammals*

A total of 16 species of non-volant mammals were deemed of probable occurrence (Table 7-26; Appendix H2). They are mostly widespread, common, and tolerant of disturbance. One species of conservation significance, the globally vulnerable but locally widespread long-tailed macaque (*Macaca fascicularis*), was recorded. Two other species of conservation significance may occur in the Study Area. The Critically Endangered Sunda pangolin (*Manis javanica*) was considered of probable occurrence as it has been recorded from the CCNR and degraded forest fragments (Nash et al., 2020). The record of this species at Maju Forest (Section 7.3.2.4.11) also suggests it is likely to occur here. The nationally Critically Endangered smooth-coated otter (*Lutrogale perspicillata*) was considered of probable occurrence due to anecdotal record of an otter (species not reported) at a pond within Corona Florist (Ho et al., 2019). This is likely to be a transient record of the otter.

Visual surveys and camera trapping documented five species of non-volant mammals, including the long-tailed macaque (*Macaca fascicularis*) (Table 7-26; Appendix H2). A troop of macaques were observed twice roosting on a tree at night in the south. The common treeshrew (*Tupaia glis*) was recorded only from camera traps. The common palm civet was seen several times along both northern and southern terrestrial routes. Species not recorded largely comprised murids, which are difficult to identify from camera trapping and visual surveys.

Within the proposed worksite area, mammal richness was low, and sightings comprised the plantain squirrel (*Callosciurus notatus*), long-tailed macaque (*Macaca fascicularis*) and common palm civet (*Paradoxurus musangus*).

The 12 camera traps yielded 713 independent detections and five species of mammals over 853 trap-nights (Table 7-30; Table 7-31). The list of camera trap data is available in Appendix J2. The most commonly recorded was the common treeshrew (*Tupaia glis*) followed by the plantain squirrel (*Callosciurus notatus*) with 304 and 246 independent detections across all camera traps respectively. The highest mammalian species richness (five species) was recorded at CT_11 in the southern part of the Study Area (Table 7-31). The highest detection rate of mammals (3.4 independent detections per trap-night) was recorded at CT_09. It was largely contributed by the plantain squirrel (*Callosciurus notatus*) and common treeshrew (*Tupaia glis*).

Table 7-30 Locations and Number of Independent Detections of Recorded Mammalian Species

Species	Common Name	CT Location No.	No. of Independent Detections
Callosciurus notatus	Plantain squirrel	All (01–12)	246
Macaca fascicularis	Long-tailed macaque	09, 11	6
Paradoxurus musangus	Common palm civet	03, 07, 11, 12	6
Rattus sp.	Rat	02, 05, 07, 08, 09, 11, 12	151
Tupaia glis	Common treeshrew	01, 02, 05–09, 11, 12	304
Total			**713**

Table 7-31 Number of Species and Detection Rate of Mammals Recorded at Each Camera Trap at Clementi Forest

Station	No. of Trap Nights	No. of Mammalian Species Recorded	Detection Rate of Mammals
CT_01	69	2	0.3
CT_02	73	3	0.3
CT_03	69	3	0.1

Station	No. of Trap Nights	No. of Mammalian Species Recorded	Detection Rate of Mammals
CT_04	49	1	0.4
CT_05	111	3	0.7
CT_06	65	2	0.1
CT_07	65	4	2.5
CT_08	69	3	0.2
CT_09	62	4	3.4
CT_10	65	1	0.3
CT_11	98	5	1.0
CT_12	58	4	2.9

0 100 200 m

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation

- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody

- Terrestrial sampling route 1
- Terrestrial sampling route 2

Mammalian species of conservation significance

- M. fascicularis

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

Land Transport Authority
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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
LOCATIONS OF MAMMALIAN SPECIES OF CONSERVATION SIGNIFICANCE IN CLEMENTI FOREST

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-71	-	1 of 1
	Drawn: JW	Date: JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.3.4.12 *Bats*

Eleven bat species were deemed of probable occurrence within the Study Area (Table 7-26; Appendix H2). One species was recorded via visual surveys and four via acoustic sampling (Table 7-26; Appendix H2).

Two species of probable occurrence were of conservation significance. One is the nationally Critically Endangered lesser bamboo bat (*Tylonycteris fulvida*) which is known to reside within bamboo internodes. As the morphometric measurements and acoustic signature of the lesser bamboo bat and locally widespread and common greater bamboo bat (*Tylonycteris malayana*) overlap, records cannot be identified to species accurately. It was expected on site based on presence of bamboo clusters in the Study Area and records in Maju Forest. Another species is the nationally Endangered black-bearded tomb bat (*Taphozous melanopogon*) which is known to inhabit forest and disturbed areas, and roost in caves and rock crevices (Baker, 2020). Records of this species are considered rare in Singapore, although records by us suggest that this species may be less rare than thought.

Most bat species recorded at the Study Area are known to utilise suburban parks and other rural landscapes (Pottie et al. 2005). For instance, the lesser dog-faced fruit bat (*Cynopterus brachyotis)* and the Asiatic lesser yellow house bat (*Scotophilus kuhlii*) are known to forage in urban areas and roost in man-made structures (Pottie et al., 2005). Four individuals of the lesser dog-faced fruit bat were trapped in the mist net deployed within the proposed worksite area (Figure 7-72). While the glossy horseshoe bat (*Rhinolophus lepidus*), a forest-dependent species and uncommon outside of the CCNR (Pottie et al., 2005) was recorded at two locations along with transect via acoustic recording.

Eight bamboo clusters were found within 20-m of the proposed worksite areas (Section 7.2.4.3.2). Visual roost emergence surveys detected bamboo bats acoustically at two of the clusters (BB_02 and BB_03; Figure 7-72) although roosting was not confirmed. Three bamboo bats were detected flying around the bamboo clusters. As silts were observed on the bamboos, they were deemed as potential roosting sites for the bamboo bats.

0 100 200 m

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor

Vegetation

- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody

- Terrestrial sampling route 1
- Terrestrial sampling route 2

Bat species of conservation significance

- Tylonycteris sp.

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

Land Transport Authority
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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
LOCATIONS OF BAT SPECIES OF CONSERVATION SIGNIFICANCE AT CLEMENTI FOREST

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-72	-	1 of 1
	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.4 Plant Species Accumulation Curves

Most (> 70%) of the plant species present in the Clementi Forest and Maju Forest were recorded via vegetation plot sampling alone (Table 7-32). Sample coverage for Clementi Forest is 82.8% while the sample coverage for Maju Forest is 74.8%, i.e., this proportion of the total number of species in the community belongs to those represented in the vegetation plots (Chao & Jost, 2012). Upon extrapolation, i.e., sample sizes were theoretically doubled using the statistical programme, sample coverage for Clementi Forest increases to 93.8% while the sample coverage for Maju Forest increases to 87.7%.

Even with increased vegetation plot sampling, however, approximately 7% of plant species in Clementi Forest and approximately 12% of plant species in Maju Forest will still remain undetected. This could be attributed to the large number of species likely to be present in the diverse forest patches. For diverse communities, more species will be recorded with greater number of survey units being sampled (Bunge & Fitzpatrick, 1993). As such, sampling effort would have to increase greatly in order to document most species present in the community. This is also reflected in Figure 7-73, where the species accumulation curves of both Study Areas do not appear to be reaching a steady asymptote. For such non-asymptotic datasets, richness estimators can be used to estimate true species richness (Gotelli & Colwell, 2001).

Table 7-32 Number of Recorded Species and Sample Coverage from Vegetation Plot Sampling

	Maju Forest	Clementi Forest
No. of species (observed)	87	113
Sample coverage (observed)	74.8%	82.8%
No. of species (extrapolated)	119.10	143.63
95% confidence interval	102.37–135.84	126.48–160.79
Sample coverage (extrapolated)	87.7%	93.8%

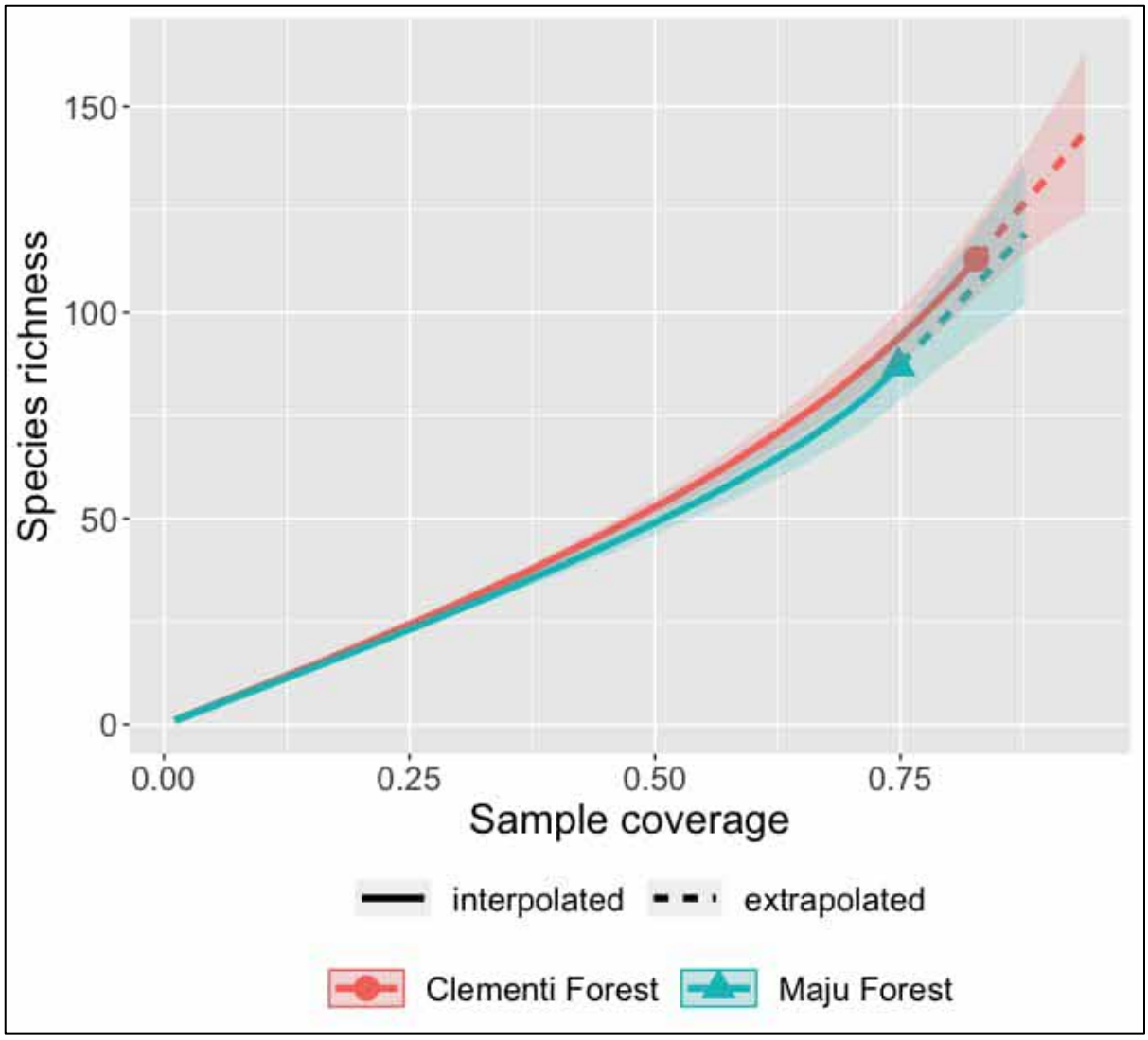

Figure 7-73 Coverage-Based Sampling Curves

The Chao estimator was used to predict total number of species in the species pool in each Study Area. Using the 'ChaoRichness' function in the iNEXT 2.0.20 package (R Development Core Team, 2016), total species richness and the 95% confidence interval were estimated and presented in Table 7-33.

In this Study, the recorded total species richness is 305 for Maju Forest and 303 for Clementi Forest. Both the figures greatly exceed the total number of species predicted for both Study Areas using the Chao estimator. This is likely because most species undetected or absent in the vegetation plots were documented during general floristic surveys, so much so that the recorded total species richness surpasses even the higher bound and more conservative estimates of total species richness for both Study Areas. Hence, the combined survey effort consisting of general floristic surveys and vegetation plot sampling were adequate in documenting floristic composition of plant communities in Maju Forest and Clementi Forest.

Table 7-33 Estimated Total Number of Species (± Standard Error) and 95% Confidence Interval Using the Chao Estimator

	Estimated total number of species ± standard error	95% lower	95% upper
Maju Forest	149.93 ± 25.74	116.11	223.02
Clementi Forest	160.85 ± 18.07	136.40	210.86

7.4 Assessment of Ecological Value

Habitats and species within the Study Areas were assessed for their ecological value based on the criteria described in Table 7-34 (habitat), Table 7-35 (plant species), and Table 7-36 (faunal species) (EPD, 2011). 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 Areas. The assessment was carried out using biodiversity baseline findings from each Study Area.

Each key biodiversity receptor was sub-categorised into their respective Priority Sensitivity Levels: Priority 1, Priority 2 and Priority 3 (from the most sensitive to the least) as shown in Table 6-1. The habitats/species with high ecological value are categorised as Priority 1 and habitats/species with low ecological value are categorised as Priority 3, while habitats/species with moderate ecological value are categorised as Priority 2.

Table 7-34 Criteria for Assessing the Ecological Value of Habitats

Criterion	Description
Naturalness	Degree to which the habitat is modified or disturbed owing to human activities, i.e., man-made, naturalised and natural. • This is indicated by species composition in terrestrial habitats. A man-made habitat is created; a naturalised habitat is dominated by exotic plant species; a natural habitat is dominated by native plant species. • In an aquatic habitat, it is indicated by the extent of human modification or disturbances. A man-made habitat is created; a naturalised habitat is modified by human actions; a natural habitat is largely pristine and not affected by human actions.
Size	Amount of physical space occupied by the habitat. Larger habitats usually have a greater carrying capacity and thus a higher ecological value.
Rarity	Extent to which the habitat occurs locally. The less common the habitat, the higher its rarity. Rare habitats are usually more difficult to create due to the need for specific conditions and thus making them less commonly occurring.
Ecological Linkage	Proximity of the habitat to other habitats. The value of a habitat increases if it lies in close proximity and/or links functionally to a high valued habitat type.
Large and Other Plant Specimens Of Value	Number of large and other plant specimens of value found within the habitat. Habitat with higher number of these specimens have higher ecological value.
Native Species	Number of native floral and faunal species and specimens in the habitat. A habitat with higher number of native species and/or more individuals of these species has higher ecological value.
Species Of Conservation Significance	Number of species of conservation significance or other faunal species of value, and number of individuals of these species in a habitat. A habitat with higher number of these species and/or more individuals of these species has higher ecological value.

All plant species were first accorded with a tentative ecological value, i.e., high, medium, or low, based on the following basic framework:

- High ecological value: Species of conservation significance
- Medium ecological value: All other native species
- Low ecological value: Exotic and cryptogenic species

Species that were tentatively assigned with medium (all other native species) or low (exotic and cryptogenic species) ecological value were then evaluated individually based on the criteria listed in Table 7-35. The evaluation of individual species served to either maintain or raise the pre-assigned ecological value. The following paragraphs detail how each criterion was considered in the evaluation.

Association with important fauna (native, exotic, and cryptogenic species): The ecological value of plant species that directly support the growth and survival of important fauna at one or various life cycle stages were

raised to high, irrespective of plant species origin, cultivation intensity and effects, as well as national distribution. Examples of such plant species include caterpillar host plants for rare butterfly species and bamboos that are refugia for nationally threatened bamboo bats. The ecological value of plant species without associations with important fauna was maintained at the original level, i.e., medium or low.

Cultivation intensity and effects (native species only): The ecological value of all native species previously or presently cultivated and/or with populations of relics or escapees, respectively, present in the secondary forests of Singapore were maintained at the medium level. Otherwise, those associated with important fauna were raised to high ecological value.

National distribution (non-cultivated native species only): The ecological value of non-cultivated native plant species with restricted national distribution—i.e., largely found in certain forest patches in Singapore or offshore islands, such as the primary and old growth secondary forests of the CCNR—were raised from the original medium level to high. On the other hand, that of non-cultivated plant species that are nationally widespread—i.e., occur at several secondary forest patches throughout Singapore—were maintained at the medium level.

There are, however, a few exceptions in which the highest ecological value was automatically assigned to species regardless of the criteria listed below. They are (1) species endemic to Singapore, (2) keystone fig species (Ficus sp.) as they fruit all year round and provide a steady source of food for frugivores (Lok et al., 2013), and (3) species planted for reforestation and/or previously thought to be extinct and are planted for species reintroduction. Additionally, the exotic rain tree (*Samanea saman*) was also automatically raised from low to medium ecological value given that it often supports the growth of epiphytes that provide habitats for fauna.

Table 7-35 Criteria for Assessing the Ecological Value of Plant Species

Criterion	Definition
Conservation Significance	Listed as nationally threatened, i.e., Vulnerable, Endangered, Critically Endangered, or Extinct, and are considered of conservation significance in this study
Cultivation Intensity and Effects	Cultivated previously or presently—for various purposes such as reforestation, landscaping, species reintroduction, commercial sale, etc—and populations of relics and/or escapees are present/absent in forests
National Distribution	Extent of spread and/or occurrence at one or multiple forest patches in Singapore
Association With Important Fauna	Directly associated with the survival of important fauna at one or various life cycle stages

Table 7-36 Criteria for Assessing the Ecological Value of Faunal Species

Criterion	Definition
Conservation Significance	Listed as globally and/or nationally threatened and/or rare
Distribution	Global and/or national extent of spread of the species population. Species with restricted extent of spread are more susceptible to impacts, thus have higher ecological value
Rarity	Frequency at which the species occurs globally or locally. Rarer species have higher conservation significance, thus ecological value.

7.4.1 Maju Forest

The ecological values of five habitats, three waterbodies, 304 plant species and 138 faunal species present within Maju Forest were assessed.

7.4.1.1 Habitats

The ecological values of five terrestrial habitats and three waterbody habitats observed at Maju Forest were assessed. Two terrestrial habitats and all the waterbody habitats were assessed to have high ecological value;

while the remaining three terrestrial habitats, were assessed to have low ecological value. A summary of the assessment of each habitat is shown in Table 7-37.

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

The native-dominated secondary forest occupies 7.9 ha (23.8%) and is the second most expansive vegetation type within Maju Forest. Coincidentally, it lies along the Old Jurong Railway Corridor, an important ecological corridor and is deemed to have high ecological linkage too. It is uncommon in Singapore as many forests have been largely disturbed and/or cleared to give way for development.

Amongst the habitat assessed in Maju Forest, it has the second highest native species richness and consists of the second highest number of conservation significant plant species (Table 7-8 and Table 7-9 respectively). It has the lowest average native faunal species richness and average conservation significant faunal species (Table 7-38). Yet it has value in supporting high faunal diversity which is dependent on native floral host or food plants due to its floristic composition of native species and conservation significance plant species.

ii. Abandoned-land Forest (High Ecological Value; Priority 1)

The abandoned-land forest occupies 10.9 ha (32.8%), making it the most expansive vegetation type in Maju Forest. The abandoned-land forest exists in large patches distributed across the Study Area and is contiguous with other vegetation type. Thus, it provides high value in ecological linkage in providing floral and faunal species to disperse or move across the Study Area. Subsequently, the abandoned-land forest habitat is uncommon in Singapore as many forests have been largely disturbed and/or cleared to give way for development.

The forest harbours a high number of average native and conservation significant plant species. Amongst the habitats assessed in Maju Forest, it ranks the highest in native species richness and also recorded the highest average number conservation significant plant species (Table 7-8 and Table 7-9 respectively). A relatively high level of average native faunal species richness and conservation significant faunal species richness were recorded across this habitat (Table 7-38). This includes faunal species such as the Sunda pangolin.

iii. Waste Woodland (Moderate Ecological Value; Priority 2)

The waste woodland occupies 4.5 ha (13.6%), making it the smaller vegetation type within Maju Forest. This is a commonly encountered habitat in Singapore -usually located on forest edges, accustomed to high disturbance, characterised by fast-growing exotic plant species that dominate the assemblage. Only three conservation significant plant species were recorded here.

Amongst the habitat assessed in Maju Forest, high numbers of average native faunal species richness and conservation significant species faunal richness were recorded across this habitat (Table 7-38). Additionally, due to its contiguity with other vegetation type, it has high value in providing ecological linkage for species utilising the Study Area.

iv. Scrubland and Herbaceous Vegetation (Moderate Ecological Value; Priority 2)

The scrubland and herbaceous vegetation occupies 5.5 ha (16.6%), making it the one of the smaller vegetation types within Maju Forest. This is a common habitat as it mostly occupies the forest edges where temperature and light levels are higher, while some occurs in small scattered patches within the forest. While it is connecting to other vegetation types, it is largely located on the forest edge, thus has lower value in ecological linkage.

Amongst the habitat assessed in Maju Forest, it has the highest numbers of average native faunal species richness and conservation significant faunal species richness recorded (Table 7-38), indicating some level of importance of this habitat.

i. Managed Vegetation (Low Ecological Value; Priority 3)

The managed vegetation occupies 4.5 ha (13.6%), making it the one of the smaller vegetation types within Maju Forest. This is a very common habitat in Singapore, represented by managed lawns, as well as small community gardens—a make-up typical of urban parks in Singapore. Most of the planted trees are exotic species, such as *Podocarpus rumphii*, *Khaya grandifoliola* and *Samanea saman*. However, it can provide habitats or foraging opportunities for faunal species, and act as a buffer for the Old Jurong Railway against disturbances such as noise and dust from the adjacent Clementi Road. While it is connecting to other vegetation types, it is largely located on the forest edge, thus has low value in ecological linkage.

ii. All Waterbodies (D/S23-25; High Ecological Value; Priority 1)

There are three natural streams present within Maju Forest, amounting to 0.37 km. The waterbodies here are considered low in ecological linkage as it is not connected to larger waterbodies. While it has a relatively high

number of native and conservation significant plant species, the faunal native and conservation significant richness observed are rather low. Despite that, such natural stream habitats are uncommon in Singapore and provide important habitats for a range of taxon; and thus are still considered of high ecological value.

Table 7-37 Habitat Ecological Assessment Table for Maju Forest

Criterion	Native-Dominated Secondary Forest	Abandoned-Land Forest	Waste Woodland	Scrubland And Herbaceous Vegetation	Managed Vegetation	D/S23-25 Waterbodies
Ecological Value	High	High	Moderate	Moderate	Low	High
Naturalness	Natural	Natural	Naturalised	Naturalised	Man-made	Natural
Size (% Of Study Area)	7.9 ha (23.8%)	10.9 ha (32.8%)	4.5 ha (13.6%)	5.5 ha (16.6%)	4.5 ha (13.6%)	0.37 km
Rarity	Rare	Uncommon	Common	Common	Common	Rare
Ecological Linkage	High	High	High	Medium	Low	Low
Native Species Richness	Flora: high Fauna: low	Flora: high Fauna: intermediate	Flora: N.A. Fauna: high	Flora: low Fauna: high	Flora: N.A. Fauna: N.A.	Flora: intermediate Fauna: low
Conservation Significance Species Richness	Flora: high Fauna: intermediate	Flora: high Fauna: high	Flora: low Fauna: high	Flora: low Fauna: high	Flora: N.A. Fauna: N.A.	Flora: high Fauna: low

Table 7-38 Average Native Species and Conservation Significant Faunal Species Richness for Each Habitat at Maju Forest

Habitat Type	Number Of Sampling Points	Average Native Species Richness	Average Conservation Significant Species Richness
Native-Dominated Secondary	12	4.17	1.33
Abandoned-Land Forest	9	7.56	1.56
Waste Woodland	1	9	2
Scrubland And Herbaceous Vegetation	2	9	2.5
D/S24_Stream	3	0.67	0
D/S23_Stream	4	0	0
D/S25_Stream	5	0.8	0

7.4.1.2 Plant Species

Of the 304 plant species assessed for their ecological value, 65 are of high value, 99 of medium value, and 140 of low value. The list of species is available in Appendix R1.

The ecological values of nine and one species were raised from the original medium and low levels, respectively, to high. The only species that was originally accorded with low ecological value is the exotic bamboo species, *Bambusa vulgaris*. This species, though not native to Singapore, partially plays an important role in the survival of nationally threatened bamboo bats; the faunae are known to reside in bamboo internodes and spend long hours roosting. One bamboo bat colony was recorded during baseline surveys carried out at Maju Forest in 2018 (Camphora Pte Ltd, unpublished data). As such, retaining bamboo clusters in the Study Area is essential in safeguarding local populations that continually face the threat of habitat loss. The other nine species originally accorded with medium ecological value are non-cultivated native species listed as nationally Common. These species recorded at Maju Forest, while listed as Common, are more often restricted to later-stage successional secondary forests or forest reserves in the CCNR. Some of these species include *Alyxia reinwardtii*,

Campnosperma auriculatum, and *Santiria apiculata*. Hence, they are valuable to be conserved in the present Study Area, which could serve as an additional refugium for these species in Singapore.

Out of the remaining 55 species of high ecological value, nine are *Ficus* species. they consist of eight native *Ficus* species (including the nationally Vulnerable *Ficus aurata* var. *aurata* and Endangered *Ficus apiocarpa*), as well as the cryptogenic strangler *Ficus benjamina*. *Ficus* plants produce figs all year round and are keystone species important for the health of entire ecosystems. Hence, all figs recorded in this Study are assigned a high ecological value. All other species of high ecological value are nationally threatened species considered of conservation significance in this Study.

7.4.1.3 Faunal Species

Of the 138 faunal species assessed for their ecological value, with 10 species of high value. This includes two butterfly, one amphibian, one reptile, seven bird, two non-volant mammal and one bat species. All national or globally threatened species were accorded high ecological value. The criteria for determining species of conservation significance are described in Section 7.2.2.3. The list of species is available in Appendix R1.

7.4.2 Clementi Forest

The ecological value of four terrestrial habitats, six waterbody habitats (including waterlogged areas along the Old Jurong Railway and A3), 301 plant species and 210 faunal species present within Clementi Forest were assessed.

7.4.2.1 Habitats

The ecological value of four terrestrial habitats and six waterbody habitats (including waterlogged areas along the Old Jurong Railway Corridor) observed at Clementi Forest were assessed. Only one terrestrial habitat and the four waterbody habitats (including waterlogged areas along the Old Jurong Railway Corridor) were assessed to be of high ecological value; while one waterbody and two terrestrial habitats were assessed to be of moderate and low ecological value respectively. A summary of ecological value assessment of each habitat is shown in Table 7-39.

i. Abandoned-land Forest (High Ecological Value; Priority 1)

The abandoned-land forest occupies 29.0 ha (49.7%), making it the most expansive vegetation type in Clementi Forest. The abandoned-land forest exists in large patches distributed across the Study Area and is contiguous with other vegetation type. Thus, it provides high value in ecological linkage in providing floral and faunal species to disperse or move across the Study Area. Subsequently, the abandoned-land forest habitat is uncommon in Singapore as many forests have been largely disturbed and/or cleared to give way for development.

Amongst the habitats assessed in Clementi Forest, it ranks the highest in native species richness and also recorded the highest average number conservation significant plant species (Table 7-20 and Table 7-23 respectively). Areas where high numbers of threatened swamp-associated plant species were recorded along the Old Jurong Railway lie within this habitat type as well. An intermediate average native faunal species richness but low average conservation significant species richness was recorded across this habitat (Table 7-40).

ii. Scrubland and Herbaceous Vegetation (Moderate Ecological Value; Priority 2)

The scrubland and herbaceous vegetation occupies 18.5 ha (31.7%) and is the second most expansive vegetation type within Clementi Forest. This is a common habitat as it mostly occupies the scattered patches within the forest where temperature and light levels are higher; and because of that, it is contiguous with other vegetation type, making it high value in providing ecological linkage for species utilising the Study Area.

Amongst the habitat assessed in Clementi Forest, it has low numbers of average native floral species richness but intermediate numbers of average conservation significant floral species richness recorded (Table 7-20 and Table 7-23 respectively); while high average native faunal species richness but low average conservation significant faunal species richness were recorded (Table 7-40).

iii. Waste Woodland (Moderate Ecological Value; Priority 2)

The waste woodland occupies 4.8 ha (8.5%), making it one of the smaller vegetation types within Clementi Forest. This is a commonly encountered habitat in Singapore -usually located on forest edges, accustomed to high disturbance, characterised by fast-growing exotic plant species that dominate the assemblage. Though observed in patches across Study Area, it is still contiguous with other vegetation type, making it high value in providing ecological linkage for species utilising the Study Area.

This habitat ranks low in average richness of native species and conservation significant plant species (Table 7-20 and Table 7-23 respectively).

iv. Managed Vegetation (Low Ecological Value; Priority 3)

The managed vegetation occupies 4.4 ha (7.7%), making it the smallest vegetation type within Clementi Forest. The managed vegetation is located on the forest edges and comprises mainly of planted trees that are exotic species. This is a very common habitat in Singapore, represented by managed lawns, as well as small community gardens—a make-up typical of urban parks in Singapore. Most of these areas observed in Clementi Forest are managed lawns, open and turfed with grass. Subsequently, because of this, fauna are easier to be observed and thus resulted in high numbers of average native species richness and conservation significant faunal species richness (Table 7-40).

v. Waterbody (D/S22, D/S1 and D/S2 Streams; High Ecological Value; Priority 1)

A natural stream system (1.38 km) runs across the middle of Clementi Forest and extends beyond Clementi Forest Study Area; thus, is considered to have high ecological connectivity for the aquatic fauna residing within this waterbody (Figure 7-8).

The stream is characterised with scrubland and herbaceous vegetation, which has low numbers of average native floral species richness but intermediate numbers of average conservation significant floral species richness – where several individuals of two nationally threatened plant species, the Critically Endangered *Neoscortechinia* cf. *sumatrensis* and Vulnerable *Alsophila latebrosa* were observed. Subsequently, such natural stream habitats are uncommon in Singapore and provide an important habitat for the common walking catfish (*Clarias* cf. *batrachus)* which has local population decline in recent years; and thus, is still considered of high ecological value.

vi. Waterbody (A3; Moderate Ecological Value; Priority 2)

The A3 waterbody stretches over a small distance. It does not appear to be connecting to a larger waterbody aboveground, but may be fed by underground water source. During wet period, it is waterlogged at several sections. During dry period, the area become slightly wet and muddy. Nevertheless, the waterlogged conditions provide suitable habitats for species favouring species associated with swampy habitats, such as the nationally near-threatened red-tailed sprite (*Teinobasis ruficolis*). It appears favourable for amphibians favouring such habitats, although none was recorded.

vii. Waterbody (A4 Pond; Moderate Ecological Value; Priority 1)

The A4 pond is a natural 0.01 ha pond located in the southern part of Clementi Forest. It appears to be ephemeral and not connected to a larger waterbody, thus considered to have low ecological linkage. Despite that, the presence of exuviae at the pond and sightings of *Gynacantha* spp. suggests the importance of this area for the breeding of *Gynacantha* spp. There is a 50% possibility that the *Gynacantha* spp. observed is a nationally threatened species as two of the four *Gynacantha* species present in Singapore are Vulnerable. Subsequently, numerous individuals of the nationally Vulnerable stream-associated plant species were also recorded in close proximity.

viii. Waterbody (A5 Pond; Low Ecological Value; Priority 3)

The A5 pond at Corona florist does not connect to a larger waterbody. No conservation significant floral or faunal species were recorded. Species recorded were common with widespread distribution.

ix. Waterbody (Waterlogged areas along Old Jurong Railway; High Ecological Value; Priority 1)

The central section of the Old Jurong Railway Corridor is waterlogged during rainy periods, creating a perfect habitat for some stream associated plant species and faunal species favouring swampy habitats. Two thought to be nationally extinct plant species were also recorded along the railway. Amphibians associated with swampy habitats, such as the malesian frog (*Limnonectes malesianus*) and masked rough-sided frog (*Pulchrana laterimaculata*), were observed along the railway. Several individuals of the nationally Endangered variable featherlegs (*Copera vittata*) were also recorded in the muddy sections.

More importantly, the Old Jurong Railway Corridor provides an important ecological connectivity for the dispersal of floral and faunal species between Clementi Forest and Maju Forest, and with other green spaces along the Old Jurong Railway Corridor. It would be especially important during the construction phase as Clementi Forest may serve as a refuge for the fauna displaced during construction at Maju Forest (for base scenario for worksites). Additionally, this Corridor is connecting to the BTNR, a biodiversity of hotspot in Singapore, which may allow forest-dependent species to disperse from BTNR to the Study Areas (Ho et al., 2019). Thus, it has high value in ecological linkage.

Table 7-39 Habitat Ecological Assessment Table for Clementi Forest

Criterion	Abandoned-land Forest	Scrubland and Herbaceous Vegetation	Waste Woodland	Managed Vegetation	Waterbody (D/S22, D/S1 and D/S2 Streams)	Waterlogged Areas Along A3	Waterbody (A4 Pond)	Waterbody (A5 Pond)	Waterlogged Areas Along Old Jurong Railway Corridor
Ecological Value	High	Moderate	Moderate	Low	High	Moderate	High	Low	High
Naturalness	Natural	Naturalised	Naturalised	Man-made	Natural	Natural	Natural	Man-made	Natural
Size (% Of Study Area)	29.0 ha (49.7%)	18.5 ha (32.6%)	4.8 ha (8.5%)	4.4 ha (7.7%)	1.38 km	0.08 km	0.01 ha	0.04 ha	0.36 km
Rarity	Uncommon	Common	Common	Common	Uncommon	Uncommon	Uncommon	Common	Uncommon
Ecological Linkage	High	High	High	Low	Low	Low	Low	Low	High
Native Species Richness	Flora: high Fauna: intermediate	Flora: low Fauna: high	Flora: low Fauna: N.A.	Flora: N.A. Fauna: high	Flora: N.A. Fauna: low	Flora: N.A. Fauna: N.A.	Flora: N.A. Fauna: N.A.	Flora: N.A. Fauna: N.A.	Flora: N.A. Fauna: N.A.
Conservation Significance Species Richness	Flora: high Fauna: low	Flora: intermediate Fauna: low	Flora: intermediate Fauna: N.A.	Flora: low Fauna: high	Flora: high Fauna: low	Flora: N.A. Fauna: N.A.	Flora: N.A. Fauna: N.A.	Flora: N.A. Fauna: N.A.	Flora: N.A. Fauna: N.A.

Table 7-40 Average Conservation Significance and Native Faunal Species Richness for Each Habitat at Clementi Forest

Habitat Type	Number Of Sampling Points	Average Native Species Richness	Average Conservation Significant Species Richness
Abandoned-Land Forest	26	8.35	1.85
Scrubland And Herbaceous Vegetation	4	10.25	1.75
Managed Vegetation	6	14.33	4
D/S1 and D/S2 Stream	7	1.14	0.43
DS22_Stream	2	2	1

7.4.2.2 Plant Species

A total of 69 species in Clementi Forest were accorded with high ecological value, while 94 and 138 species are of medium and low ecological value, respectively. Altogether, 301 plant species present in Clementi Forest were evaluated. The list of species is available in Appendix R2.

Of the 69 species of high ecological value, six and three were raised from the original medium and low levels, respectively. The three species initially accorded with low ecological value are *Bambusa heterostachya*, *Bambusa vulgaris*, *Thyrsostachys siamensis*, all of which are exotic bamboo species. In spite of their origin, however, the ecological value was raised to the highest level because the plants could be utilised by nationally threatened bamboo bats. These faunae were recorded at Clementi Forest during acoustic and visual surveys. While it is unsure whether they roost within the internodes of the bamboos, it is still important to conserve the latter for the purpose of safeguarding local populations of bamboo bats. The other six species of which the ecological value was raised from medium to high are native species listed as nationally Common and not known to be cultivated locally. Though listed as Common, the distribution of plants of these species are more often restricted to the CCNR and not commonly found in other secondary forests of Singapore. Some of these species are *Dischidia major* and *Maesa ramentacea*.

The remaining 60 species of high ecological value consist of 11 keystone *Ficus* species and 49 other plant species of conservation significance. In addition to being important keystone plants, three out of the 11 *Ficus* species are also nationally threatened and considered of conservation significance, namely, the nationally Vulnerable *F. aurata* var. *aurata*, Endangered *F. vasculosa*, and Critically Endangered *F. villosa*. The other eight figs are made up of six nationally Common species, one exotic species (*F. elastica*), and one cryptogenic species (*F. benjamina*).

7.4.2.3 Faunal Species

Of the 210 faunal species evaluated for their ecological value, 18 were of high value as they were considered of conservation significance. This includes one aculeate hymenopteran, two odonate, two butterfly, three amphibian, one reptile, 10 bird, one non-volant mammal and one bat species. The criteria for determining species of conservation significance are described in Section 7.2.2.3. With the exception of the Sunda pangolin (*Manis javanica*), all species were recorded within Clementi Forest. The pangolin was recorded in the adjacent Maju Forest, thus highly possible to occur in Clementi Forest and included in the evaluation. The list of species is available in Appendix R2.

7.5 Areas of High Conservation Value

The assessment of habitat and species ecological value was used to identify areas of high conservation value. Areas of high conservation value within the Study Areas are of highest priority and should be kept untouched as much as possible. Any development within these areas is likely to result in major to moderate impacts. A 30-m buffer was placed around some of these features to further safeguard these features from habitat degradation and reduce the impacts of edge effects. It is important to note that other areas of medium or low conservation value also contribute towards the ecological integrity of the Study Area and should be preserved as well.

7.5.1 Maju Forest

The areas of high conservation value at Maju Forest are (Figure 7-74):

i) All waterbodies (D/S23-25 Streams): Waterbodies are important habitats which are uncommon in Singapore. Stream associated vegetation and faunal species are recorded here. A cluster of nationally threatened plant species, the *Alsophila latebrosa* and *Blechnum finnlaysosianum*, were found along the western stream (D/S25). It also provides a breeding and foraging habitat for aquatic fauna, such as the uncommon copper-cheeked frog (*Chalcorana labialis*) whose tadpoles were observed.

ii) Native-dominated secondary forest: It is an uncommon habitat type in Singapore. It may develop into late-successional forests if left undisturbed. It harbours a high number of native and conservation significant plant species. Correspondingly, it provides habitats for faunal species dependent on native flora, particularly butterflies that are host-dependent. Uncommon butterflies, the Malay-tailed Judy (*Abisara savitri savitri*) and ultra snow flat (*Tagiades ultra*), were observed here.

iii) Old Jurong Railway Corridor: More specifically the waterlogged areas along Old Jurong Railway Corridor. Waterlogged areas along the railway corridor provide habitat for threatened stream-associated plant species and faunal species favouring swampy habitats. More importantly, the corridor provides important ecological connectivity as described in Section 4.6.

The railway, together with the native-dominated secondary forest and southern waterbodies, is approximately 7.13 ha.

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor
- Areas of high conservation value

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Waterbody

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

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Figure Title :
AREAS OF HIGH CONSERVATION VALUE AT MAJU FOREST

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JW	JAG/NHT	JAG	7-74	-	1 of 1
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Note: Source of basemap - Google Earth Map

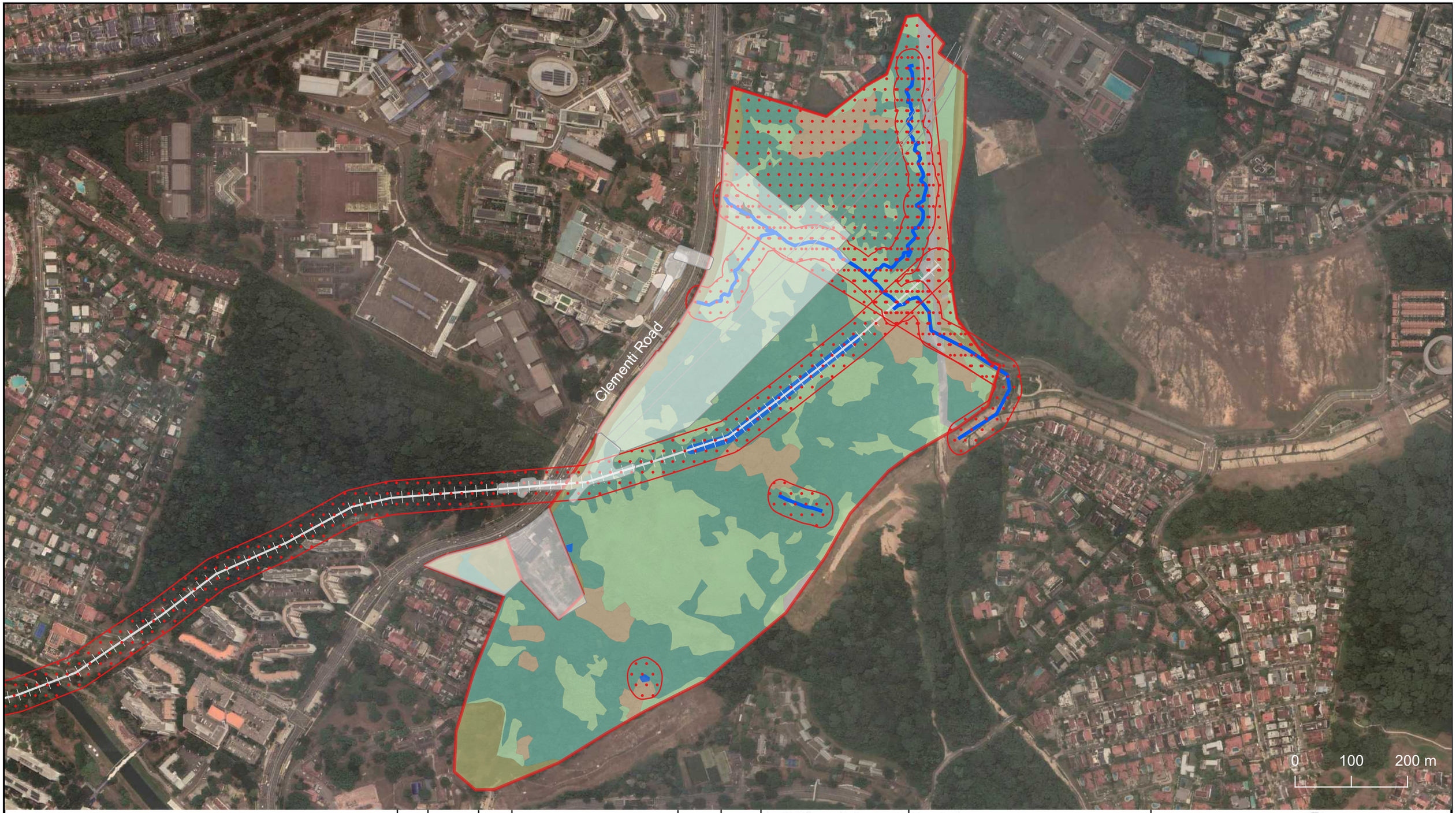
7.5.2 Clementi Forest

Areas of high conservation value at Clementi Forest are described below (Figure 7-75):

i) All waterbodies except the man-made A5 pond: Waterbodies are important habitats which are uncommon in Singapore. Stream associated vegetation and faunal species are located along and around the stream parallel to Rail Corridor. A3 in the south of the Study Area is a breeding habitat for several dragonfly species, *Gynacantha* spp.

ii) Old Jurong Railway: More specifically the waterlogged areas along Old Jurong Railway. Waterlogged areas along the railway corridor provide habitat for threatened stream-associated plant species and faunal species favouring swampy habitats, including the variable featherlegs (*Copera vittata*) and masked rough-sided frog (*Pulchrana laterimaculata*). More importantly, the corridor provides important ecological connectivity as described in Section 4.6.

iii) Northern forest patch: A large cluster of threatened plant species, including the Critically Endangered *Neoscortechinia* cf. *sumatrensis* and Vulnerable *Alsophila latebrosa*, reside within the abandoned-land forest. The northern forest patch including the main stream and its 30-m buffer is approximately 15.7 ha.



Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor
- Areas of high conservation value

Vegetation

- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
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Consultant : AECOM

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Project Title :
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Figure Title :
AREAS OF HIGH CONSERVATION VALUE AT CLEMENTI FOREST

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JW	JAG/NHT	JAG	7-75	-	1 of 1
	Drawn: JW	Date: JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.6 Identification of Biodiversity Sensitive Receptors

Potential impacts to biodiversity arising from construction (Section 3.2) and operational (Section 3.3) activities are assessed in this section based on the base scenario of CR16 worksites. The ecological impacts were identified and described in Section 7.8.The latest proposed development plans used for this assessment were provided by the LTA on 31st March 2022.

The two main categories of impacts are (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 receptors are defined as areas within 150 m and 30 m from worksites of the proposed development respectively. This is to primarily account for edge effects in forests adjacent to worksites, based on studies that found edge effects affecting vegetation up to 150 m from forest boundaries (Paton, 1994; Murcia, 1995; Didham, 1997; Laurance and Bierregaard, 1997). The impact zone for faunal receptors is the entire forest as most fauna are mobile throughout the Study Area.

Table 7-41 List of Ecological Impacts

Receptor	Impact type	Description	Impact category
Construction Phase			
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
	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
	Change in species composition	Formation of forest edge habitats that favour the growth of certain exotic plants and fauna, and accidental introduction of exotic species from construction materials (such as soil with seeds or bio-degradable erosion blankets with insect eggs)	Indirect
Plant Species	Mortality	Direct removal of vegetation to create space for construction activities	Direct
	Impediment to seedling recruitment	Pollution of habitats from improper disposal of construction waste and accidental release of hazardous materials (such as construction slurry, paint, and/or solvents)	Indirect
	Competition from exotic plant species	Formation of forest edge habitats that favour the growth of certain exotic plants and accidental introduction of exotic species from construction materials (such as soil with seeds)	Indirect
	Decline in plant health and survival	Changes in microclimatic conditions (i.e., dust, noise, and light, temperature, and humidity) and hydrology	Indirect
Faunal Species	Loss of/reduction in habitats and food sources	Direct removal of vegetation to create space for construction activities	Direct
	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), and accidental kills by construction personnel	Direct
	Loss of ecological connectivity for faunal movement	Habitat fragmentation from the removal of vegetation	Indirect
Operational Phase			
Habitat	Change in plant species composition	Long-term changes in light, temperature, and humidity in habitats surrounding facility structures	Indirect

Receptor	Impact type	Description	Impact category
	Habitat degradation	Trampling on vegetation and pollution from increased human traffic	Indirect
Plant Species	Mortality	Stealing/poaching of plants by humans	Direct
	Competition from exotic plant species	Accidental and/or intentional release of exotic plants by humans	Indirect
Faunal Species	Collisions with buildings (birds only)	Distorted perceptions of reflective surfaces on buildings as flyways, greenery, and/or water	Direct
	Loss of ecological connectivity for faunal movement	Habitat fragmentation from the removal of vegetation	Indirect
	Injury or mortality	Navigation failures into the wrong areas and entrapment in facility structures	Indirect

7.6.1 Construction Phase

The construction phase consists of two stages – Pre-construction and Construction. Three main activities occur at pre-construction stage – i) road/traffic diversion, ii) site clearance and iii) establishment of temporary site offices. Main activities during the construction stage are construction of shafts, station boxes, ancillary structures and tunnel boring works. Since the impacts of pre-construction and construction stages may sometimes overlap, they will be assessed together.

7.6.1.1 Maju Forest

As base scenario of CR16 worksites, a at grade-level station access at Maju Forest and an underpass along Old Jurong Railway will connect CR16 station at Clementi Forest to Maju Forest. For this connection, 0.14 ha–constituting 1.71% of Maju Forest Study Area—of vegetation clearance and soil excavation is expected to occur. Four terrestrial habitat types and three plant species are likely to be impacted, while all faunal species recorded are expected to be impacted as most fauna are mobile throughout the Study Area (Figure 7-76). Additionally, ecological connectivity along Old Jurong Railway Corridor is expected to be impacted due to the proposed underpass along Old Jurong Railway Corridor. This underpass will directly impact (approximately) 0.19 km of the Old Jurong Railway Corridor. However, indirect impacts are expected to extend up to 2 km of the Old Jurong Railway Corridor.

A summary of the key biodiversity receptors impacted during construction phase within Maju Forest is shown in Table 7-42.

Table 7-42 Key Biodiversity Habitat Receptors Likely to Experience Direct and Indirect Impacts in Maju Forest During Construction Phase

Category	Key Biodiversity Receptor	Priority Level and Other Relevant Status	Direct Impact (% of Total Habitat Type within Study Area)	Indirect Impact (% of Total Habitat Type within Study Area)
Habitat	Native-dominated Secondary forest	Priority 1 Area of High Conservation Value	0.14 ha (1.71%)	1.98 ha (25.00%)
	Scrubland and Herbaceous Vegetation	Priority 3	NA	0.67 ha (12.15%)
	Waste Woodland	Priority 3	NA	0.25 ha (5.62%)
	Managed Vegetation	Priority 3	NA	1.47 (0.91 from Clementi Forest) ha (32.56%)

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor
- 150 m impact zone

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Waterbody

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
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Figure Title :
THE IMPACT ZONES 150 M FROM THE WORK SITES IN MAJU FOREST

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	Drawn JW	Date JUL 2022	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

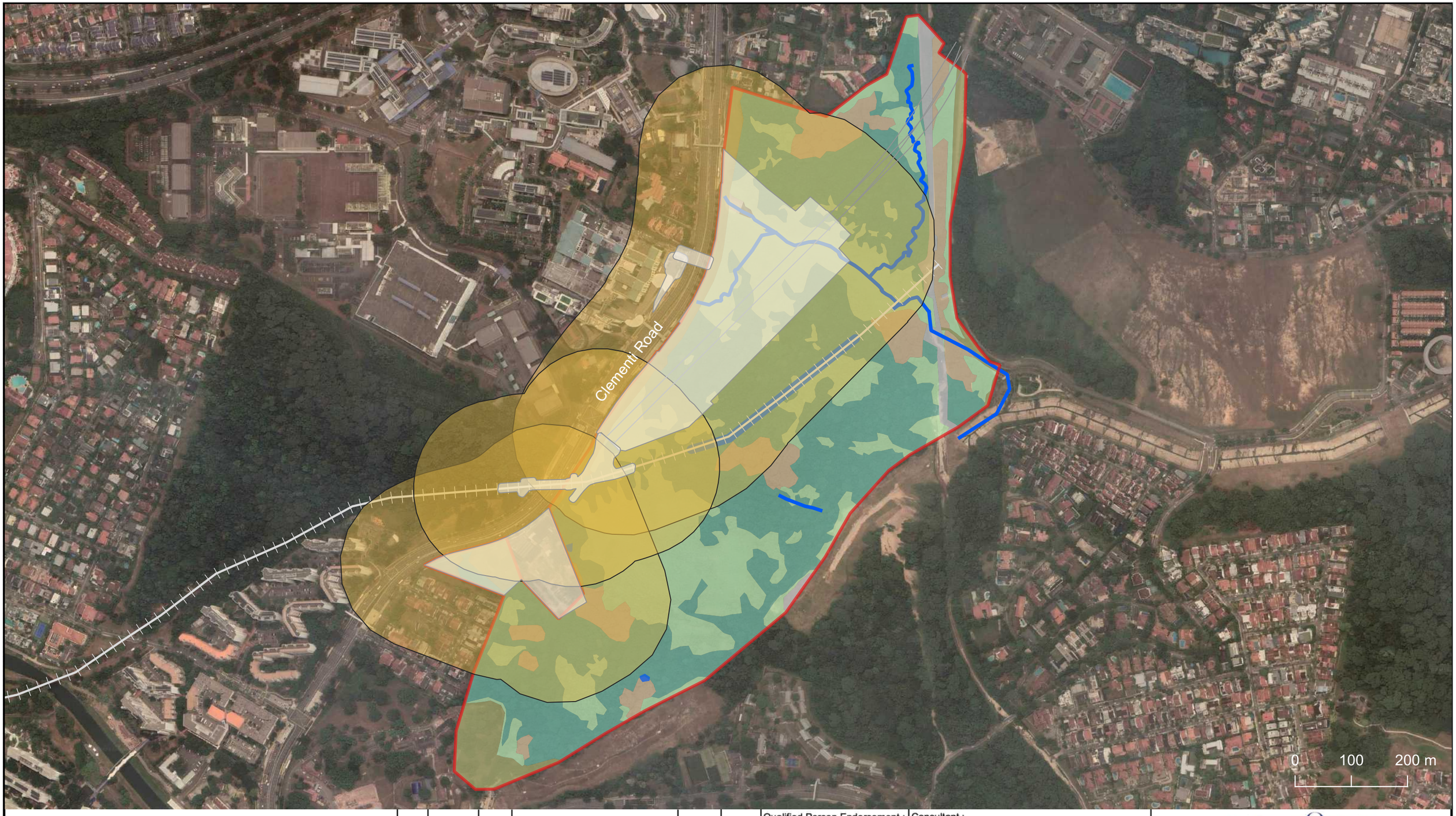
7.6.1.2 Clementi Forest

The CR16 Station with its cripple sidings and TBM launch/retrieval shafts will be constructed in the western part of Clementi Forest, with a section of cut and cover over the main stream as the base scenario of the CR16 worksites. The CR16 worksite is estimated to be approximately 12.4 ha, with 10.3 ha in Clementi Forest. Worksite clearance is expected to amount to of 18.2% of the Study Area (Figure 7-77). Four terrestrial habitat types, four waterbodies and 15 plant species are likely to be impacted, while all faunal species recorded are expected to be impacted as most fauna are mobile throughout the Study Area. Additionally, ecological connectivity along Old Jurong Railway Corridor is expected to be directly impacted due to the proposed development plans at Maju Forest and indirectly impacted due to work activities at Clementi Forest. The underpass will directly impact (approximately) 0.19 km of the Old Jurong Railway Corridor. However, indirect impacts are expected to extend up to 2 km of the Old Jurong Railway Corridor.

A summary of the key biodiversity receptors impacted during construction phase within Clementi Forest is shown in Table 7-43.

Table 7-43 Key Biodiversity Habitat Receptors Likely to Experience Direct and Indirect Impacts in Clementi Forest Woods During Construction Phase

Category	Key Biodiversity Receptor	Priority Level and Other Relevant Status	Direct Impact (% of total habitat type within Study Area)	Indirect Impact (% of total habitat type within Study Area)
Habitat	Abandoned-land Forest	Priority 1 Area of High Conservation Value	4.14 ha (14.28%)	Approximately 11.80 ha (40.68%)
	Scrubland and Herbaceous Vegetation	Priority 2	4.07 ha (22%)	Approximately 7.50 ha (40.50%)
	Waste Woodland	Priority 2	NA	Approximately 0.19 ha (4.00%)
	Managed Vegetation	Priority 3	1.95 ha (44.32%)	NA
	D/S22 and D/S2 Waterbodies	Priority 1 Area of High Conservation Value	150 m	Majority of the stream (1.38 km)
	A5 Pond	Priority 3	NA	0.01 ha (100% of total Corona Florist Pond)
	Waterlogged areas along the Old Jurong Railway	Priority 1 Area of High Conservation Value	NA	Majority of the stream (1.38 km)



Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Old Jurong Railway Corridor
- 150 m impact zone

Vegetation

- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

Qualified Person Endorsement :
NA

LTA Endorsement :
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Consultant : AECOM

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Project Title :
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Figure Title :
150 M IMPACT ZONE OF WORK SITES IN CLEMENTI FOREST

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JW	JAG/NHT	JAG	7-77	-	1 of 1
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Note: Source of basemap - Google Earth Map

7.6.2 Operational Phase

The main activities occurring at operational phase can be differentiated depending on the proposed development – either a station box or vent shaft. Station box (CR16 at Maju Forest and Clementi Forest), will be fully function as part of the entire Cross Island Line. The Study Areas will see an associated increase in human activity such as traffic movement, lighting, and general activities increase in the vicinity of the development. Stations are assumed to be operational from 5.30am to 12.00am daily with maintenance works of MRT and the relevant operational supporting systems expected to be undertaken during engineering hours (from 1am to 4am depending on rail operators) once per week for each station, as well as in cases of emergency or when necessary, during non-engineering hours (operational hours of the trainline).

7.6.2.1 Maju Forest

Though no permanent building structure, facilities such as lifts and ramps at the access point of Maju Forest are expected. An underpass is also expected along the Old Jurong Railway Corridor as a connection for the public from Maju Forest access point to Clementi Forest CR16 station; the underpass along Old Jurong Railway Corridor is present within the base scenario but will be removed from the mitigated scenario. Four terrestrial habitat types are likely to only be indirectly impacted, while all faunal species recorded are expected to be impacted as most fauna are mobile throughout the Study Area. Additionally, ecological connectivity along Old Jurong Railway Corridor is still expected to be impacted due to the proposed underpass along Old Jurong Railway Corridor. This underpass will directly impact (approximately) 0.19 km of the Old Jurong Railway Corridor. However, indirect impacts are expected to extend up to 2 km of the Old Jurong Railway Corridor.

A summary of the key biodiversity receptors impacted during operational phase within Maju Forest is shown in Table 7-44.

Table 7-44 Key Biodiversity Habitat Receptors Likely to Experience Direct and Indirect Impacts in Maju Forest During Operational Phase

Category	Key Biodiversity Receptor	Priority Level and Other Relevant Status	Indirect Impact (% of Total Habitat Type within Study Area)
Habitats	Native-dominated secondary forest	Priority 1 Area of High Conservation Value	2.05 ha (25.95%)
	Scrubland and herbaceous vegetation	Priority 3	0.62 ha (11.27%)
	Waste woodland	Priority 3	0.14 ha (3.11%)
	Managed vegetation	Priority 3	1.42 ha (31.56%)

7.6.2.2 Clementi Forest

The CR16 station worksite will be converted to permanent buildings as station box. Four terrestrial habitat types and four waterbodies are likely to only be indirectly impacted, while all faunal species recorded are expected to be impacted as most fauna are mobile throughout the Study Area. Additionally, ecological connectivity along Old Jurong Railway is expected to be directly impacted due to the proposed development plans at Maju Forest and indirectly impacted due to work activities at Clementi Forest. The underpass will directly impact (approximately) 0.19 km of the Old Jurong Railway Corridor. However, indirect impacts are expected to extend up to 2 km of the Old Jurong Railway Corridor.

A summary of the key biodiversity receptors impacted during operational phase within Clementi Forest is shown in Table 7-45.

Table 7-45 Key Biodiversity Habitat Receptors Likely to Experience Direct and Indirect Impacts in Clementi Forest During Operational Phase

Category	Key Biodiversity Receptor	Priority Level and Other Relevant Status	Indirect Impact (% of Total Habitat Type within Study Area)
Habitats	Abandoned-land Forest	Priority 1 Area of High Conservation Value	Approximately 11.80 ha (40.68%)
	Scrubland and Herbaceous Vegetation	Priority 2	Approximately 7.50 ha (40.50%)
	Waste Woodland	Priority 2	Approximately 0.19 ha (4.00%)

Category	Key Biodiversity Receptor	Priority Level and Other Relevant Status	Indirect Impact (% of Total Habitat Type within Study Area)
	Managed Vegetation	Priority 3	NA
	A1 and A2 Waterbodies	Priority 1 Area of High Conservation Value	Majority of the stream (1.38 km)
	A5 Pond	Priority 3	0.01 ha (100% of total Corona Florist Pond)
	Waterlogged areas along the Old Jurong Railway	Priority 1 Area of High Conservation Value	Majority of the stream (1.38 km)

7.7 Minimum Control Measures

This section lists biodiversity-specific minimum controls commonly implemented in Singapore for similar construction and operational activities. These are assumed to be implemented for the purpose of the impact assessment. Since work activities/methods are largely similar across the Study Areas, all minimum control measures proposed are applicable to all worksites. Subsequently, these measures should be proposed in tandem with that proposed for other environmental receptors (i.e., hydrology, noise, etc).

7.7.1 Construction Phase

Main construction activities that would likely occur at all worksites include vegetation clearance for worksite and excavation for levelling ground, followed by above and below ground construction. With the exception of Maju Forest (CR16) worksite, piling and TBM tunnelling will occur. With these work activities anticipated, the related minimum control measures are listed down in Table 7-46.

Table 7-46 Minimum Control Measures for the Construction Phase

Work Activities	Minimum Controls	Worksite
Vegetation Clearance	• Trees that are to be retained within worksite would require an 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. • 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. • Soil erosion control measures are to be executed once vegetation has been removed and soil is exposed as described in Section 8 under Hydrology and Surface Water Quality and Section 9 under Soil and Groundwater.	All
Excavation	• Implement soil erosion control measures as described in Section 8 under Hydrology and Surface Water Quality. • Implement dust control measures as described in Section 10 under Air Quality. • Implement noise barrier as described in Section 11 under Airborne Noise.	All
Above and Below 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 9 under Soil and Groundwater (and Waste).	All
Pilling and TBM Tunnelling Along Alignment	• Ensure noise levels are within approved limits as described in Section 11 under Airborne Noise. • Ensure vibration levels are within approved limits as described in Section 12 under Ground-borne Vibration.	All

General	• Installation of hoarding to delineate worksite.
	• Put in place wildlife management protocol with an approve wildlife management Contractor in accordance to Section 10 of 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 Manager on site.
		All

7.7.2 Operational Phase

Apart from presence of entrances and exits of CR16 station, there are largely no above ground buildings as most of the station's facility will be below ground. Despite minimal above ground structures, the presence of a new station will present as a new source of disturbance to the surrounding forest; higher levels of disturbances are also expected from increased human flow and vehicular traffic along the respective roads abutting the station. Additionally, regular/ad-hoc maintenance are also expected to occur. However, at the operational stage, not much can be controlled, apart from daily operational works and regular maintenance works.

7.8 Assessment of Ecological Impacts

7.8.1 Construction Phase

In this section, key biodiversity receptors identified are evaluated against potential sources of impacts based on the impact intensity of work activity from base scenario of worksites (refer to Table 6-6) and likelihood of impact occurring (refer to Table 6-7).

Following the assessment of ecological value for all plant species (Section 7.4), some were selected for the assessment of ecological impacts. The selection was based on the following: (1) species with specimens of conservation significance, large specimens, and/or other specimens of value found inside and within 30 m from the proposed worksite area, (2) keystone species, which are only the *Ficus* species in this Study, (3) species associated with important fauna, and (4) species that make up ≤ 1% of the total number of specimens of conservation significance. The selected species receptors were then evaluated based on impact intensity and likelihood, which eventually gives impact significance.

The various levels of impact intensity and likelihood for each impact type during the construction phase were specifically defined for plant species receptors.

A few assumptions were made in defining the levels of impact intensity for plant species receptors:

1. Habitats within 30 m from the worksites are assumed to experience the greatest extent of edge effects, though some studies have shown that edge effects could be up to 150 m. The effects of forest edges may be experienced by species more sensitive to microclimatic changes more than 30 m away from the worksites; these are considered during species-specific impact evaluations.
2. For tree/strangler species that are not bamboos or of conservation significance (i.e., native common or exotic species), and hence do not have count data, total specimen count was taken from arboricultural survey data. Note that the area for arboricultural surveys is a subset of the entire Study Area. For species with zero counts (i.e., were not recorded during arboricultural surveys), it is assumed that the intensity of impacts of work activities on them is negligible. The impacts, however, were still considered specifically for each species during evaluation.
3. For native common or exotic climbing fig species/species associated with important fauna that do not have count data from both floristic and arboricultural surveys, it is assumed that the intensity of impacts of work activities on them is negligible since most of these species are expected to be widespread. The impacts, however, were still considered considered specifically for each species during evaluation (e.g., *Ficus heteropleura* and *Ficus punctata*).

Table 7-47 Definitions of Each Level of Impact Intensity for All Four Impact Types During the Construction Phase for Plant Species Receptors

	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
Impediment to Seedling Recruitment	No specimens of this species are within 30 m from the worksites	Less than 50% of all plant specimens of this species are within 30 m from the worksites	More than or exactly 50% of all plant specimens of this species are within 30 m from the worksites	All specimens of this species are within 30 m from the worksites
Competition from Exotic Species				

	Negligible	Low	Medium	High
Decline in Plant Health and Survival				

Table 7-48 Definitions of Each Level of Likelihood for all Four Impact Types During the Construction Phase for Plant Species Receptors

	Mortality	Impediment To Seedling Recruitment	Competition From Exotic Species	Decline In Plant Health And Survival
Unlikely/Remote	No plant specimens of this species are within the worksites	Plants are epiphytes and/or do not grow on soil	No formation of forest edges (i.e., construction activities are fully underground and/or in existing built-up areas outside the forest)	
Less Likely/Rare	N.A.	N.A.	Formation of very little forest edges in managed vegetation only	
Possible/Occasional	No count data/locations of specimens of this species is available, but specimens could possibly be within the worksites	Plants that grow on soil and whose dispersals are not restricted, i.e., they disperse via wind, water, and/or terrestrial fauna	Formation of little forest edges in scrubland areas only	
Likely/Regular	N.A.	N.A.	Formation of some forest edges in a mix of managed vegetation, scrubland and forested areas	
Almost Certain/Continuous	Plant specimens of this species are within the worksite	Plants that grow on soil whose dispersals are restricted owing to environmental factors and/or growth strategies (e.g, bamboos that propagate via underground rhizomes and ground orchids)	Formation of new forest edges (i.e., complete clearance within forested areas)	

7.8.1.1 Maju Forest

7.8.1.1.1 *Habitats*

The most substantive impact to the habitats from construction phase at Maju Forest is of moderate significance and is a result of vegetation loss, habitat degradation and changes in species composition. There is no permanent building structure and site clearance of 0.44 ha would remove 1.33% of the total native-dominated secondary forest habitat present, resulting in low impact intensity. Coupled with likelihood of site clearance being certain, impact significance is moderate. While impact intensity is negligible for areas that are not directly affected by site clearance, together with likelihood of occurrence of unlikely, results in negligible impact significance.

The impact intensity of habitat degradation for native-dominated secondary forest is deemed to be medium because the habitat is highly susceptible though work activities are relatively small-scale. While the likelihood of habitat degradation impact differs for different habitat type depending on the proximity of habitat to worksite; because the native-dominated secondary forest is adjacent to the worksite, likelihood is higher than the rest of the habitats not adjacent to worksite. Therefore, with medium intensity and likelihood of possible, the highest impact significance from habitat degradation impact would be moderate to the native-dominated forest, while the remaining habitat types range from negligible to minor.

Changes in species composition is also expected to occur with the presence of new forest edge. Intensity is co-related to the spatial extend of exposed forest edge while the likelihood differs for different habitat type depending on the proximity of habitat to worksite. Clearing of 0.44 ha for worksite within the native-dominated secondary forest would result in formation of a new edge that will be susceptible to changes in species composition; likelihood of impact occurrence is possible as this new edge now resides adjacent to the worksite. Therefore, with medium

intensity and likelihood of possible, the highest impact significance from changes in species composition impact would be moderate to the native-dominated forest. Subsequently, the remaining habitat types range from negligible to minor

Summary of impact evaluation for the habitat at Maju Forest can be found in Appendix R1.

7.8.1.1.2 *Plant Species*

A total of 48 plant species recorded from Maju Forest were selected for the assessment of ecological impacts. In the assessment of the four types of impact on individual species during the construction phase— (1) mortality, (2) impediment to seedling recruitment, (3) competition from exotic species, and (4) decline in plant health and survival—the impact significance was negligible, low, moderate, or major. Here, we present the most severe impact for each species from the assessment of all four impact types. This was also carried out for the other Study Areas.

The significance of the impacts is major for one species, moderate for four species, minor for 41 species, and negligible for the remaining two species (Appendix R1).

The only species likely to experience major impacts is the nationally Vulnerable fern species *Pteris semipinnata*. This species is likely to experience major impacts because of two main reasons: (1) it is a species of conservation significance of high ecological value and (2) only one specimen of this species was recorded in Maju Forest and the specimen is location within the proposed worksite. As such, the impact of mortality on this species is major.

The four species likely to experience moderate impacts are (1) the nationally Vulnerable tree fern *Alsophila latebrosa*, (2) nationally Vulnerable climber species *Aspidopterys concava*, (3) nationally Endangered shrub species *Callicarpa longifolia*, and (4) nationally Critically Endangered climber species *Uncaria longiflora* var. *pteropoda*, all of which are species of conservation significance with high ecological value.

1) The impacts on *Alsophila latebrosa* is assessed to be moderate as approximately 5% of all specimens of this species recorded at Maju Forest are located within the proposed worksite. While the impact intensity is low, it is almost certain that these specimens would be affected by construction activities. Hence, the impact of mortality on this species is moderate.

2) The impacts on *Aspidopterys concava* is assessed to be moderate as 50% of all specimens of this species recorded at Maju Forest are located within 30 m from the proposed worksite, giving an impact intensity of the medium level. As a flowering seed plant that grows on soil and whose dispersal modes are not restricted, there is a possibility that seedling recruitment for 50% of the specimens found within 30 m from the proposed worksite may still be somewhat impeded as a result of construction activities, such as pollution from improper disposals and/or accidental release of construction waste. Hence, the impact of impediment to seedling recruitment is moderate.

3) The impacts on *Callicarpa longifolia* is assessed to be moderate for reasons identical to that for *Aspidopterys concava*.

4) The impacts on *Uncaria longiflora* var. *pteropoda* was assessed to be moderate for reasons identical to that for *Aspidopterys concava*.

The remaining 41 species likely to experience minor impacts are all of high ecological value. Most do not have any or have < 50% of all specimens recorded at Maju Forest located within 30 m from the proposed worksites, giving an impact intensity of negligible or low levels, respectively. As flowering seed plants that grow on soil and whose dispersal modes are not restricted, except for *Bambusa vulgaris* (see Table 7-48 for the definitions for each level of likelihood), there is a possibility that seedling recruitment may still be somewhat impeded. Hence, the impact of impediment to seedling recruitment is minor. As for *Bambusa vulagris*, while it is almost certain that propagation could be affected by construction activities since it reproduces underground via rhizomes, none of the specimens are located within 30 m from the proposed worksite. Hence, the impact of seedling recruitment on *Bambusa vulgaris* is minor.

The two species likely to experience negligible impacts are of medium ecological value and none of the specimens lie inside or within 30 m from the proposed worksites.

7.8.1.1.3 *Faunal Species*

Species that are most impacted by the proposed worksite are the terrestrial mammals, mainly due to the loss of ecological connectivity. The worksite for underpass proposed along Old Jurong Railway Corridor impacts an ecological connection, which is important for terrestrial fauna that requires it to move between forest patches (i.e.

Clementi Forest and Maju Forest). This results in major impacts significance to faunal species such as the Sunda pangolin (*Manis javanica*).

Bird species impacted are likely able to find alternative habitats in the surroundings. However, impacts are expected in the form of disturbances from noise, light and vibration. Impacts of disturbances to these species are unclear, but noise disturbances may affect its communication with other individuals. The impact intensity is considered low or medium, and overall impact significance is moderate.

As stream habitats are not directly or indirectly impacted by the worksite, the overall impact significance for most aquatic species is considered negligible or minor.

Ecological impacts to fauna are assessed to be negligible to minor from vibrations and noise generated during construction phase.

The detailed evaluation of impact significance to each species is shown in Appendix R1.

i) Birds

Minor impacts from habitat loss, injury and mortality are expected for the majority of the bird species in the Study Area as the worksite only affects 1.71% of the Study Area—with most of the bird species being highly mobile, they are able to move out of the impact zone and use other areas of the Study Area. Similarly, the loss of ecological connectivity from the construction of the underpass would unlikely impact the highly mobile bird species as they are able to still fly over from Maju Forest to Clementi Forest. However, less mobile species such as the red-legged crake (*Rallina fasciata*) which are more ground-dwelling, is possibly affected by the loss of connectivity from the construction of the underpass. But it will still be expected to eventually only experience minor impacts as impact intensity is considered low due to small area of worksite.

Subsequently, nesting records were observed for the changeable hawk-eagle (*Nisaetus cirrhatus*) in the middle of the site. Impacts to this species are largely from disturbances in the form noise, light and vibration. It has adapted to disturbed habitats such as parklands and is increasingly more widespread. They are likely able to use alternative habitats around the Study Area. Hence the impact intensity is expected to be low and impact significance is minor.

ii) Non-volant mammals

The Sunda pangolin (*Manis javanica*) species has been recorded from the CCNR and degraded forest fragments in Singapore. Notably, Singapore is a global stronghold for the species and is crucial in contributing to the conservation of pangolin populations globally. Yet, habitat loss, degradation and fragmentation, and road kills threaten the viability of the national population. The presence of infants also suggests a breeding population in the Study Area. However, because the worksite only results in loss of small area of habitats and based on distribution records, it is able to use other parts of the Study Area, the impact from habitat loss and mortality of fauna are deemed as possible/less likely to occur, resulting in only minor impacts. Instead, major impacts are incurred from the impediment of ecological connectivity along the Old Jurong Railway Corridor. This corridor is important to the pangolin as it allows the species to move between forest patches to sustain its large home range (7 - 41 ha) for survival (Lim, 2008).

Unlike the pangolin, being arboreal and highly adaptable, the long-tailed macaque (*Macaca fascicualris*) would experience minor impacts from the loss of connectivity. They are expected to be able to still cross over to Maju Forest and still utilise the resources there.

Subsequently, impacts from mortality and injury during the construction phase is deemed to be moderate for both the pangolin and macaque.

iii) Bats

The bamboo bat (*Tylonycteris sp.)* though not recorded within the worksite, it will not be affected by habitat loss. However, similar to most of the bat species, it may use the Old Jurong Railway Corridor, thus impacts were expected to be minor mainly due to loss in connectivity.

7.8.1.2 Clementi Forest

7.8.1.2.1 *Habitats*

The most substantive impact to the habitats from construction phase at Clementi Forest is of major significance and is a result of vegetation loss. During construction phase, site clearance will result in removal of 10.3 ha (constituting 18.2% of the Study Area). Worksite consists of three habitat types, with high ecological value

abandoned-land forest making up the largest proportion (4.14 ha; refer to Table 7-43 for area directly impacted by construction works). Lower ecological value habitat type such as the managed vegetation habitat (low ecological value; priority 3) would still experience moderate impacts significance from the loss of vegetation. Additionally, 150 m of the D/S1 and D/S2 stream would experience habitat loss due to cross over works. This results in major impact significance because the habitat loss in a relatively large area is considered permanent and irreversible. While impact intensity is negligible for areas that are not directly affected by site clearance, together with likelihood of occurrence of unlikely, results in negligible impact significance.

The impact intensity of habitat degradation for waterbodies are deemed to be high because the habitat is highly susceptible and work activities are planned directly along the stream. Subsequently, high intensity is also deemed for habitat that are adjacent to worksite due to the large scale of works. From discussions with engineers, there was also mention of bore piling works near the Old Jurong Railway Corridor. Coupled with likelihood of likely and possible, depending on proximity of habitat types to worksite, impact significance ranged from minor to major.

Changes in species composition is also expected to occur with the presence of new forest edge. Intensity is co-related to the spatial extend of exposed forest edge while the likelihood differs for different habitat types depending on proximity of habitat to worksite. Clearing of 10.3 ha for worksite within Clementi Forest would result in formation of new edges within abandoned-land forest, and scrubland and herbaceous vegetation habitats, that will be susceptible to changes in species composition; likelihood of impact occurrence is likely as this new edge now resides adjacent to the worksite. Therefore, with medium intensity and likelihood of possible, the highest impact significance from changes in species composition impact would be moderate to abandoned-land forest and scrubland and herbaceous vegetation habitats. Subsequently, the remaining habitat types have minor impact significance because they are not adjacent to the worksite.

Habitat degradation and changes in species composition impacts were not evaluated for managed vegetation habitat type as all the habitats within Study Area have been cleared for worksite.

Summary of impact evaluation for the habitat at Clementi Forest can be found in Appendix R2.

7.8.1.2.2 *Plant Species*

A total of 51 plant species recorded from Clementi Forest were selected for the assessment of ecological impacts. The significance of the impacts is major for nine species, moderate for 13 species, and minor for 29 species (Appendix R2).

All nine species likely to experience major impacts are of high ecological value. Of these, six species are likely to experience major impacts as a result of mortality, while three are likely to experience major impacts as a result of competition from exotic species and decline in plant health and survival.

1) The six species likely to experience major impacts as a result of mortality are (1) the nationally Presumed Extinct fern species *Asplenium nitidum*, (2) nationally Vulnerable shrub species *Chassalia chartacea*, and (3) four *Ficus* species (*F. benjamina*, *F. elastica*, *F. microcarpa*, and *F. variegata*). All *Asplenium nitidum* and *Chassalia chartacea* specimens and more than 50% of all four *Ficus* specimens recorded at Clementi Forest are located within the proposed worksite, giving an impact intensity of high and medium, respectively. It is almost certain that these specimens will be removed as site clearance is carried out for construction. As such, the impact of mortality on these species is major.

2) The three species likely to experience major impacts as a result of competition from exotic species and decline in plant health and survival are (1) the nationally Endangered *Ficus vasculosa*, (2) nationally Vulnerable herb species *Oldenlandia crispa*, and (3) nationally Critically Endangered *Selaginella argentea*. All specimens of these species recorded at Clementi Forest are located within 30 m from the proposed worksite, giving an impact intensity of high. As the habitats expected to be cleared for construction in Clementi Forest are a mix of managed vegetation, scrubland and herbaceous vegetation, and abandoned-land forest, it is likely that some forest edges will be formed as a result of the clearance. Assuming that forest edge effects are the greatest in habitats within 30 m from the cleared areas, all the specimens of the three species would experience competition from exotic species as the formation of forest edge habitats favours the growth of certain exotic plants. Additionally, changes in microclimatic conditions at forest edges may also cause a decline in plant health and survival of the specimens. As such, the impacts of competition from exotic species and decline in plant health and survival on these species is major.

Twelve out of the 13 species likely to experience moderate impacts are of high ecological value, while the remaining one species is of low (exotic tree species *Pterocarpus indicus*) ecological value, respectively. Most species would experience minor to moderate level impacts from all four impact types (Appendix R2).

All 29 species likely to experience minor impacts are of high ecological value. They are likely to experience minor impacts as a result of impediment to seedling recruitment, competition from exotic species, as well as decline in plant health and survival. The impact intensity of all three impact types is negligible or low for all species since none or less than 50% of the specimens are location within 30 m from the proposed worksite, respectively. As such, the impacts are minor for all three types of impact.

7.8.1.2.3 *Faunal Species*

Similar to Maju Forest, species that are most impacted by the proposed worksite are the terrestrial mammals. The loss of connectivity by the underpass in Maju Forest also leads to a loss of connectivity at Clementi Forest since they are directly connected.

Bird species impacted are likely able to find alternative habitats in the surroundings. However, impacts are expected in the form of disturbances from noise, light and vibration. Impacts of disturbances to these species are unclear, but noise disturbances may affect its communication with other individuals. The impact intensity is considered low or medium, and overall impact significance is moderate.

Stream habitats will be directly impacted by the worksites, resulting in loss of habitat for aquatic fauna. There are no hydrological impacts expected downstream. The overall impact significance for most aquatic species is considered moderate.

Ecological impacts to fauna are assessed to be minor from vibrations and noise generated during construction phase.

The detailed evaluation of impact significance to each species is shown in Appendix R2.

i) Aculeate hymenopteran

The halictid bee *Lipotriches takauensis* is nationally Vulnerable. It was recorded in the north-east part of the Study Area, away from the worksite. The habitat requirement of this species is unclear. Nevertheless, as it is likely able to use the entire Study Area, moderate impacts are expected from habitat loss.

ii) Odonates

Odonates have a part of their life cycle tied to the aquatic habitat, hence any changes to the aquatic habitat including hydrology, will be detrimental. However, waterbodies that these odonates have been recorded at will not be directly affected by construction works (i.e. removal of habitat)—resulting in negligible impact significance for loss or reduction in habitats and food sources.

The small duskhawker (*Gynacantha bayadera*) was recorded in the southern part of Study Area which will not be impacted. The variable featherlegs (*Copera vittata*) was recorded along the Old Jurong Railway Corridor. While their habitats are not directly impacted, they may use the Old Jurong Railway Corridor to move between forest patches. While they are volant, the presence of works may cause them to avoid using the corridor. Hence, the affected connectivity along Old Jurong Railway Corridor may have moderate impacts on this species.

iii) Butterflies

The Formosan swift (*Bornbo cinnara*) and common birdwing (*Troides helena cerberus*) are both and likely able to find alternative habitats within or adjacent to the Study Area, only negligible or minor impacts are expected.

iv) Birds

Moderate to minor impacts from habitat loss, injury and mortality are expected for the majority of the bird species in the Study Area as the worksite affects about 18.2% of the Study Area; but with most of the bird species being highly mobile, they are able to move out of the impact zone and use other areas of the Study Area. Similarly, the loss of ecological connectivity from the construction of the underpass would unlikely impact the highly mobile bird species as they are able to still fly over from Clementi Forest to Maju Forest. However, less mobile species such as the red-legged crake (*Rallina fasciata*) which are more ground-dwelling, is possibly affected by the loss of connectivity from the construction of the underpass. But it was still expected to eventually only experience minor impacts as impact intensity was considered low due to small area of worksite.

It should be noted that while impacts of disturbances to these bird species are unclear, noise and vibration disturbances may also result in decline in species fitness and survival. Noise disturbances may affect its communication with other individuals and light disturbances may reduce the suitability of habitat for its breeding.

v) Reptiles

The Malayan softshell turtle (*Dogania subplana*) was recorded along the forest stream within the northern portion of Clementi Forest. It will not be affected by hydrological loss. However, as this species can travel to and utilise other parts of the stream, moderate impacts were expected from loss of habitats and injury/mortality. Subsequently, as the stream would be affected by works, ecological connectivity would also moderately impact this species.

vi) Non-volant mammals

Though not recorded within Clementi Forest during field surveys, species has been included in this assessment as the Sunda pangolin was recorded in Maju Forest and is likely to be using Clementi Forest as well. The worksite results in loss of large area of habitats within Clementi Forest that could be the potential habitat for the Sunda pangolin. Impacts such as habitat loss and mortality of fauna are deemed as possible to occur, resulting in only moderate impacts. Subsequently, major impacts are incurred from the impediment of ecological connectivity along the Old Jurong Railway Corridor. This corridor is important to the pangolin as it allows the species to move between forest patches to sustain its large home range (7 - 41 ha) for survival (Lim, 2008).

Unlike the pangolin, being arboreal and highly adaptable, the long-tailed macaque (*Macaca fascicualris*) would experience minor impacts from the loss of connectivity. They are expected to be able to still cross over to Maju Forest and still utilise the resources there.

Lastly, impacts from mortality and injury during the construction phase is deemed to be moderate for both the pangolin and macaque.

vii) Bats

Visual roost emergence surveys detected bamboo bats acoustically at two of the clusters (BB_02 and BB_03) within the worksite, although roosting was not confirmed. Three bamboo bats were detected flying around the bamboo clusters. As silts were observed on the bamboos, they were deemed as potential roosting sites for the bamboo bats. Bamboo bats are not known to have roost fidelity and can use multiple bamboos. Despite that, because of limited information on these species, it should be assumed that removing potential rooting site will result in habitat loss, mortality, displacement and, decline in fitness and survival of the bamboo bats. Subsequently, it is a nocturnal species, and will be subjected to disturbances in the form of noise, light and vibration that may be detrimental to it. Hence, major impacts were expected from habitat loss and injury/mortality of individuals.

7.8.2 Operational Phase

The various levels of impact intensity and likelihood for each impact type during the operational phase were specifically defined for plant species receptors.

Table 7-49 Definitions of Each Level of Impact Intensity for Both Impact Types During the Operational Phase for Plant Species Receptors

	Negligible	Low	Medium	High
Mortality	No plant specimens of this species could get stolen	Less than 50% of plant specimens of this species could get stolen (i.e., most plant species)	More than or exactly 50% of all plant specimens of this species could get stolen (i.e., orchids)	All plant specimens of this species could get stolen (i.e., pitcher plants)
Competition from Exotic Species	Only native species are planted	Exotic species listed as 'Cultivated Only' are planted	Exotic species listed as 'Casual' are planted	Exotic species listed as 'Naturalised' are planted

Table 7-50 Definitions of Each Level of Likelihood for Both Impact Types During the Operational Phase for Plant Species Receptors

	Mortality	Competition From Exotic Species
Unlikely/Remote	Species not known to have been stolen before	Original vegetation mostly retained with no new landscaping
Less Likely/Rare	N.A.	N.A.
Possible/Occasional	Flowering species known to have been stolen before	Some original vegetation retained with some new landscaping (e.g., Springleaf Precinct, Rifle Range Nature Park)
Likely/Regular	N.A.	N.A.
Almost Certain/Continuous	"Charismatic species" known to be stolen most of the time (i.e., pitcher plants and orchids)	Original vegetation mostly cleared with new large-scale landscaping (e.g., Tengah Forest Town)

7.8.2.1 Maju Forest

7.8.2.1.1 *Habitats*

At the operational stage, only habitat degradation impact and changes in species composition impacts are expected to occur. Similar to the construction phase, likelihood depends on the proximity of receptors to, in this case, operational footprint. Operational footprint is much smaller than construction footprint as the area not used will be reinstated to managed vegetation (assuming to be turfed). Therefore, the habitats that used to adjacent to work site are not adjacent to operational footprint anymore.

Habitat degradation appears to be less likely to occur because of 1. habitats will probably not be directly adjacent to station access as the reinstated area becomes a buffer for these habitats, 2. public are not legally allowed to enter these adjacent habitats and pollute them and 3. operational works are at a much lower intensity than construction phase. Therefore, intensity of habitat degradation is deemed to be low; together with likelihood of less likely, impact intensity is at negligible to minor.

Species composition is likely to change for habitats that were once adjacent to worksite during the construction phase because a forest edge has been exposed which will almost always favour the growth of certain exotic plants and fauna and is more susceptible to accidental/purposeful (from humans) introduction of exotic species. Therefore, assessment remains as status quo from construction phase – minor to moderate impact significance.

Summary of impact evaluation for the habitat at Maju Forest can be found in Appendix R1.

7.8.2.1.2 *Plant Species*

A total of 48 plant species recorded from Maju Forest were selected for the assessment of ecological impacts. In the assessment of the two types of impact for individual species during the operational phase—(1) mortality and (2) competition from exotic species—the impact significance was negligible, low, moderate, or major. Here, we present the most severe impact for each species from the assessment of both impact types. This was also conducted for the other Study Areas.

The significance of the impacts is moderate for 46 species, all of which are of high ecological value, and minor for two species of medium ecological value (Appendix R1). The species are likely to experience moderate impacts as a result of competition from exotic plant species. It is assumed that casual species, i.e., species that "do not form self-replacing populations and rely on repeated introductions or limited asexual reproduction for persistence" (Chong et al., 2009), would be planted as part of landscaping efforts during the operational phase, giving an impact intensity of the medium level. This is a possible event as some original vegetation are expected to be retained, with some others cleared and replaced with landscaping. Hence, the impact of competition from exotic species is moderate.

7.8.2.1.3 *Faunal Species*

The impact significance is expected to be negligible from the collision of birds with buildings and injury/mortality of fauna. However, with the infrastructure in place along the Old Jurong Railway Corridor, the impact significance from the loss of ecological for species likely using the Old Jurong Railway Corridor for connectivity is expected to be major for terrestrial species such the Sunda pangolin (*Manis javanica*).

Ecological impacts to fauna are assessed to be negligible to minor from vibrations and noise generated during operation phase.

7.8.2.2 Clementi Forest

7.8.2.2.1 *Habitats*

At the operational stage, only habitat degradation impact and changes in species composition impacts are expected to occur. Similar to the construction phase, likelihood depends on the proximity of receptors to, in this case, operational footprint. Operational footprint is much smaller than construction footprint as the area not used will be reinstated to managed vegetation (assuming to be turfed). Therefore, the habitats that used to adjacent to work site are not adjacent to operational footprint anymore.

Habitat degradation appears to be less likely to occur because of 1. habitats will probably not be directly adjacent to station access as the reinstated area becomes a buffer for these habitats, 2. public are not legally allowed to enter these adjacent habitats and pollute them and 3. operational works are at a much lower intensity than construction phase. Therefore, intensity of habitat degradation is deemed to be low; together with likelihood of less likely, impact intensity is at negligible to minor.

Species composition is likely to change for habitats that were once adjacent to worksite at the construction phase because a forest edge which has been exposed will almost always favour the growth of certain exotic plants and fauna and is more susceptible to accidental/purposeful (from humans) introduction of exotic species. Therefore, assessment remains as status quo from construction phase – minor to moderate impact significance.

Habitat degradation and changes in species composition impacts were not evaluated for D/S22 stream as all the habitat within Study Area has been cleared during construction phase.

Summary of impact evaluation for the habitat at Clementi Forest can be found in Appendix R2.

7.8.2.2.2 *Plant Species*

A total of 51 plant species recorded from Clementi Forest were selected for the assessment of ecological impacts. The significance of the impacts is major for one species, moderate for 48 species, and minor for the remaining two species (Appendix R2).

The only species likely to experience major impacts is the nationally Critically Endangered terrestrial orchid *Dienia ophrydis*. This species is likely to experience major impacts as a result of mortality because, as an orchid species, more than 50% of all plant specimens could get stolen, giving an impact intensity of medium. This is based on the assumption that members of the public are able to recognise specimens of this species in the Study Area. Orchids are also known to have been stolen, hence the likelihood of mortality is almost certain. With medium impact intensity and almost certain likelihood, this gives an impact significance of major.

The other 48 species are likely to experience moderate impacts as a result of competition from exotic species. All 48 species are of high ecological value. It is assumed that casual species, i.e., species that “do not form self-replacing populations and rely on repeated introductions or limited asexual reproduction for persistence” (Chong et al., 2009), would be planted as part of landscaping efforts during the operational phase, giving an impact intensity of the medium level. This is a possible event as some original vegetation are expected to be retained, with some others cleared and replaced with landscaping. Hence, the impact of competition from exotic species is moderate.

There are two species likely to experience minor impacts as a result of competition from exotic species. They are the exotic tree species *Pterocarpus indicus*, which has low ecological value, and the common native tree species *Syzygium grande*, which has medium ecological value. Nonetheless, it could still face competition from other exotic species planted as part of landscaping efforts. Hence, the impact of competition from exotic species is minor.

7.8.2.2.3 *Faunal Species*

The impact significance is expected to be negligible from the collision of birds with buildings and injury/mortality of fauna. However, with the infrastructure in place along the Old Jurong Rail, the impact significance from the loss of ecological for species likely using the Old Jurong Railway Corridor for connectivity is expected to be major for terrestrial species such the Sunda pangolin (*Manis javanica*).

Ecological impacts to fauna are assessed to be negligible from noise and minor from vibrations generated during operational phase.

7.9 Recommended Mitigation Measures

In this section, mitigation measures for the Project are discussed. Mitigation measures are implemented in the following order: (1) avoidance (elimination), (2) minimisation (substitution, engineering controls and administrative controls), and (3) compensation and enhancement. Avoidance of the impact is first attempted. If avoidance is not possible, the construction impacts should be minimised. Finally, if habitat loss must occur, compensation and enhancement of remaining/nearby habitats should be suggested as a form of impact mitigation.

It is important to note that the successful implementation of mitigation measures requires the commitment of Contractors, arborists, and biodiversity specialists. Some of the major concerns around this proposed Project include habitat loss, habitat connectivity and potential fauna mortality.

7.9.1 Mitigation at Design Phase

Although impacts only occur downstream (i.e., construction phase onwards), the design stage is of paramount importance. The design can significantly influence the extent of impacts, as the structural design will dictate the location of structures, construction methods and the intensity of impacts caused during the construction and operational phases.

7.9.1.1 Maju Forest

7.9.1.1.1 *Avoidance (Elimination)*

- It is recommended to shift access to CR16 worksite and avoid using the Old Jurong Railway Corridor as underpass for access from CR16 to Maju Forest as it is currently situated on areas of high conservation value (Figure 7-74). Furthermore, the shift is recommended to avoid disrupting the ecological connectivity for faunal movement along Old Jurong Railway.
- To mitigate biodiversity impacts to ecological valuable biodiversity, LTA has agreed to shift construction works, completely removing worksite from the Maju Forest (Figure 7-78).

Legend

- Study Area
- Old Jurong Railway Corridor

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody
- Mitigated Scenario Construction Worksite Footprint
- Proposed CRL Alignment (Mitigated)
- Base Scenario Construction Worksite Footprint
- Proposed CRL Alignment (Base)

N

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-	JUL 2022	JW	EIS (Clementi Forest and Maju Forest)	JAG/NHT	JAG

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Consultant : AECOM

Land Transport Authority — We Keep Your World Moving

Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
(A) RECOMMENDED DESIGN SHIFT IN CR16 ACCESS POINT AS MITIGATED SCENARIO AND (B) CURRENT CR16 ACCESS POINT AS BASE SCENARIO

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Note: Source of basemap - Google Earth Map

7.9.1.1.2 *Minimisation (Engineering Controls) / Enhancement*

- Retain fruit and fig trees, which are known food sources. Some examples are *Leea indica*, *Bridelia tomentosa*, *Clausena excavata*, *Dillenia suffruticosa* and *Ficus spp*. (LCKNHM, 2020b).
- Retain large trees (≥ 0.5cm DBH) and fallen logs which are known to be used by the pangolin for their natal dens (Lim & Ng, 2007).
- On the ground, considerations for increasing connectivity include:
    - Plant keystone flora such as fig trees. These trees have uncoordinated fruiting periods but fruit abundantly when in season. Fig trees are important food source for avian fauna and small mammals. In addition, planting of flowering plants will attract the pollinators such as butterflies, bees, wasps and improve ecological processes.
    - Increase vertical vegetation structures (i.e., ground cover, shrub, understorey and canopy layers) and forms (e.g., epiphytes, shrubs, ferns, trees).
    - It is recommended that only native plant species are planted because they are genetically representative of the region's biodiversity and higher conservation value.
    - Select a diversity of flowering and fruiting plant species to include butterfly and bird attracting plant species. The planting palette should be planned for continuous flowering and fruiting throughout the year in order to provide food and improve ecological processes. However, planting location of bird attracting species should take into consideration bird collisions recommendations.
    - Prioritise intensive greening along streets or in areas with low disturbances (e.g., low traffic volumes and speeds, low human activities).

7.9.1.2 Clementi Forest

7.9.1.2.1 *Avoidance (Elimination)*

- It is recommended that above ground building should have no opening where fauna can be trapped.
- It is recommended to shift CR16 worksite and avoid affecting the sensitive waterbodies within Maju Forest (i.e. D/S1, D/S2 and D/S22) (Figure 7-75). However, it is noted that due to the alignment, major shifts in the worksite are not practical and possible. Therefore, given this circumstance, it is recommended that priority is given to shift works away from the main stream (D/S1 and D/S2) over the tributary (D/S22). This is because the main stream (D/S1 and D/S2) habitat appears to be better at supporting a diversity of species (refer to Section 7.3.3.2.5).
- To mitigate for biodiversity impacts to ecological valuable biodiversity, LTA has agreed to shift construction works away from the northern tip of CR16 worksite through worksite area optimization, hence reducing the footprint of CR16 construction worksite (Figure 7-79).

(A)

(B)

Clementi Road

Clementi Road

0 50 100 m

Legend

- Study Area
- Old Jurong Railway Corridor

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody
- Mitigated Scenario Construction Worksite Footprint
- Proposed CRL Alignment (Mitigated)
- Base Scenario Construction Worksite Footprint
- Proposed CRL Alignment (Base)

N

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Land Transport Authority
We Keep Your World Moving

Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
(A) RECOMMENDED DESIGN SHIFT IN CR16 WORKSITE AS MITIGATED SCENARIO AND (B) CURRENT CR16 WORKSITE AS BASE SCENARIO

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Note: Source of basemap - Google Earth Map

7.9.1.2.2 *Minimisation (Substitution)*

Bird Collision can be reduced by substituting certain aspects of bird-friendly building design. Bird-friendly building design can significantly reduce the incidences of bird collisions, especially for higher storeys that are above tree canopy height. Although the proposed CR16 station box does not appear to be higher than two storeys, because of the proximity of these buildings to forested areas, bird collisions are still possible. Some recommendations are stated here (Sheppard & Phillips, 2015):

- Minimise the quantity or surface area of glass. This could be achieved by reducing the amount of glass façade or installing a decorative cladding over the glass façade so that the reflections on the glass facades are broken up.
- Incorporate features that increase the visibility of glass (including mirrored and non-mirrored reflective glass, and transparent glass) or dampen reflections to reduce the appearance of clear passage to sky or vegetation. Possible strategies include film coating (e.g., CollidEscape; http://www.collidescape.org), angled glass, interior or exterior shades, decals, fenestration patterns, grilles, sunshades, screens, blinds and netting. Exterior shades confer the freedom of choosing to only use it during periods where bird collisions are expected to be most frequent, such as during the migratory seasons.
- When decals or patterns are added to increase the visibility of the glass, it is advised that the pattern should be as dense as possible as it will appear more clearly as a solid object to birds and thus be more effective (Green Development Standard, 2007). For example, for WindowAlert decals, it is recommended for decals to be 5 cm apart horizontally and 10 cm apart vertically (FLAP, n.d.).
- Avoid interior vegetation near windows as birds may confuse this with exterior vegetation and fly towards them.
- Avoid planting vegetation close to glass so that reflection of vegetation does not confuse birds, which may fly into the building. If there are sides which are close to the natural vegetation, the façade should have shades installed or netting that are a short distance away from the glass to prevent birds from crashing into it.
- Buildings should not have courtyards or corridors that are enclosed by glass as these may confuse birds to fly through.
- Animals perceive light differently from humans. Any level of artificial light above that of moonlight masks the natural rhythms of lunar sky brightness and thus, can disrupt patterns of foraging, mating, as well as the circadian rhythm (Voight et al., 2018; P-89). Artificial lighting at night (ALAN) can disorient birds, bats and insects, altering their behaviour that results in them being more vulnerable to predation and other risks (Blackwell et al., 2015; P-4). For example, ALAN may repel light-adverse bats from lit areas and restrict their use of commuting or feeding space. If night-time works are essential, it is recommended to adopt the following framework:
    - Prevent areas from being artificially lit, where lighting should only be installed when necessary.
    - Limit the duration of lighting, where peak nocturnal fauna activity is avoided.
    - Reduce the trespass of lighting. This can be done via the use of a minimal number of luminaires, at low positions in relation to the ground, directed and shielded to provide the least amount of spill to adjacent habitats while achieving the necessary lighting levels for working safely (Figure 7-80 and Figure 7-81). Accessories such as baffles, hoods or louvres can be used to reduce light spill and direct it only to where it is needed (ILP, 2018).
    - Change the spectrum of lighting. Lights with reduced or filtered blue, violet and ultra-violet wavelengths should be used. Short wavelength light (blue) scatters more readily in the atmosphere and therefore contributes more to sky glow than longer wavelength light. Furthermore, most wildlife is sensitive to short wavelength (blue/violet) light. Therefore, as a general rule, only lights with little or no short wavelength (400–500 nm) violet or blue light should be used to avoid unintended effects. Where wildlife is sensitive to longer wavelength light (e.g., some bird species), consideration should be given to wavelength selection on a case-by-case basis. It is also recommended that warm colour temperature light sources to be employed preferably at <2,700 Kelvin.
    - Setting dark buffers, illuminance limits and zonation.
    - Species-specific strategy.

Figure 7-80 Low Level Bollards Directed Downwards and Shielded to Limit Lighting to Only the Area Intended

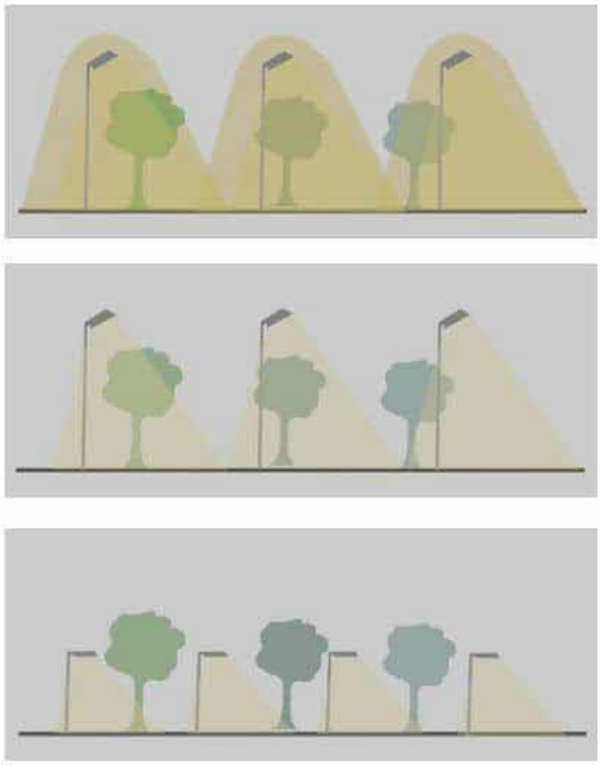


Figure 7-81 Combined Effect of Shielded Luminaires and Short Poles on Reducing Light Trespass. First Picture—Unshielded Luminaires, Second—Luminaires with Shield, Third—Shielded Luminaires on Short Poles which Cut-Off Light Trespass and Keep Adjacent Areas Dark.

7.9.1.2.3 *Minimisation (Engineering Controls) / Enhancement*

- Subsequently, despite the recommendations proposed above, it should not indicate that D/S22 is of lower priority and can be removed. The hydrology of Clementi Forest should remain as it is to ensure no downstream impacts (refer to Section 8). Box culverts or stream diversion of D/S22 are some of the mitigating measures that can be applied to ensure that hydrology remains intact.

7.9.2 Mitigation in Construction Phase

Mitigation measures stated here should be relevant for all the Study Areas and enforced if applicable. Most of the mitigation measures stated have overlapping and cascading effects on other impacts. For example, reviewing the construction footprint primarily reduces working space and the need for vegetation removal. Subsequently, this would also reduce other potential impacts such as habitat degradation, fauna and flora mortality, and the decline in species fitness and survival etc. Therefore, the relevant mitigation measures proposed should be implemented as good practice even if the impacts were evaluated as insignificant (i.e. negligible or minor).

7.9.2.1 Flora

7.9.2.1.1 *Avoidance (Elimination)*

- Ensure there are no works and disturbances to areas outside of worksite, especially into areas of high conservation value as shown in Section 7.5 (Maju Forest – Figure 7-74; Clementi Forest – Figure 7-75). This includes prohibiting workers access to Old Jurong Railway for any reasons.
- Ensure any associated slope stabilisation and grading works will not impact topography of areas outside worksite and, water quality and hydrology of the waterbodies within the Study Area; this includes Old Jurong Railway for any reasons. The proposed 30-m buffer to waterbodies and areas of high conservation value should be observed at all times (Maju Forest – Figure 7-74; Clementi Forest – Figure 7-75).
- Consider engaging arborists, flora and fauna specialists to clearly mark out areas and plants with conservation value before the start of works. This would minimise the working space, reduce the disturbance to adjacent forested areas and eliminate the need of removing specimens of value and plants of conservation significance as much as possible. It is important to conserve large trees and fruit trees as they serve important ecological processes and provide habitat and food for faunal species.
- To eliminate the need of removing bamboo clusters found within worksites as they are found to be potential roosting sites for the Critically Endangered bamboo bats (*Tylonycteris spp.*). Proper Tree Protection Zones (TPZs) should be established to ensure proper conservation of these bamboo clusters (if any).

7.9.2.1.2 Minimisation (Substitution, Engineering and Administrative Controls)

- Transplant or harvest trees/saplings of conservation significance instead if they are to be cleared.
- Erect Tree Protections Zones to prevent encroachment of construction activities and excessive vegetation clearance around retained trees or areas (if any).
- Conduct regular inspections to ensure Contractor compliance and identify any impacts to the adjacent forested areas.

7.9.2.2 Fauna

7.9.2.2.1 *Avoidance (Elimination)*

- It is recommended to avoid felling trees and clearing vegetation during the peak bird breeding season (March to July).

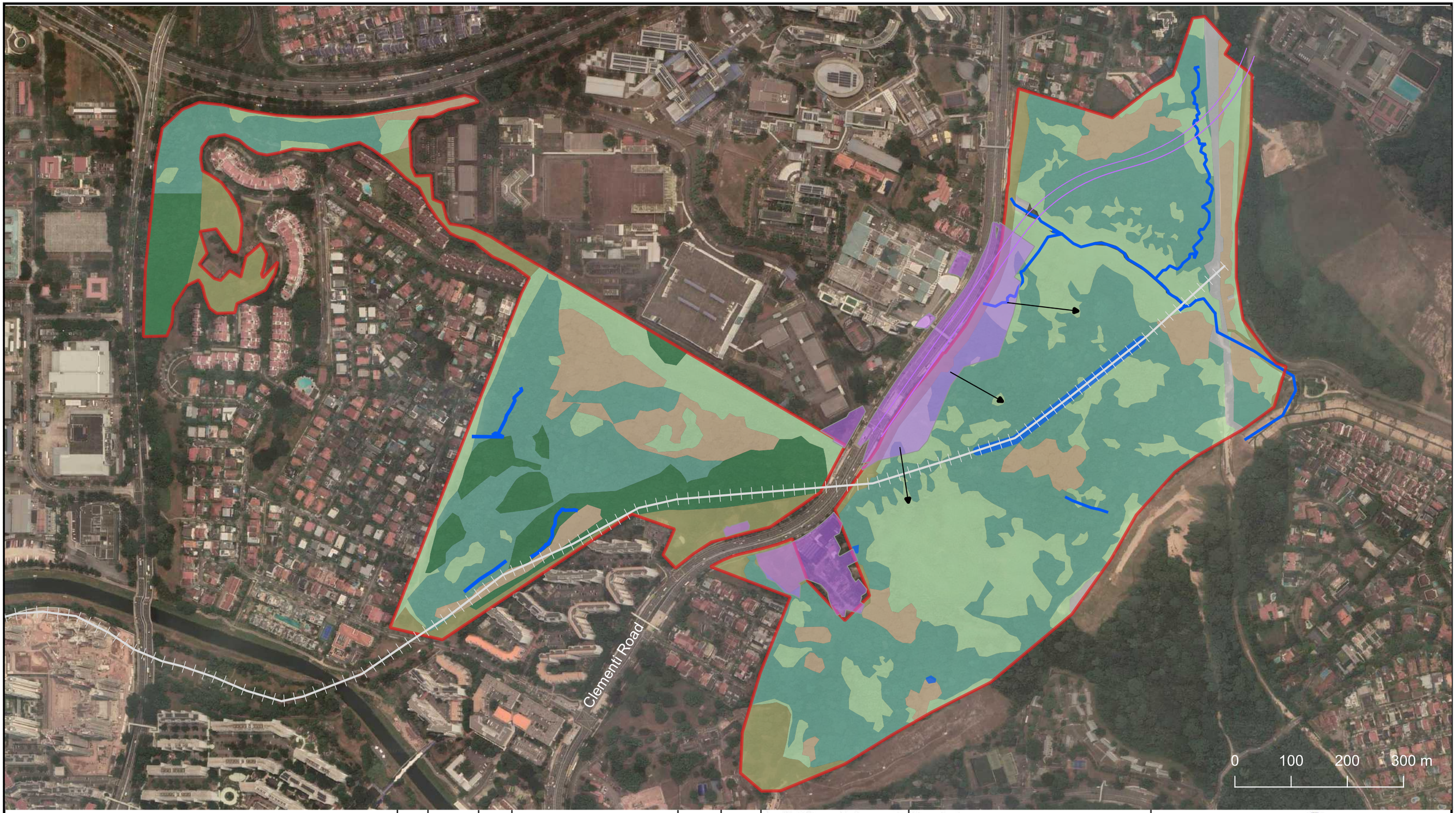
7.9.2.2.2 *Minimisation (Substitution, Engineering and Administrative Controls)*

- Wildlife shepherding via directional clearing should be adopted over the usual site clearance (Figure 7-82). This entails clearing the site from built up areas towards forested refuge areas so as to avoid trapping ground-dwelling mammals within the site. This should be planned and overseen by an Ecologist. Table 7-51 describes the direction that should be adopted for each worksite.
- Pre-felling fauna inspection should be conducted before felling any trees or removing any vegetation. This should be planned and overseen by an Ecologist.
- Noisy work activities should only be allowed from 0900–1700-h.

- Above-ground works not critical for safety reasons should be avoided to prevent disturbance to nocturnal fauna; recommended to restrict working hours to 0700–1900-h. If night works are necessary, lighting strategies as mentioned in Section 7.9.1.2.2 should be adopted.
- Subsequently, noise impacts from night work would need to be kept to the minimal as well. Measures that should be adopted can be found in Section 11.10.
- Retain ground cover for as long as possible before removal. When ground cover is removed, earth control measures (ECM) are to be in place. Use only fully biodegradable erosion control blankets (ECB) to avoid trapping fossorial fauna such as snakes.
- Train site personnel on biodiversity awareness and actions to take when encountering wildlife.
- Ensure good housekeeping controls such as provision of wildlife proof bins and eating areas.
  - Execute fauna response and rescue protocol when fauna is found on-site—as specified in Appendix K.
  - Monitor the water quality and aquatic faunal community in retained streams and streams adjacent to the construction areas.
  - Ensure silt fences or other silt control measures along the site hoarding are installed and maintained properly.
  - Practise due diligence in proper storage and handling of machinery to prevent leaching of oil or harmful materials such as bentonite slurry. Store and handle harmful materials well away from waterbodies.
- Engage a Qualified Erosion Control Professional (QECP) to formulate and implement ECM plan in accordance with PUB requirements.
- Implement dust control measures such as dust screens and water suppression systems.
- Implement acoustic barriers to reduce noise pollution outside worksites.
- Conduct regular site inspections to ensure Contractor compliance and to identify potential fauna entrapments.

Table 7-51 Direction of Clearing to be Adopted at Each Study Area

Work Site	Directional Of Clearing
CR16 Station (Clementi Forest**)**	The development clearance of vegetation should be done in the direction towards undisturbed forested areas adjacent to the Green Corridor forest. More importantly, concurrently, the Old Jurong Railway should remain undisturbed to allow ground-dwelling fauna to move towards the undisturbed forest at Maju Forest.



Legend

- Study Area
- Old Jurong Railway Corridor

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Cleared area
- Waterbody
- Mitigated Scenario Construction Worksite Footprint
- Proposed CRL Alignment (Mitigated)
- Direction of clearance

N

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Project Title :
CONTRACT 2005 ENVIRONMENTAL IMPACT STUDY (CLEMENTI FOREST AND MAJU FOREST)

Figure Title :
SHOWING DIRECTION OF CLEARING AT CLEMENTI FOREST

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7.9.3 Mitigation in Operational Phase

Mitigation measures stated here should be relevant for all the Study Areas and enforced if applicable. However, most of the strategies for avoidance (elimination) and enhancement should have been considered during the design phase. Minimisation (substitution, engineering control and administrative controls) would be the most applicable at the operational phase.

7.9.3.1 Flora

- Areas not used should be returned to earth ground and replanted if possible. Planting scheme should be as similar to forest composition to adjacent forest, if not as native as possible. Other than minimising edge effects, it can serve as a natural barrier to light, noise and dust to reduce disturbance. As a general guide, 400 trees should be replanted for every hectare to be reinstated.
- Conduct regular site inspections in the initial operational phase (at least 6 months) to ensure that proposed planting/mitigating measures are effective and to identify any impacts to the adjacent forest areas.

7.9.3.2 Fauna

- Conduct regular site inspections in the initial operational phase to ensure that proposed mitigating measures are effective and to identify any impacts to the adjacent forest areas. Key species such as the straw-headed bulbul and Sunda pangolin should be monitored. This will contribute to evaluating the actual impact of the developments.
- If night lighting such as street lighting around the station is required, wildlife friendly night lighting as mentioned in Section 7.9.1.2.2 should be adopted.

7.10 Residual Impacts

Impacts evaluated to have major and moderate significance in Section 7.8 were addressed with appropriate mitigation measures to reduce the impact as much as possible. However, the significance of certain impacts such as site clearance (resulting in vegetation and habitat loss) remains as major because it is a permanent and irreversible impact that cannot be mitigated. Hence, the greatest impact significance of proposed developments at some of the Study Areas are still expected to be major/moderate.

7.10.1 Construction Phase

7.10.1.1 Maju Forest

7.10.1.1.1 *Habitats*

The most substantive pre-mitigation impact significance from Maju Forest during the construction phase is moderate (Section 7.8.1.1.1) as a result of vegetation loss. After mitigation measures are applied, impact significance can be reduced to **negligible/minor**. Refer to Table 7-52 for residual impact significance after application of mitigation measures during the construction phase.

Table 7-52 Residual Impact Significance After the Implementation of Proposed Mitigation Measures at Maju Forest During the Construction Phase

Impact Type	Receptor	Pre-mitigation Impact Significance	Mitigation Measures	Post-mitigation Impact Significance
Loss of Vegetation	Native-dominated Secondary Forest (Priority 1)	Moderate	By adopting the shift in worksite (Section 7.9.1.1.1), vegetation removal within Maju Forest will not be necessary. Only 0.07 ha (1.56%) of managed vegetation at Clementi Neighbourhoood Park will be removed for the creation of temporary site office.	**Negligible**
	Scrubland and Herbaceous Vegetation (Priority 2)	Negligible		**Negligible**
	Waste Woodland (Priority 2)	Negligible		**Negligible**
	Managed Vegetation (Priority 3)	Negligible		**Minor**
Habitat Degradation	Native-dominated Secondary Forest (Priority 1)	Moderate	By adopting the shift in worksite (Section 7.9.1.1.1), worksite will not be within Maju Forest. Mitigated worksite A2 will only be temporary site office at the advance works stage and will be removed during stage 1 and 2. However, mitigated worksite at stage 1 and 2 have worksite that is in proximity to the native-dominated secondary forest, Old Jurong Railway Corridor and habitat degradation is considered to be less likely. Mitigation measures to reduce habitat degradation impact should still be applied. • Retain ground cover for as long as possible. When ground cover is removed, erosion control measures are to be in place. • Practise due diligence in proper storage and handling of	**Minor**
	Scrubland and Herbaceous Vegetation (Priority 2)	Negligible		**Negligible**
	Waste Woodland (Priority 2)	Negligible		**Negligible**
	Managed Vegetation (Priority 3)	Negligible		**Negligible**

Impact Type	Receptor	Pre-mitigation Impact Significance	Mitigation Measures	Post-mitigation Impact Significance
			machinery to prevent leaching of oil or harmful materials such as bentonite slurry. Store and handle harmful materials well away from waterbodies. • Engage a qualified erosion control professional to formulate and implement ECM plan in accordance with pub requirements. • Conduct regular inspections to ensure Contractor compliance and identify any impacts/unnecessary clearance in adjacent forest areas. • Conduct regular biodiversity surveys to monitor the flora and faunal community in retained and forest adjacent to the construction areas. Applying the above mitigation strategies together with design recommendations, post-mitigation impact significance can be reduced from moderate to negligible/minor.	
Change In Species Composition	Native-dominated Secondary Forest (Priority 1)	Moderate	By adopting the shift in worksite (Section 7.9.1.1.1), worksite will not be within Maju Forest. Mitigated worksite A2 will only be temporary site office at the advance works stage and will be removed during stage 1 and 2. However, mitigated worksite at stage 1 and 2 have worksite that is in proximity to the native-dominated secondary forest, Old Jurong Railway Corridor and habitat degradation is considered to be less likely. Mitigation measures to reduce habitat degradation impact should still be applied. • Conduct regular inspections to ensure Contractor compliance and identify any impacts/unnecessary clearance in adjacent forest areas. • Conduct regular biodiversity surveys to monitor the flora and faunal community in retained and forest adjacent to the construction areas. Applying the above mitigation strategies together with design recommendations, post-mitigation impact significance can be reduced from moderate to minor.	**Minor**
	Scrubland and Herbaceous Vegetation (Priority 2)	Negligible		**Negligible**
	Waste Woodland (Priority 2)	Negligible		**Negligible**
	Managed Vegetation (Priority 3)	Negligible		**Negligible**

7.10.1.1.2 *Plant Species*

For the 48 plant species recorded from Maju Forest and selected for the assessment of ecological impacts, the most severe impacts during the construction phase before mitigation measures were theoretically implemented are major for one species, moderate for four species, and minor for 41 species, and negligible for the remaining two species (Appendix R1).

Following the implementation of mitigation measures, the impacts on all 48 plant species would, theoretically, be reduced to moderate for two species, minor for 44 species, and negligible for the remaining two species.

The two species likely to experience moderate impacts are *Alsophila latebrosa* and *Ficus aurata* var. *aurata*, both of which are nationally Vulnerable. They are likely to experience moderate impacts as a result of competition from exotic species and decline in plant health and survival. Less than 50% of all specimens of these species recorded at Maju Forest are located within 30 m from the proposed worksite under the mitigation plan, giving an impact intensity of low. Assuming that forest edge effects are the greatest in habitats within 30 m from the cleared areas, the specimens of both species would experience competition from exotic species as the formation of forest edge habitats favours the growth of certain exotic plants. Additionally, changes in microclimatic conditions at forest edges may also cause a decline in plant health and survival of the specimens. As such, the impacts of competition from exotic species and decline in plant health and survival on this species is moderate.

All remaining 46 species are likely to experience **minor to negligible** level impacts from all four impact types after mitigation measures are implemented.

7.10.1.1.3 *Faunal Species*

The most severe pre-mitigation impact significance from Maju Forest during the construction phase is major (Section 7.8.1.1.3) as a result of loss of ecological connectivity for faunal movement along the Old Jurong Railway, an ecological connection that is important to ground dwelling fauna. After mitigation measures are applied—mainly due to the shift in worksite (Section 7.9.1.1.1)—there would not be works directly resulting in the loss of ecological connectivity for the pangolin. This reduces the impact to minor. Subsequently, worksite will also not result in any removal of habitat, which means the reduction in habitats, food sources and faunal injury or mortality impacts will also largely be reduced to negligible for majority of the faunal species. However, chances of pangolin and macaque entering construction worksite were still considered less likely and not unlikely. Therefore, **minor** impacts are still incurred in terms of injury and mortality to the macaque and pangolin.

7.10.1.2 Clementi Forest

7.10.1.2.1 *Habitats*

The highest pre-mitigation impact significance of the proposed development during the construction phase was expected to be major (refer to Section 7.8.1.2.1). After mitigation measures are applied, the overall impact significance of habitat loss during the construction phase remains unchanged at major. However, the significance of the other impacts has been reduced to **minor**. Refer to Table 7-53 for residual impact significance after application of mitigation measures during the construction phase.

Habitat degradation and changes in species composition impacts were not evaluated for managed vegetation habitat type as all the habitats within Study Area have been cleared for worksite.

Table 7-53 Residual Impact Significance after the Implementation of Proposed Mitigation Measures at Clementi Forest During the Construction Phase

Impact Type	Receptor	Pre-mitigation Impact Significance	Mitigation Measures	Post-mitigation Impact Significance
Loss of Vegetation	D/S1 and D/S2 (Priority 1)	Major	By adopting the shift in worksite away from D/S1 and D/S2 stream (Section 7.9.1.2.1), there is no need for works along the stream, resulting in negligible post-mitigation impact significance. However, there would still be some loss of vegetation to habitats within the worksite (i.e. abandoned-land forest, scrubland and	**Negligible**
	D/S22 (Priority 2)	Moderate		**Moderate**
	Waterlogged areas along the Old	Negligible		**Negligible**

Impact Type	Receptor	Pre-mitigation Impact Significance	Mitigation Measures	Post-mitigation Impact Significance
	Jurong Railway (Priority 1)		herbaceous vegetation and managed vegetation). As worksite has been optimised, the area of vegetation loss would also be substantially less. However due to the categorising of impacts, loss of vegetation is still considered moderate for scrubland and herbaceous vegetation as the decrease in area is lesser as compared to the rest of the vegetation type.	
	A5 Pond (Priority 3)	Negligible		**Negligible**
	Abandoned-land Forest (Priority 1)	Major		**Moderate**
	Scrubland and Herbaceous Vegetation (Priority 2)	Moderate		**Moderate**
	Waste Woodland (Priority 2)	Negligible		**Negligible**
	Managed Vegetation (Priority 3)	Moderate		**Moderate**
Habitat Degradation	D/S1 and D/S2 (Priority 1)	Major	• For mitigating measures related to ensuring minimal habitat degradation to waterbodies (i.e. maintaining water quality and hydrology of Clementi Forest), refer to Section 8.6 and 8.8. • Monitor the water quality and aquatic faunal community in retained streams and streams adjacent to the construction areas. • Adopting shift of worksite away from D/S1 and D/S2 streams. • Retain ground cover for as long as possible. When ground cover is removed, erosion control measures are to be in place. • Practise due diligence in proper storage and handling of machinery to prevent leaching of oil or harmful materials such as bentonite slurry. Store and handle harmful materials well away from waterbodies. • Engage a qualified erosion control professional to formulate and implement ECM plan in accordance with pub requirements. • Conduct regular inspections to ensure Contractor compliance and identify any impacts/unnecessary clearance in adjacent forest areas. • Conduct regular biodiversity surveys to Monitor the flora and faunal community in retained and forest adjacent to the construction areas. Applying the above mitigation strategies together with design recommendations, post-mitigation impact significance can be reduced from moderate/major to negligible/minor.	**Minor**
	D/S22 (Priority 2)	NA		NA
	Waterlogged areas along the Old Jurong Railway (Priority 1)	Moderate		**Minor**
	A5 Pond (Priority 3)	Minor		**Minor**
	Abandoned-land Forest (Priority 1)	Moderate		**Minor**
	Scrubland and Herbaceous Vegetation (Priority 2)	Moderate		**Minor**
	Waste Woodland (Priority 2)	Minor		**Minor**
	Managed Vegetation (Priority 3)	Minor		**Minor**
	D/S1 and D/S2	Minor	• Conduct regular inspections to ensure Contractor compliance and identify	**Minor**

Impact Type	Receptor	Pre-mitigation Impact Significance	Mitigation Measures	Post-mitigation Impact Significance
Change In Species Composition	(Priority 1)		any impacts/unnecessary clearance in adjacent forest areas. • Conduct regular biodiversity surveys to monitor the flora and faunal community in retained and forest adjacent to the construction areas. Applying the above mitigation strategies together with design recommendations, post-mitigation impact significance can be reduced from moderate to minor.	
	D/S22 (Priority 2)	NA		NA
	Waterlogged areas along the Old Jurong Railway (Priority 1)	Minor		**Minor**
	A5 Pond (Priority 3)	Minor		**Minor**
	Abandoned-land Forest (Priority 1)	Moderate		**Minor**
	Scrubland and Herbaceous Vegetation (Priority 2)	Moderate		**Minor**
	Waste Woodland (Priority 2)	Minor		**Minor**
	Managed Vegetation (Priority 3)	Negligible		**Negligible**

7.10.1.2.2 *Plant Species*

For the 51 plant species recorded from Clementi Forest and selected for the assessment of ecological impacts, the most severe impacts during the construction phase before mitigation measures were theoretically implemented are major for nine species, moderate for 13 species, and minor for 29 species (Appendix R2).

Following the implementation of mitigation measures, the impacts would, theoretically, be reduced to major for one species, moderate for nine species, and minor for 41 species. The only species likely to experience major impacts are the fern species *Asplenium nitidus*, once thought to be nationally Extinct.

1) *Asplenium nitidus* is likely to experience major impacts as a result of competition from exotic species and decline in plant health and survival. The only specimen of this species recorded at Clementi Forest is located within 30 m from the proposed worksite under the mitigation plan, giving an impact intensity of high. As the habitats expected to be cleared are a mix of managed vegetation, scrubland and herbaceous vegetation, and abandoned-land forest, it is likely that some forest edges will be formed as a result of the clearance. Assuming that forest edge effects are the greatest in habitats within 30 m from the cleared areas, all the specimens of this species would experience competition from exotic species as the formation of forest edge habitats favours the growth of certain exotic plants. Additionally, changes in microclimatic conditions at forest edges may also cause a decline in plant health and survival of the specimens. As such, the impacts of competition from exotic species and decline in plant health and survival on this species is major.

All remaining 50 species are likely to experience **minor to moderate** level impacts from all four impact types after mitigation measures are implemented.

7.10.1.2.3 *Faunal Species*

The most substantive impact significance from Clementi Forest during the construction phase is major (Section 7.8.1.2.3) resulting from the loss of habitats for bamboo bats, which will be directly impacted. After mitigation measures are applied, the main stream system will be avoided and so will worksite reduce in size. This will avoid

directly impacting the bamboo bats and therefore residual impact can be reduced to **negligible**. However, a tributary of the stream (D/S22) remains impacted. Additionally, as underpass has also been removed, ecological connectivity along Old Jurong Railway Corridor was not expected to be impacted, reducing major impacts from loss of ecological connectivity for the pangolin to negligible (Appendix R2).

7.10.2 Operational Phase

7.10.2.1 Maju Forest

7.10.2.1.1 *Habitats*

The most substantive pre-mitigation impact significance of the proposed development during the operational phase was expected to be moderate from change in species composition to the native-dominated secondary forest. After mitigation measures are applied, the significance of the residual impacts has been reduced to **negligible**. Refer Table 7-54 for residual impact significance after application of mitigation measures during the operational phase.

Table 7-54 Residual Impact Significance After the Implementation of Proposed Mitigation Measures at Maju Forest During the Operational Phase

Impact Type	Receptor	Pre-mitigation Impact Significance	Mitigation Measures	Post-mitigation Impact Significance
Habitat Degradation	Native-dominated Secondary Forest (Priority 1)	Minor	At the operational stage, not much can be controlled to prevent habitat degradation as it will mainly come from the public with the increase in human traffic. However, the removal of station access along Old Jurong Corridor and Maju Forest has helped with reducing the likelihood of habitat degradation from occurring.	**Negligible**
	Scrubland and Herbaceous Vegetation (Priority 2)	Negligible		**Negligible**
	Waste Woodland (Priority 2)	Negligible		**Negligible**
	Managed Vegetation (Priority 3)	Negligible		**Negligible**
Change In Species Composition	Native-dominated Secondary Forest (Priority 1)	Moderate	Similarly, with the shift of the station access, there is no need for vegetation removal within native-dominated secondary forest and therefore the changes in species composition can be reduced to negligible. However, station access is still in proximity to Maju Forest and propose EMMP measures should still be adopted to ensure further reduction in impacts. • Conduct regular inspections (at least 6 months) to ensure Contractor compliance and identify any impacts/unnecessary clearance in adjacent forest areas. • Conduct regular biodiversity surveys to monitor the flora and faunal community in retained and forest adjacent to the construction areas.	**Negligible**
	Scrubland and Herbaceous Vegetation (Priority 2)	Minor		**Negligible**
	Waste Woodland (Priority 2)	Minor		**Negligible**
	Managed Vegetation (Priority 3)	Minor		**Negligible**

7.10.2.1.2 *Plant Species*

For the 48 plant species recorded from Maju Forest and selected for the assessment of ecological impacts, the most severe impacts during the operational phase before mitigation measures were theoretically implemented are

moderate for 46 species and minor for two species (Appendix R1). The species are likely to experience moderate impacts as a result of competition from exotic plant species.

Following the implementation of mitigation measures, the impacts on all 48 plant species would, theoretically, be reduced to **negligible** for both impact types. By using native planting palettes, it would reduce the impact intensity (and subsequently, the impact significance) of competition from exotic plant species to negligible.

7.10.2.1.3 *Faunal Species*

The most severe pre-mitigation impact significance from Maju Forest during the operational phase is negligible (Section 7.8.2.1.3). By adopting mitigation measure of shifting worksite (Section 7.9.1.1.1) to an area outside of Maju Forest Study Area, it will further ensure no/minimal impacts of CR16 access point at operational phase to the faunal species residing within Maju Forest. However, station access is still in proximity to Maju Forest and propose EMMP measures should still be adopted to ensure further reduction in impacts.

7.10.2.2 Clementi Forest

7.10.2.2.1 *Habitats*

The most substantive pre-mitigation impact significance of the proposed development during the operational phase was expected to be moderate. After mitigation measures are applied, the significance of the residual impacts has been reduced to **minor**. Refer to Table 7-55 for residual impact significance after application of mitigation measures during the operational phase.

Table 7-55 Residual Impact Significance After the Implementation of Proposed Mitigation Measures at Clementi Forest During the Operational Phase

Impact Type	Receptor	Pre-mitigation Impact Significance	Mitigation Measures	Post-mitigation Impact Significance
Habitat Degradation	D/S1 and D/S2 Waterbodies (Priority 1)	Minor	At the operational stage, not much can be controlled to prevent habitat degradation as it will mainly come from the public with the increase in human traffic. Furthermore, pre-mitigated impacts are already negligible/minor (lowest impact significant levels).	**Minor**
	D/S22 Waterbody (Priority 2)	N.A.		N.A.
	Waterlogged areas along the Old Jurong Railway (Priority 1)	Minor		**Minor**
	A5 Pond (Priority 3)	Negligible		**Negligible**
	Abandoned-land Forest (Priority 1)	Negligible		**Negligible**
	Scrubland and Herbaceous Vegetation (Priority 2)	Negligible		**Negligible**
	Waste Woodland (Priority 2)	Negligible		**Negligible**
	Managed Vegetation (Priority 3)	N.A.		N.A.
Change In Species Composition	D/S1 and D/S2 Waterbodies (Priority 1)	Minor	• Conduct regular inspections to ensure Contractor compliance and identify any impacts/unnecessary clearance in adjacent forest areas. • Conduct regular biodiversity surveys to monitor the flora and	**Minor**
	D/S22 Waterbody (Priority 2)	N.A.		N.A.

Impact Type	Receptor	Pre-mitigation Impact Significance	Mitigation Measures	Post-mitigation Impact Significance
	Waterlogged areas along the Old Jurong Railway (Priority 1)	Minor	faunal community in retained and forest adjacent to the construction areas. Applying the above mitigation strategies together with design recommendations, post-mitigation impact significance can be reduced from moderate to minor.	**Negligible**
	A5 Pond (Priority 3)	Minor		**Minor**
	Abandoned-land Forest (Priority 1)	Moderate		**Minor**
	Scrubland and Herbaceous Vegetation (Priority 2)	Moderate		**Minor**
	Waste Woodland (Priority 2)	Minor		**Negligible**
	Managed Vegetation (Priority 3)	N.A.		N.A.

7.10.2.2.2 *Plant Species*

For the 51 plant species recorded from Clementi Forest and selected for the assessment of ecological impacts, the most severe impacts during the operational phase before mitigation measures were theoretically implemented are major for one species, moderate for 48 species, and minor for the remaining two species (Appendix R2).

Following the implementation of mitigation measures, the impacts on all 51 plant species would, theoretically, still be major for one species, while that for the rest would be reduced to **minor** (48 species) and **negligible** (two species), respectively.

The only species likely to experience major impacts is the nationally Critically Endangered terrestrial orchid *Dienia ophrydis*. This species is likely to experience major impacts as a result of mortality because, as an orchid species, it faces risks of being stolen or poached by members of the public, even with mitigation measures in place, such as education, based on the assumption that members of the public are able to recognise specimens of this species in the Study Area.

All remaining 50 species are likely to experience **negligible to minor** level impacts from both impact types after mitigation measures are implemented.

7.10.2.2.3 *Faunal Species*

The most severe pre-mitigation impact significance from Clementi Forest during the operational phase is major (Section 7.8.2.2.3). By adopting mitigation measure of shifting worksite (Section 7.9.1.1.1) away from the main stream system (i.e. D/S1 and D/S2) and the optimisation of the worksite, ecological connectivity will remain intact and habitat loss will be minimal. This can help reduce major and moderate impacts to **minor/negligible**. However, station access is still in proximity to Maju Forest and propose EMMP measures should still be adopted to ensure further reduction in impacts.

7.11 Cumulative Impacts from Other Major Concurrent Developments

7.11.1 Construction Phase

7.11.1.1 Maju Forest

Two major concurrent developments have been identified in Section 3.4.1 to be in the vicinity of C2 worksite.

1) PUB DTSS2 link sewer will have overlapping construction timeline with construction of worksite C2 for at least two years. These proposed manholes and pipelines are planned to be allocated along Clementi Road and Old Jurong Railway.

2) Brookvale Drive Project will have overlapping construction timeline with construction of worksite C2 for at least one year. The construction of a new road along Maju Camp, abutting Maju Forest, connecting to Clement Road will also include new junction configuration, resurfacing works, traffic light construction and other related works.

Considering the magnitude and proximity of works between the two major concurrent developments, Brookvale Drive Project was expected to be more impactful to biodiversity within Maju Forest.

Impacts to habitats and flora: Direct impacts such as vegetation removal would occur within the scrubland and herbaceous vegetation along the fringe Maju Forest. Indirect impacts such as habitat degradation, impediment to seedling recruitment and possibly decline in plant health and survival on the remaining habitats and flora within the Maju Forest. Dust impacts to the plant species within Maju Forest should also be considered (See Section 10.10 for cumulative dust impacts). Therefore, cumulative impact was assessed to be a **significant** increase in impacts to the habitats and flora within Maju Forest.

Impacts to fauna: Similarly, direct impacts from vegetation removal would result in loss/reduction in habitat for fauna, while indirect impacts such as habitat degradation, increase in noise and dust would also impact fauna species utilising Maju Forest. For dust and noise cumulative impacts to the fauna species within Maju Forest, please refer to Section 10.10 and Section 11.10, respectively. Therefore, cumulative impact was assessed to be a **significant** increase to the fauna within Maju Forest.

7.11.1.2 Clementi Forest

Three major concurrent developments have been identified in Section 3.4.1 to be in the vicinity of CR16 worksite within Clementi Forest.

1) Old Jurong Line Nature Trail will have overlapping construction timeline with construction of CR16 worksite within Clementi Forest where at most minor cut and fill works are expected to occur. Works will mainly be confined along Old Jurong Railway Corridor, south of Clementi Forest.

2) Clementi Nature Trail will have overlapping construction timeline with construction of CR16 worksite within Clementi Forest where at most minor cut and fill works are expected to occur. Works will mainly be confined in the northern portion of Clementi Forest, in the vicinity of D/S1 and D/S2 streams.

3) CR15 will have overlapping construction timeline with construction of CR16 worksite within Clementi Forest where at major cut and fill works are expected to occur. Works will be outside of Clementi Forest but adjacent to the rail corridor.

Impacts to habitats and flora: Considering all the works, it was expected to have direct impacts such as vegetation removal within Clementi Forest, while indirect impacts such as habitat degradation, impediment to seedling recruitment and possibly decline in plant health and survival on the remaining habitats and flora within the Clementi Forest. Dust impacts to the plant species within Clementi Forest should also be considered (See Section 10.10 for cumulative dust impacts). Therefore, cumulative impact was assessed to be a **significant** increase in impacts to the habitats and flora within Clementi Forest.

Impacts to fauna: Similarly, direct impacts from vegetation removal would result in loss/reduction in habitat for fauna, while indirect impacts include habitat degradation, increase in noise and dust would also impact fauna species utilising Clementi Forest. For dust and noise cumulative impacts to the fauna species within Clementi Forest, please refer to Section 10.10 and Section 11.10, respectively. Therefore, cumulative impact was assessed to be a **significant** increase to the fauna within Maju Forest.

7.11.2 Operational Phase

7.11.2.1 Maju Forest

Two major concurrent developments identified in Section 3.4.1 to be in the vicinity of worksite C2 will be converted in to the following.

1) PUB DTSS2 will have no above ground structures, possibly only manholes access for regular and/or ad-hoc maintenance.

2) Brookvale Drive Project will present as a new road along Maju Camp—abutting Maju Forest—connecting to Clement Road, with a traffic junction at its connection point to Clementi Road.

Assuming that maintenance works of PUB DTSS2 do not result in increased light, noise and vibration levels, and significance tree/habitat loss, the impacts to biodiversity were assessed to be **insignificant** relative to impacts from the new road.

Impacts to habitats and flora: Assuming that maintenance works do not result in increased light, noise and vibration levels, and significance tree/habitat loss, the impacts were assessed to be **insignificant**.

Impacts to fauna: Similarly, assuming that maintenance works do not result in increased light, noise and vibration levels, and significance tree/habitat loss, the impacts were assessed to be **insignificant**.

7.11.2.2 Clementi Forest

Three major concurrent developments identified in Section 3.4.1 to be in the vicinity of CR16 worksite within Clementi Forest will be converted into the following.

1) Old Jurong Line Nature Trail will be a trail open to public.

2) Clementi Nature Trail will be a trail open to public.

3) CR15 will be a functioning station.

All identified developments would not only substantially increase the human and vehicular traffic within or in the vicinity of Clementi Forest, light and noise was also expected to increase.

Hence, impacts to habitats, flora and fauna were assessed to be significant.

7.12 Summary of Key Findings

7.12.1 Proposed Mitigated Scenario (CR16)

With the original worksite as CR16 Base Scenario that utilises the existing Old Jurong Railway Corridor as underpass to access CR16 from Maju Forest, the biodiversity impact towards the ecologically-rich Old Jurong Railway could not be avoided. LTA has agreed to shift worksite away to avoid direct impact to the ecological connectivity of Old Jurong Railway Corridor (Refer to Section 7.9.1.1.1; Figure 7-78).

Besides, to mitigate biodiversity impact of the main stream (D/S1 and D/S2 streams), LTA has agreed to shift construction works away from the northern tip of CR16 worksite through worksite area optimization, hence reducing the footprint of CR16 construction worksite. (Refer to Section 7.9.1.2.1; Figure 7-79).

All the above design changes have formed the CR16 Mitigated Scenario.

7.12.2 Maju Forest

The Maju Forest plays a role in ecological connectivity as it lies along the Old Jurong Railway Corridor, which connects Maju Forest to Clementi Forest, and subsequently connected to Bukit Batok forests, BTNR and CCNR to the east. Maju Forest is also connecting to the Toh Tuck Forest to the west. This connectivity is important as it allows movement and dispersal of floral and faunal species across the landscape. The proximity of the Study Area to the Rail Corridor and the connection to an adjacent larger forest patch (Clementi Forest) allows for the possible presence of conservation significant species.

Maju Forest is characterised by five vegetation types. Abandoned-land forest and native-dominated secondary forest occupy more than half of the site, and the rest of the site comprise scrubland and herbaceous vegetation, waste woodland and managed vegetation. A total of 305 plant species and species groups from 101 families were recorded. The floristic assemblage is largely native (52.8% native species). Forty-seven plant species of conservation significance were recorded and mostly distributed within the native-dominated secondary forest and abandoned-land forest. Several individuals of stream-associated species were encountered near the waterbodies in Maju Forest, particularly along the Old Jurong Railway Corridor. Five specimens of conservation significance lie within and very near the boundary of the proposed worksite (base scenario only) in Maju Forest; they are the nationally Vulnerable tree fern *Alsophila latebrosa* specimens, one nationally Vulnerable fern *Pteris semipinnata* specimens, and one nationally Endangered shrub *Callicarpa longifolia* specimen.

The faunistic field assessment recorded 130 species with more than half of the recorded assemblage dominated by bird and butterfly species. A total of 10 species of conservation significance were recorded, although they were distributed across the Study Area with no distinct hotspot. They are likely able to be using the entire Study Area. Some notable records include the nationally Vulnerable chocolate sailor (*Neptis harita harita*), the straw-headed bulbul (*Pycnonotus zeylanicus*) and Sunda pangolin (*Manis javanica*) to which Singapore is a stronghold for. The records of forest-dependent species and/or species of restricted distribution, such as the glossy horsehoe bat (*Rhinolophus lepidus*) and copper-cheeked frog (*Chalcorana labialis*) show the value of the Study Area in supporting local populations of these species. Furthermore, native-dominated secondary forest, such as that present within the Study Area, provides resources and habitats for native fauna.

The waterbodies within the Study Area are relatively ephemeral in nature, as they were often dry with disconnected willow pools of water. Records of aquatic fauna were poor along the waterbodies, but they provide habitat to some uncommon or forest-dependent species such as the copper-cheeked frog (*Chalcorana labialis*).

The native-dominated secondary forest, abandoned-land forest and all waterbodies present within Maju Forest are regarded as high ecological value.

The most severe impact from the construction phase at Maju Forest is of major/moderate significance from habitats, floral and faunal species. This was mainly due to works resulting in loss of habitat and/or vegetation during site clearance to habitats, mortality to floral species and the loss of ecological connectivity for faunal species. After application of mitigation measures, major/moderate impact significance were all reduced to minor/negligible impact significance. This is chiefly due to the shift in worksite out of Maju Forest.

The most severe impacts from the operational phase at Maju Forest are of major/moderate significance. This was mainly due to loss of ecological connectivity from proposed pedestrian walkway along Old Jurong Railway Corridor. However, after the shift in worksite out of Maju Forest, major/moderate impact significance was reduced to minor/negligible impact significance.

Subsequently, **significance** cumulative impacts were expected to be incurred to habitats, floral and faunal species with the present of PUB DTSS2 and Brookvale Drive Project.

7.12.3 Clementi Forest

Similar to Maju Forest, Clementi Forest plays an important role in ecological connectivity as it lies along the Old Jurong Railway Corridor. Furthermore, Clementi Forest is in closer proximity to BTNR and CCNR forests. The proximity to BTNR suggests possible presence of uncommon or rare species in Clementi Forest.

Clementi Forest is characterised by four vegetation types, with half the site dominated by abandoned-land forest. The remaining area comprised scrubland and herbaceous vegetation, waste woodland and managed vegetation. A total of 303 plant and species groups from 97 families were recorded. The floristic assemblage is largely native (52.1% native species). Fifty-one species of plants of conservation significance were recorded and mostly distributed within the abandoned-land forest. While these patches constitute some threatened species, the forest canopy layers were dominated by rubber trees (*Hevea brasiliensis*) persisting from past cultivation practices.

The faunistic field assessment recorded 210 species with more than half of the recorded assemblage dominated by bird and butterfly species. A total of 18 species of conservation significance were recorded, although they were distributed across the Study Area with no distinct hotspot. Some notable records include the nationally Critically Endangered Malayan softshell turtle (*Dogania subplana*), nationally Vulnerable small duskhawker (*Gynacantha bayadera*) and straw-headed bulbul (*Pycnonotus zeylanicus*). The Study Area, therefore, supports local populations of fauna conservation significance, and other forest-dependent fauna and/or species of restricted distribution that are increasingly threatened by habitat loss.

Vegetation along the Old Jurong Railway Corridor is relatively distinct, vegetated with several plants of the stream-associated species, *Alsophila latebrosa* and *Blechnum finnlaysonianum*, in the understorey. The native *Campnosperma auriculatum* trees and saplings were also found growing along the track. A specimen of the *Asplenium nitidum* fern was found growing on the trunk of an *Elaeis guineensis* palm, near the entrance to Clementi Forest via the Old Jurong Railway Corridor and adjacent to Clementi Road. This species is nationally Presumed Extinct and no cultivation locally recorded. Notably, two individuals of the rare terrestrial orchid species, *Dienia ophrydis*, that was thought to be extinct in Singapore, were seen growing in the relatively shaded forest understorey along the Old Jurong Railway Corridor. A cluster of plants of species of conservation were also recorded in the patch of abandoned-land forest in the northern area. The waterlogged habitats along Old Jurong Railway Corridor also provide habitats to species favouring swampy conditions. Examples are the forest-dependent masked rough-

sided frog (*Pulchrana laterimaculata*) and nationally Vulnerable variable featherlegs (*Copera vittata*). More importantly, it serves as an ecological corridor.

Along the main stream, records consist mainly of common aquatic fauna that are tolerant of disturbance, including several non-native fish species. Streams are uncommon habitats in Singapore. The presence of native species, such as common walking catfish, illustrates its value in supporting local populations of these aquatic species. A pond present in the southern portion of Clementi Forest (A4) also provides breeding habitats for uncommon duskhawker species.

Within the proposed worksites, a total of 33 individuals and clusters of specimens of conservation significance and eight bamboo clusters are present. Two clusters recorded bamboo bats acoustically, although the roosting of this species in the bamboo was not recorded.

The abandoned-land forest and all natural waterbodies (except man-made A5 pond) present within Clementi Forest are regarded as high ecological value.

The most severe impact from the construction phase at Clementi Forest is of major/moderate significance from habitats, floral and faunal species as for base scenario. This was mainly due to works resulting in loss of habitat and/or vegetation during site clearance to habitats, mortality to floral species and the loss of terrestrial and aquatic ecological connectivity for faunal species. After application of mitigation measures, **major/moderate** impact significance was mostly reduced to minor/negligible impact significance. This is largely due to the shifting worksite away from main stream (D/S1 and D/S2 streams) and the optimisation of worksite within Clementi Forest. Yet, there are still residual **moderate** impact significance due to worksite still resulting in disturbance to tributary stream (D/S22) and habitat/vegetation loss are permanent and irreversible.

The most severe impacts from the operational phase at Clementi Forest are of major/moderate significance. This was mainly due to loss of ecological connectivity from the proposed pedestrian walkway along Old Jurong Railway Corridor for faunal species. After application of mitigation measures, moderate impact significance was mostly reduced to minor/negligible impact significance.

For summary of significance of impacts from construction and operational phase at Maju and Clementi Forest, refer to Table 7-56.

Subsequently, cumulative impacts were expected to be incurred to habitats, floral and faunal species of Clementi Forest with the present of Old Jurong Line Nature Trail, Clementi Nature Trail and CR15.

Table 7-56 Summary of Biodiversity Impact Assessment

Sensitive Receptor	Impact Significance with Minimum Controls	Residual Impact Significance with Mitigation Measures (if required)
Construction Phase		
Maju Forest	Major – Negligible	**Minor – Negligible**
Clementi Forest	Major – Negligible	**Moderate[1] – Negligible**
Operational Phase		
Maju Forest	Moderate – Negligible	**Minor – Negligible**
Clementi Forest	Major – Negligible	**Minor – Negligible**

Note:

1. Though vegetation and habitat loss has been reduced by moving the station footprint away from Clementi Forest and main stream (DS/1 and DS/2), the loss of vegetation due to site clearance from the new worksite would still result in moderate impact for scrubland and herbaceous vegetation. Such vegetation and habitat loss are permanent and irreversible