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Biodiversity and Environmental Studies for BBNP, BBTP and BBHNP

Volume I: Biodiversity and Environmental Impact Assessment Report

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Prepared by	**Chloe Tan (CT), Clarice Teo (CT), Daphne Lim (DL), Isabelle Tan (IT), Jace Tan (JT), Jessica Lee (JL), Joon Chuah (JC), Siti Zaleha (SZ)**
Checked by	**Jafon Ng (JN), Derek Yap (DY)**
Approved by	**Cara Quinn (CQ)**
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Ramboll Pte Ltd
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ACRONYMS

ABC	Active, Beautiful, Clean Waters Programme
APCP	air pollution control plan
ASR	air sensitive receptors
BBHNP	Bukit Batok Hillside Nature Park
BBNC	Bukit Batok Nature Corridor
BBNP	Bukit Batok Nature Park
BBTP	Bukit Batok Town Park
BTNR	Bukit Timah Nature Reserve
Camphora	Camphora Pte Ltd
CBD	United Nations Convention on Biological Diversity
CCTV	closed circuit television
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora, also known as the Washington Convention
CO	carbon monoxide
COD	chemical oxygen demand
COP	Codes of Practice
CS	Conservation Significance
dB(A)	A-weighted decibels
DIVs	Dutch Intervention Values
ECM	Earth Control Measures
EIA	Environmental Impact Assessment
EIS	Environmental Impact Study
EMMP	Environmental Management and Monitoring Programme
EPMA	Environmental Protection and Management Act
GFRC	glass fiber reinforced concrete
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
ha	hectares
HDB	Housing Development Board of Singapore
HL	Henning Larsen
IA	Impact Assessment
JTC	JTC Corporation
IAQM	Institute of Air Quality Management
ISO	International Organization for Standardization
km	kilometre
LAUD	LAUD Architects Pte Ltd
LTA	Land Transport Authority of Singapore
Lw	Sound power level unit
m	metre
m^2	squared metre
m^3	cubic metre
MITA	Ministry of Information and the Arts
MRT	Mass Rapid Transit
M&E	Mechanical and Engineering
NAS	National Archives of Singapore
NBSAP	National Biodiversity Strategy and Action Plan
NCMP	Nature Conservation Master Plan
NEA	National Environment Agency

NHB	National Heritage Board of Singapore
NO_2	nitrogen dioxide
NParks	National Parks Board of Singapore
NSR	noise sensitive receivers
O_3	ozone
PCN	Park Connector Network
PCS	Pollution Control Study
PIE	Pan-Island Expressway
PM	Particulate Matter
PSI	Pollutant Standards Index
PUB	PUB, Singapore's National Water Agency
QECP	Qualified Erosion Control Professional
Ramboll	Ramboll Pte Ltd
RC	Reinforced concrete
RWH	Restricted Working Hours
SHD	Singapore Height Datum
SO_2	sulphur dioxide
TDS	total dissolved solids
TIW	Toxic Industrial Waste
TPZ	tree protection zone
TSS	total suspended solid
TVOCs	Total Volatile Organic Compounds
UNFCCC	United Nations Framework Convention on Climate Change
URA	Urban Redevelopment Authority of Singapore
WHO	World Health Organization
WSUD	Water sensitive urban and building design

GLOSSARY

The following words and expressions shall have the meanings hereby assigned to them except where the context otherwise requires:

Term	Definition
Agencies requirements	The latest approved code of practice, all applicable current industry standards, regulations, specification, statutes, and good engineering practices or as required from authorities such as National Parks Board (NParks or "the Board"), Building and Construction Authority, Land Transport Authority (LTA or "the Authority"), Urban Redevelopment Authority (URA) as well as other organisations and all utility agencies such as PUB, SingTel, SP Power etc.
Baseline	The physical, biological, cultural and human conditions that will prevail in the absence of the Project, including interactions amongst them
Leq	Shorthand for "Equivalent Continuous Noise Level" - as noise levels often fluctuate over a wide range with time, noise is measured over a given duration
Main Contractor	The Contractor (and his team) to be engaged by the Board to execute the Contract for the Proposed Development
Project	The proposed development of the Bukit Batok Nature Park (BBNP), Bukit Batok Town Park (BBTP), and Bukit Batok Hillside Nature Park (BBHNP) will comprise of observation decks, boardwalks and nature trails.
Residual environmental impacts	Significant project-related impacts that might remain after on-site mitigation measures (avoidance, management controls, abatement restoration, etc) have been implemented
Study Area	The area which was studied in order to adequately describe the Project Site and the existing pre-development conditions of the surrounding environment

EXECUTIVE SUMMARY

Ramboll Pte Ltd (Ramboll) has been appointed by National Parks Board (NParks or "the Board") to carry out an **Environmental Impact Assessment (EIA)** ("the Study") for the development of the proposed Bukit Batok Nature Park (BBNP), Bukit Batok Town Park (BBTP) and Bukit Batok Hillside Nature Park (BBHNP), collectively referred to as the proposed "Project" or "Study Area", which falls within the proposed Bukit Batok Nature Corridor (BBNC).

The proposed BBNC consists of forested areas around Bukit Batok, including the Former Bukit Timah Fire Station (BTFS), the eco-pedestrian bridge, BBNP, BBTP, Bukit Batok Central Nature Park (BBCNP) and BBHNP with a total land area of over 125 hectares (ha). The BBNC provides important habitats for biodiversity, including fauna moving between the Central Nature Park Network and Tengah Forest Corridor, as well as migratory birds flying along the East Asian-Australasian Flyway. The proposed BBNC will serve as an ecological corridor that will connect the Former BTFS, BBNP, BBTP, BBHNP, Central Nature Park Network and the future Tengah Forest Corridor.

Environmental and biodiversity baseline studies were conducted from February 2022 to April 2023 for BBNP, BBTP and BBHNP. The studies comprised flora and fauna baseline assessments as well as monitoring of physical environmental parameters (water, sediment, noise, and air quality) within the Study Area. The Studies also include a topographical survey for the proposed Study Area and a hydrographical survey of the quarry lakes, namely Poh Kim Quarry, Little Guilin and Seng Chew Quarry.

The Impact Assessments for BBNP, BBTP and BBHNP have been conducted based on the baseline studies, the conceptual development plans and the construction footprint provided to Ramboll. This EIA Report is formed to inform the Client of major issues, if any, based on the conceptual plans provided, and to provide a high-level identification, prediction and evaluation of potential environmental impacts arising from the construction and operation of the Project.

As the proposed alignment for the eco-pedestrian bridge was still under discussion at the time of reporting, this Impact Assessment Report only focuses on the discussions on the assessments for BBNP, BBTP and BBHNP.

Proposed Key Developments

A summary of the key developments to be carried out at BBNP, BBTP and BBHNP are listed below:

BBNP

- Construction of the BBNP Plaza & Play Area;
- Construction of boardwalks and viewing decks at the enhanced Proposed trails towards quarry;
- Refurbishment or construction of existing or proposed trails;
- Slope stabilization works at the Heritage trail;
- Stream / waterbody enhancement near to the existing car park; and
- Refurbishment of the existing park car park.

BBTP

- Construction of the BBTP Arrival Courtyard;
- Slope cutting, sheet piling and construction of retaining wall;
- Construction of elevated boardwalks, floating pontoon and viewing decks near Little Guilin;
- Construction of viewing deck at Seng Chew Quarry and Little Guilin;
- Refurbishment of existing trails i.e., trail along the western bank of Little Guilin i.e., the Little Guilin Experience Trail; and

- Construction of new trails.

BBHNP

- Demolition of existing structures, including Glass Fiber Reinforced Concrete (GFRC) using excavator mounted with hydraulic breaker;
- Demolition of existing wooden shelter, pergola and boardwalk using handheld equipment e.g., jack hammers and welding or cutting equipment;
- Construction of the BBHNP Arrival Node;
- Construction of boardwalks;
- Construction of new trails i.e., Stream and Fern Trail and Nature Loop; and
- Stream / waterbody enhancement near to the proposed BBHNP Arrival Node.

EIA Approach and Methodology

The Baseline Studies were carried out to characterise the pre-development environmental conditions of the Study Area and surroundings in order to establish a baseline against which future pollution, emissions, incidents, or complaints can be assessed. Secondary (desktop) data collection and primary data collection (field surveys) were undertaken in order to establish the baseline pre-development environmental conditions. Steps involved in the baseline studies include: (1) identify the Baseline Study area; (2) scope the Baseline Study; (3) conduct desk-based assessment of environmental values; (4) conduct field-based assessment of environmental values; and (5) document findings of the Baseline Studies. Both physical and biological environment conditions were characterised as part of the Baseline Studies.

The impact assessment (IA) methodology used in the Study comprises a systematic approach to (1) Identify / predict potential environmental impacts; (2) Characterise the magnitude / intensity of the identified impacts; (3) Characterise the sensitivity of the receptors; (4) Based on the magnitude of the impact and sensitivity of the receptor, determine the consequences of the potential impact(s); and (5) Based on the consequences of potential impact(s) and likelihood of occurrence, determine the significance of the potential impact(s).

Impacts assessed as Negligible or Minor require no additional management or mitigation measures (on the basis that the intensity of the impact is sufficiently small, or that the receptor is of low sensitivity, or the likelihood is low and/or that adequate controls were already included in the project design). Further management or mitigation measures will be required for Impacts assessed as Moderate and Major to minimize or reduce the impact to an acceptable level as much as possible. Ramboll adhered to the framework of the mitigation hierarchy (avoid, minimise, restore, and further measures to compensate), which serves as a prioritised set of possible management responses to anticipated impacts.

Environmental Baseline

Noise

A baseline ambient noise monitoring survey was conducted between 19 April 2022 and 21 May 2022 at four (4) locations across BBNP, BBTP and BBHNP, namely N3 through N6, to establish the ambient baseline noise levels in the Study Area. The maximum monitored noise levels during daytime (7 am – 7 pm) and during the evenings (7 pm – 10 pm) were generally below the regulatory maximum permissible noise levels for construction sites. While the maximum recorded noise levels at all locations during night-time (10 pm - 7 am) generally exceeded the maximum permissible level, these readings were most likely associated with the background wildlife and weather noise within the Study Area.

Air

A baseline ambient air quality monitoring survey was conducted between 7 July 2022 and 9 November 2022 at four (4) locations across BBNP, BBTP and BBHNP, namely A3 through A6, to establish the the ambient baseline air quality levels within the Study Area. Air quality parameters, including nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), ozone (O_3), PM_{10}, and $PM_{2.5}$ were recorded using an AQMesh whilst Total Volatile Organic Compound (TVOC) were recorded. Overall, the air quality at all four (4) locations were within acceptable range; no exceedances of National environment Agency (NEA)'s air quality targets were observed and TVOC concentrations were recorded at low levels unlikely to cause any public health and environmental concerns.

Stream Mapping and Characterization

Characterisation of the abiotic and biotic features of the on-site earth streams was also carried out. Biotic features characterised included the dominant riparian flora species found, percentage coverage of riparian plants, percentage of canopy cover, and percentage coverage of leaf litter on the stream bed. Abiotic characteristics characterised included the stream's cross-sectional profile (mean depth of standing water, wetted width, and full bank width), mean stream velocity, stream flow rate, and stream bank erosion risk. Overall, the on-site streams at BBNP, BBTP and BBHNP have closed canopies and were mostly well vegetated. The fastest flow velocity was recorded in Stream SB2b located at Study Area B2, which went up to 1.2 meter per second (m/s) during dry weather.

The bank erosion hazard score for streams located within BBNP, BBTP and BBHNP ranged from 29% to 88%. SB1a (BBNP), SB2a (near to BBNP; outside of the proposed development footprint), and SD1a (BBTP; outside of the proposed development footprint) reported bank erosion hazard scores exceeding 60%.

Surface Water and Sediment

Surface water and sediment quality baseline assessments were conducted at streams, ponds and quarries within the Study Area. Water quality surveys included in-situ and ex-situ (lab analysis) measurements. Surface water samples and sediment samples were collected from quarry lakes QD1, QD2, QB, and earth streams SB1a, SB2a, SB2b, SD1a and SE1a between 26 April 2022 and 3 November 2022. Surface water quality was generally observed to be within the applicable criteria, although exceedances in oil and grease, and total suspended solid (TSS) were observed across selected surface water sampling points, especially at SB1a and SD1a, which also reported high stream bank erosion hazard scores (>60%). Ponds and quarries were also observed to have slightly poorer water quality in terms of total dissolved solids (TDS) and chemical oxygen demand (COD). There were no exceedances for heavy metals in the sediment sampling sites as set out by the Dutch Standards, besides chromium at SQ1, SQ2 and SQ3; however, these detections were all well below the health-based investigation levels for recreational land use (HIL C) of 300 milligram per kilogram (mg/kg). While not all parameters measured have appliable criteria, the water and sediment quality values obtained were not cause for concern.

Soil

A shallow soil sampling survey was conducted on 5 May 2023 to detect the presence of underlying pollutants in the soil. The nine (9) shallow soil sampling points chosen were located across the various study areas and where necessary, were located at areas of potential concern. Based on the site observations and laboratory analytical results, the shallow soil sampling survey did not detect the presence of significant levels of hazardous substances or petroleum products for the parameters analysed in soil samples collected, except for SS11, which reported chromium and nickel concentrations exceeding the DIVs. The source(s) of chromium and nickel in the soil sample

collected from SS11 cannot be conclusively known, although the detections could be attributed to the former road use at the area, which are commonly known to be present in road dust. The exceedance of soil DIVs for chromium and nickel does not necessarily indicate an unacceptable risk owning to the conservative nature of the screening level in relation of the current and future site setting (i.e., park). There is also low potential risk of exposure to construction/excavation workers and future visitors to the park too and thus no further action is recommended for the site at this time.

Flora

The field assessment for flora was carried out between 11 April 2022 and 30 November 2022. Abandoned kampong and/or plantation is the dominant vegetation type in the areas studied. Other vegetation types found include scrubland, abandoned kampong and/or plantation with native recruitment, urban vegetation, native-dominated secondary forest, grassland, farm, and exotic-dominated secondary forest. The remaining areas are occupied by quarry lakes, infrastructure, cleared areas, or were inaccessible during the field assessment.

In Study Area B1 (west of Lorong Sesuai) (BBNP), B2, B3, B4, C1, and C2, a total of 516 species and 44 species groups, and four (4) unknown species belonging to 144 families were recorded. Of the 552 species (excluding the eight (8) species groups with undetermined origin and four (4) unknown species) that were recorded, more than half of the species recorded (337 species; 61.05%) are native, while 203 species (36.78%) comprise exotic species, and 12 species (2.17%) are cryptogenic. One hundred and thirty-two (132) species are regarded as species of conservation significance.

In Study Area D (BBTP), a total of 352 species and 13 species group belonging to 107 families were recorded. More than half (222 species; 60.99%) are native, of which, 88 species are regarded as species of conservation significance. More than one-third (130 species; 35.71%) are exotic species, while the remaining are cryptogenic (12 species; 3.30%).

In Study Area E (BBHNP), a total of 192 species and two (2) species group belonging to 79 families, were recorded. Almost two-thirds (126 species; 65.28%) of all recorded plant species from this Study Area are native, one-third (64 species, 33.16%) are exotic species, and the remaining three (3) species (1.55%) are of cryptogenic origin. The status for one (1) exotic species, *Calophyllum soulattri*, is undetermined. Of the 126 native species, 29 species and two (2) species groups, *Combretum sp.* and *Sticherus cf. truncatus* are of conservation significance.

Fauna

Faunistic field surveys were carried out between 11 April 2022 and 6 December 2022. The field assessment documented 529 species, dominated by spiders (180 species), birds (115 species), and butterflies (90 species). Of all the species recorded, 29 were of conservation significance. While not captured in this study, 70 other species of conservation significance were considered probable, based on recent locality records within and around the Study Area, existing habitat types and dispersal abilities of the various species.

The connectivity study found that the only road where ground-dwelling and arboreal mammals can cross relatively safely is Lorong Sesuai as it is a narrow road that has several canopy linkages and low traffic. Along Old Jurong Road and Bukit Batok East Avenue 6, canopy linkages exist, although they may be subject to regular pruning along these major roads. Gliding mammals such as the Sunda colugo can utilise the tall and straight trunks of the Khaya senegalensis specimens lining these roads to move between BBNP and Toh Tuck Forest/forest across Study Area C1, although the connectivity across Bukit Batok East Avenue 6 has been hindered by forest clearance for road

widening works. The mature trees lining Upper Bukit Timah Road may also be utilised by gliding mammals to move between Study Areas A1 and A2. Across BBNC, there are currently gaps in connectivity for arboreal mammals along Upper Bukit Timah Road, Hillview Avenue, Hillview Terrace, Bukit Batok Street 51, Bukit Batok Street 52, Bukit Batok West Avenue 2, and Bukit Batok West Avenue 5. For ground-dwelling mammals, the aforementioned roads as well as Old Jurong Road and Bukit Batok East Avenue 6 are gaps in terrestrial connectivity. For gliding mammals, Hillview Avenue currently lacks mature trees that can serve as launching and landing points. The connectivity for gliding mammals across Bukit Batok East Avenue 6 is also recommended to be restored. Additional linkages in the form of grade-separated crossings (i.e., wildlife bridges, underpasses, canopy crossings) are recommended to be established to enhance the arboreal and terrestrial connectivity across BBNC subject to detailed planning.

Impact Assessment

Noise Quality

Noise impacts from the construction and operation of the proposed development were assessed on noise sensitive receptors (NSRs), both human and ecological, in the vicinity of the proposed BBNP, BBTP and BBHNP. Human NSRs identified include residents staying near the proposed Project, students from nearby schools and park visitors / members of public.

During construction phase, park visitors / members of the public could potentially be exposed to excessive noise arising from the construction activities at BBNP and BBTP, which will be partially opened throughout the construction phase. However, the visitors are not expected to be exposed over an extended period (exposed for eight hours or more in a day). Residents and students residing / located near to the Project site (off-site receptors) could potentially also be exposed to excessive noise arising from the construction activities.

No major noise sources are expected during operational phase, other than noise from vehicles from the potential of traffic increase at some of the parks, park visitors and/or park maintenance workers, park landscaping, maintenance and renovation works and operations of the park mechanical and electrical (M&E) equipment e.g., backup diesel generator and fire water pump for hosereel; which are only operational during emergencies. The park visitors and members of public could potentially be exposed to the excessive noise from these potential noise sources when visiting these parks, although the exposure is not expected to be over an extended period.

Ecological sensitive receptors, particularly fauna species that use sounds for communication, foraging, and breeding, or are known to have their behaviours disrupted by sound and are of conservation significance recorded during the Baseline Study or identified as probable species include birds, non-volant mammals and bats of conservation significance.

The results of the noise impact assessment showed that that the Impact Significance for the construction phase is assessed to be Negligible to Minor for Human Receptors, and Minor to Moderate for Ecological Receptor. Noise pollution mitigation measures shall be implemented in line with the *Singapore Standards Code of Practice for Noise Control at Construction Sites, 2014 (SS602:2014)*, where practicable, at the construction sites. Upon implementing the proposed mitigation measures, the Impact Significance for ecological receptors at BBNP, BBTP, and BBHNP is expected to be Minor.

During operational phase, the Impact Significance to both human and ecological receptors for the operational phase is assessed to be Negligible to Minor. No additional management or mitigation measures are required, other than to implement the minimum controls during the operational phase.

Air Quality

Air quality impacts from the construction and operation of the proposed development were assessed on air sensitive receptors (ASRs) in the vicinity of the proposed BBNP, BBTP and BBHNP. While park visitors / members of the public could also be potentially exposed to air pollutants (mainly PM_{10} and $PM_{2.5}$) arising from the construction activities at BBNP and BBTP, which will be partially opened throughout the construction phase. Residents and students residing / located near to the Project site (off-site receptors) could potentially be exposed to air pollutants arising from the construction activities, if carried by the prevailing wind. However, these receptors are not expected to be exposed over an extended period of time.

No major air emissions are expected during operational phase, other than the emission from vehicles from the potential of traffic increase at some of the parks, emissions from the park M&E equipment (backup diesel generator), and landscaping and maintenance works at the parks. The park visitors and members of public could potentially be exposed to the air pollutants from these potential sources of pollutants when visiting or working at these parks.

The results of the assessment showed that that the unmitigated impact significance during the construction phase as Negligible to Moderate. Other than the implementation of the minimum controls, as a mitigation measure, a site-specific Air Pollution Control Plan (APCP) should be developed to put in place measures such as establishing communications, implementation of site management measures, monitoring, etc., to further reduce the Likelihood of occurrence of the anticipated impact. Upon implementing the proposed mitigation measures, the Impact Significance for air quality at BBNP, BBTP and BBHNP is expected to be reduced to Negligible to Minor.

The Impact Significance to both human receptors and nature areas for the operational phase is assessed to be Negligible, as emissions from vehicular movement, M&E, landscaping and maintenance equipment at the parks are not expected to significantly reduce the air quality in the vicinity of the proposed developments. No additional management or mitigation measures are required, other than to implement the minimum controls during the operational phase.

Soil and Sediment Quality

The sensitive receptors identified include human receptors i.e., visitors / members of public at BBNP and BBHNP, which will be partially opened during the construction phase, visitors / members of public during the operational phase for BBNP, BBTP and BBHNP, and natures areas at all parks.

The potential impacts on soil and sediment associated with the activities conducted during the construction and operational phases include potential for direct soil and/or groundwater, and sediment contamination within the Study Area and potential pollution to the adjacent areas within the immediate vicinity of the project due to migration of soil and/or groundwater contamination, off-site, as a result of poor handling and storage of chemicals and hydrocarbon products and toxic waste, and poor handling and maintenance of oil containing equipment or machineries.

Based upon implementation of the minimum controls, where applicable, it is unlikely that discharge, spillage or leakage from construction equipment and machinery, chemicals, fuels and toxic waste handling and storage in a quantity that may adversely impact the soil (and/or groundwater) and sediment will regularly occur during the construction and operational phases. The prediction and evaluation exercise of impacts to soil and sediment concluded that there will be Minor impact during the construction phase and Negligible impact during the operational phase. No additional management or mitigation measures are required, other than to implement the minimum controls.

Surface Hydrology and Surface Water Quality

The sensitive surface hydrology and water quality receptors identified at the Project Sites are several forest streams as well as Quarry Lakes – Poh Kim, Little Guilin and Seng Chew. As nature parks and recreational areas, the key relevant works that may impact these sensitive receptors include the development of trails, boardwalks and viewing decks for visitors.

The primary and immediate concern is the potential increase of the concentration of suspended solids and turbidity in the water bodies as a result of erosion from exposed soil during the construction or site preparation phase. Because the majority of these water bodies discharge into the Public Utilities Board's (PUB) drainage systems, erosion control measures and an accompanying monitoring program are mandated to ensure that contaminated water are treated to acceptable levels before discharging into the receiving drains. In addition, mitigative measures will also be implemented to minimise surface erosion. While site clearing may occur to facilitate the development of these amenities, the idea is to do so only if necessary and to minimise vegetation cover removal. Similarly, there is no intention to make any alterations to the geomorphological features of the natural streams at all the Project Sites. As such, potential impacts to surface hydrology that may result in hydrological changes, e.g. increase in peak flow, flow rate, and incidences of slope failures adjacent to stream banks, are likely to be minimal.

At the completion of the project, during the operational phase, the planned amenities (i.e., trails, boardwalks, viewing decks) will bring visitors closer to the water bodies. Here, the key concern is the matter of littering by park users. While routine maintenance to remove litter is expected, it may be equally effective to put up educational signs to minimise the incidences of littering by visitors. The spatially limited increase in the extent of impervious ground cover relative to the broader catchment area is not expected to result in long-term deviation in hydrological conditions from the baseline conditions.

Considering the sensitivity of the receptors, the consequence and likelihood of the potential impacts, as well as the minimum control measures to be put in place, the impact significance during the construction and operational phases are largely Minor or Negligible. No additional management or mitigation measures are required.

Biodiversity

Biodiversity impacts from the construction and operation of the proposed development were assessed on ecological receptors within BBNP, BBTP, and BBHNP. The ecological receptors identified for the Project include habitats, flora species, and fauna species recorded within BBNP, BBTP, and BBHNP during the Baseline Study. Fauna species of conservation significance that were not recorded during the Baseline Study but deemed of probable occurrence within the respective Study Areas were also considered as sensitive receptors.

During construction phase, habitats could be exposed to loss of habitat, habitat degradation, and formation of edge effects because of construction activities. These construction activities include site clearance, demolition and removal of existing building or structure, earthworks, including excavations, slope forming and slope stabilization, general construction activities, including site preparation works, superstructure, finishing works, movement and operation of machinery, equipment and heavy vehicles and piling / substructure works. Flora species could be affected by mortality as well as decline in plant health and survival. Fauna species could experience loss of or reduction in habitats and food sources, accidental injury or mortality, human-wildlife conflict, loss of or reduction in ecological connectivity for faunal movement, light disturbances, and human disturbances.

During operational phase, habitats could be exposed to habitat degradation, changes in microclimatic conditions, and introduction of exotic species (aquatic habitats only) because of the increase in human traffic and newly built structures. Flora species could be affected by poaching. Fauna species could experience accidental injury or mortality, human-wildlife conflict, poaching, loss of or reduction in ecological connectivity for faunal movement, light disturbances, and human disturbances.

The Impact Significance for the construction phase is assessed to be Negligible to Moderate for habitat receptors, Negligible to Major for flora species receptors, and Negligible to Major for fauna species receptors. Major impacts are expected for mortality of three flora species at BBNP, decline in plant health for one flora species at BBNP, decline in plant health for one flora species at BBHNP, accidental injury and mortality for two species of bamboo bats (*Tylonycteris* spp.) at BBNP, and human disturbances to nine fauna species at BBHNP. Mitigation measures to reduce the Impact Intensity of plant mortality and decline in plant health include adjusting the alignment of boardwalks and trails to avoid these plants, erecting hoardings to delineate worksites involving heavy machinery, and ensuring the extent of the working space if clearly demarcated on-site and cross-checked by a flora specialist to avoid unnecessary vegetation clearance. Mitigation measures to reduce the Likelihood of accidental injury and mortality to bamboo bats include conducting bamboo bat rescue and translocation. A mitigation measure to reduce the Likelihood of human disturbances to fauna species is restricting the entry of personnel beyond the worksite. Upon implementing the proposed mitigation measures, the Major impacts are reduced to Negligible–Moderate.

The Impact Significance for the operational phase is assessed to be Negligible to Minor for habitat receptors, Negligible to Minor for flora species receptors, and Negligible to Major for fauna species receptors. Major impacts are expected for poaching of 11 fauna species at BBHNP, human disturbances to three fauna species at BBHNP, and light disturbances to 16 fauna species at BBHNP. Mitigation measures to reduce the Likelihood of poaching include conducting regular patrols to deter poaching activities and designing trails and boardwalks to deter visitors from venturing off-trail (e.g., dense landscaping along sides of trails/boardwalks, railings). Mitigation measures to reduce the Likelihood of human disturbances include designing trails and boardwalks to deter visitors from venturing off-trail and closing the park during the night (1900–0700h). Mitigation measures to reduce the Likelihood of light disturbances include incorporating wildlife-friendly lighting and closing the park during the night (1900–0700h). Upon implementing the proposed mitigation measures, the Major impacts are reduced to Minor–Moderate.

Mitigation Measures

The following mitigation measures have been developed to minimise the adverse impacts (Moderate to Major Impact Significance) during the construction and operational phases of the Project on the identified sensitive receptors:

Table 1: Summary of Key Mitigation Measures

Environmental Parameter	Mitigation Measures
Noise Quality	<u>Construction Phase</u> • Implement noise pollution mitigation measures in line with the *Singapore Standards Code of Practice for Noise Control at Construction Sites, 2014 (SS602:2014)*, where practicable, at the construction sites <u>Operational Phase</u>

Environmental Parameter	Mitigation Measures
	• Impact significance during operational phase were negligible to minor; no additional management or mitigation measures required
Air Quality	Construction Phase • Develop a site-specific APCP to put in place measures such as establishing communications, implementation of site management measures, monitoring Operational Phase • Impact significance during operational phase were negligible to minor; no additional management or mitigation measures required
Soil and Sediment Quality	Impact significance during both construction and operational phase were negligible to minor; no additional management or mitigation measures required
Surface Hydrology and Water Quality	Impact significance during both construction and operational phase were negligible to minor; no additional management or mitigation measures required
Biodiversity	Design Phase • Avoid areas of high conservation value; • Adjust construction footprint to avoid Priority 1 plant species; • Avoid changes to watercourses; • Put up signages to remind visitors not to litter or pollute the habitats; • Put up signages to remind visitors not to release exotic species; • Put up signages to remind visitors not to stray off-trail; • Put up signages to educate visitors on appropriate behaviours when encountering fauna; • Design the boardwalks and trails to deter visitors from trampling/ venturing off-trail (e.g., install railings, dense landscaping along the sides of boardwalks and trails); • Transplant plant specimens of conservation significance away from publicly accessible areas; • Design for dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions; • Integrate road-calming measures; • Design bins to be wildlife-proof; • Avoid installation of artificial lights; • Incorporate wildlife-friendly lighting; and • Design for stream enhancement Construction Phase

Environmental Parameter	Mitigation Measures
	• Erect hoardings to delineate worksites involving heavy machinery; • For worksites involving manual work only (I.e., trails and boardwalks), ensure the extent of the working space is clearly demarcated on-site and cross-checked by a Flora Specialist to avoid unnecessary vegetation clearance; • Ensure construction works, material and waste storage, access routes, etc., are kept within the boundaries of the worksite or agreed working space; • Arborists to determine suitable Tree Protection Zones (TPZs) for any trees that will be retained within the worksites; • Transplant or salvage saplings of conservation significance; • Adjust the construction footprint of boardwalks and trails to avoid Priority 1 plant species, in consultation with a Flora Specialist; • Avoid changes to watercourses; • Ensure unobstructed flow of water along existing watercourses during construction of Wetland and stream enhancement works at BBHNP; • Ensure earth control measures (ECM) are implemented prior to site clearance. The ECM plan should be formulated by Qualified Erosion Control Personnel (QECP); • Implement dust control measures such as dust screens and water suppression systems; • Conduct regular monitoring to identify any impacts to habitats adjacent to the worksite. This includes visual inspection of surrounding aquatic habitats and monthly wildlife monitoring in habitats adjacent to the site; • Conduct regular site inspections to ensure contractor compliance with the Environmental Monitoring and Management Plan (EMMP); • Conduct regular inspections in the surrounding habitats to ensure no removal of vegetation has occurred beyond the agreed worksite boundaries; • Implement dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions; • Implement assisted natural regeneration at the degraded patch of abandoned kampong and/or plantation that lines Stream SB1a; • Use only fully biodegradable wildlife-friendly erosion control blankets to avoid trapping fossorial fauna such as snakes; • Conduct regular trainings and toolbox briefings for site personnel on biodiversity awareness and actions to take when encountering wildlife; • Formulate a wildlife response plan to be executed when trapped/ injured/ dead/ dangerous fauna is found on-site; • Ensure good housekeeping such as the provision of wildlife-proof food waste bins and enclosed eating areas; • Conduct bamboo bat rescue and translocation; and

Environmental Parameter	Mitigation Measures
	• Restrict entry of site personnel beyond the worksite Operational Phase • Carry out regular maintenance of the park (e.g., removal of litter, emptying of trash, ensure integrity of railings along trails and boardwalks); • Conduct regular patrols to deter visitors from straying off-trail, releasing exotic species into waterbodies, and poaching activities; • Conduct outreach programmes to educate visitors on the harmful effects of introduction of exotic species; • Conduct regular removal of exotic species from aquatic habitats; • Transplant specimens of conservation significance away from publicly accessible areas; • Close the parks and associated facilities to the public during the night (1900–0700 h); and • Conduct regular post-construction biodiversity monitoring to determine if the increased visitorship has affected fauna species

Conclusions and Recommendations

A summary of the potential impact significance (and residual impact significance, post-implementation of mitigation measures) of the assessed environmental aspects for the BBNP, BBTP and BBHNP are summarised in the table below.

Table 2: Summary of Impact Significance

Environmental Parameter		Unmitigated Impact Significance (with minimum controls)	Residual Impact Significance (post-mitigation measures)
Construction Phase			
Noise Quality	Human Receptors	Negligible - Minor	N/A
	Ecological Receptors	Minor - Moderate	Minor
Air Quality	Human Receptors	Negligible – Moderate	Negligible – Minor
	Nature Areas	Negligible - Moderate	Negligible - Minor
Soil and Sediment		Minor	N/A
Surface Water Quality		Minor	N/A
Surface Hydrology		Negligible - Minor	N/A
Biodiversity		Negligible - Major	Negligible - Moderate
Operational Phase			
Noise Quality	Human Receptors	Negligible	N/A
	Ecological Receptors	Negligible - Minor	N/A
Air Quality	Human Receptors	Negligible	N/A
	Nature Areas	Negligible	N/A
Soil and Sediment		Negligible	N/A
Surface Water Quality		Negligible – Minor	N/A
Surface Hydrology		Negligible - Minor	N/A
Biodiversity		Negligible - Major	Negligible - Moderate

Environmental Parameter	Unmitigated Impact Significance (with minimum controls)	Residual Impact Significance (post-mitigation measures)
Note: 1) N/A – where the impact significance with minimum controls is scored Negligible to Minor, no mitigation measures were proposed and hence, did not warrant for further assessment.		

The findings of the EIA indicate that the predicted adverse environmental impacts arising from the construction phase can be effectively mitigated and minimised to meet regulatory limits and acceptable residual levels. The recommended mitigation measures include design and planning measures as well as management of construction practice that will help avoid, minimise and control the potential impacts.

Environmental Monitoring and Management Plan

An EMMP (presented as Volume II, a separate document from this EIA report) has been prepared for implementation on-site during the construction phase. The EMMP has been developed to ensure that the potential impacts of the Project on the physical environment, flora and fauna are minimised and managed effectively. The EMMP outlines the roles and responsibilities of various parties involved in the Project, the monitoring methods and frequency, the reporting requirements, and the corrective actions to be taken in case of non-compliance or unforeseen circumstances.

On commencement of the construction contract, the Contractor is to ensure that the environmental control measures are adequate to minimise impact on the environment and validate any changes to the recommended mitigation measures. This is to be documented through the preparation of an EMMP Implementation Plan to be submitted for approval prior to commencement of physical works on the site. NParks is committed to undertaking the proposed Project in an environmentally sustainable manner and will take all necessary actions to ensure that the Contractor is in compliance with the final EMMP and all prevailing environmental regulations.

The environmental control measures recommended including mitigation, monitoring, management plans and procedures associated with the identified impacts have been presented and discussed, and it is concluded that these are sufficient to ensure the sound management of impacts throughout the development of BBNP, BBTP and BBHNP.

1. BACKGROUND OF THE PROJECT

1. Background

Ramboll Pte Ltd (Ramboll) is pleased to present this **Impact Assessment Report** to National Parks Board (NParks or "the Board"), which was prepared as of the Biodiversity and Environmental Studies ("the Studies") for the proposed development of the Bukit Batok Nature Park (BBNP), Bukit Batok Town Park (BBTP) and Bukit Batok Hillside Nature Park (BBHNP) (collectively referred to as the proposed "Project" or "Study Area"), which are parts of the proposed Bukit Batok Nature Corridor (BBNC). Ramboll's team includes Camphora Pte Ltd (Camphora) as the Biodiversity Specialist for the Studies.

In June 1990, NParks was established as a statutory board under the Ministry of National Development to manage and enhance the national parks, comprising Singapore Botanic Gardens and Fort Canning Park, and the nature reserves. NParks' City in Nature vision is a key pillar of the Singapore Green Plan 2030 – a national movement to chart Singapore's course for sustainable development. NParks will also create Nature Corridors, which are identified pathways that provide important ecological connections between areas rich in biodiversity, such as the Nature Reserves. The proposed BBNC project is one such corridor.

The proposed BBNC consists of forested areas around Bukit Batok, including the Former Bukit Timah Fire Station (BTFS), the eco-pedestrian bridge, BBNP, BBTP, Bukit Batok Central Nature Park (BBCNP) and BBHNP with a total land area of over 125 ha. The BBNC provides important habitats for biodiversity, including fauna moving between the Central Nature Park Network and Tengah Forest Corridor, as well as migratory birds flying along the East Asian-Australasian Flyway. The proposed BBNC will serve as an ecological corridor that will connect the Former BTFS, BBNP, BBTP, BBHNP, Central Nature Park Network and the future Tengah Forest Corridor.

Ramboll has conducted a biodiversity and environmental baseline survey, which has established the environmental baseline conditions of the Study Area i.e., noise quality, air quality, water quality, sediment quality and soil quality, and biodiversity. The baseline information of existing environmental conditions is used to identify the scale and severity of possible human impacts on these natural systems arising from the proposed development of Project under this report, and to develop measures to address these impacts.

1.1 Objective

The objective of this Impact Assessment Report is to assesses the nature and extent of environmental impacts arising from the construction and operation of the Project.

1.2 Scope of Work

This study comprises four (4) stages as listed below.

- ✓ Stage 1: Scoping and Inception Report, Topographical and Hydrographical Surveys, Flora Baseline Study, Tree Tagging and Assessment, Fauna Baseline Study, and other environmental baseline studies;
- ✓ Stage 2: Environmental Impact Assessment (EIA) and Environmental Monitoring and Management Plan (EMMP);
- ✓ Stage 3: Implementation of EMMP at Construction Stage; and
- ✓ Stage 4: Implementation of EMMP at Post-construction Stage.

This **Draft EIA Report (Stage 2)** details the relevant regulatory framework, standards, guidelines, identification of impacts, the prediction, evaluation and mitigation environmental impacts, and provide a summary of impacts and mitigation measures.

1.3 Consultation with NParks

Consultation with NParks was conducted during the course of the Study, comprising:

- Kick-off meeting with NParks and Architect teams;
- Site visits to Project Site with NParks and Architects team; and
- Bi-weekly progress meetings with NParks and Architects team.

1.4 Organisation of Report

The EIA for the Project comprises two (2) volumes, as follows:

Table 1-1: Contents of the Final EIA Report

Section	Title
Volume I	
1.	Background of the Project
2.	Description of the Project
3.	Relevant Regulatory Framework, International Standards, and Guidelines
4.	Description of Environment
5.	EIA Approach and Methodology
6.	Identification of Impacts
7.	Noise Quality Impact Evaluation and Mitigation
8.	Air Quality Impact Evaluation and Mitigation
9.	Soil and Sediment Quality Impact Evaluation and Mitigation
10.	Water Quality Impact Evaluation and Mitigation
11.	Biodiversity Impact Evaluation and Mitigation
12.	Conclusion
Volume II	
1.	Environmental Monitoring and Management Plan

1.5 Reliance and General Limitation

This report has been prepared for the exclusive use of the Board and other Government Bodies and may not be relied upon by any other person or entity without Ramboll's prior express written permission. The conditions described in this report represent conditions encountered at the time and location of the field surveys; future conditions at the Study Area may change and differ significantly from those described in this report.

This report has been prepared in conformance with generally accepted standards of practice in the fields of environmental sciences and engineering at the time the services were rendered. Ramboll makes no other warranty or representation, either expressed or implied, with respect to its services.

The level of details carried out during Ramboll's desktop assessment and field surveys for this study is appropriate to meet the study objectives as defined in this report; however, there is no warranty or guarantee, expressed or implied, that the assessment and surveys have uncovered all potential environmental and ecological findings and aspects associated with the Study Area.

The Project is at the preliminary stages of project design. The EIA has been prepared based on preliminary project information and is based on the following limitations / assumptions:

Accuracy of information

The information used to conduct the EIA is as accurate as Ramboll's knowledge at the point of the Study. Ramboll will not be liable for any updates to the Project (e.g. development design and other information) after the conduct of the EIA.

2. DESCRIPTION OF THE PROJECT

2.1 Need for the Project

Nature Corridors are identified by NParks as pathways that map out important ecological connections between areas rich in biodiversity, such as nature reserves and nature parks. Within Nature Corridors, ecological connectivity is enhanced through creating connections between existing parks, Nature Ways, and the Park Connector Network, as well as safeguarding new ones. Nature Corridors were conceptualised by taking into account the ecological profile of the areas, as well as their ecological connectivity with surrounding habitats.

BBNP, BBTP and BBHNP falls within the proposed BBNC, which lies between Bukit Timah Nature Reserve (BTNR) and the Tengah Forest Corridor (Figure 2-1). The hills within this nature corridor are intermediate nodes that allow the movement of wildlife, which can facilitate the exchange of genetic material between the two areas, and healthier biodiversity populations.

Altogether, the proposed BBNC will comprise about 125 ha of nature parks and over 10 kilometres (km) of trails that will also serve as ecological connectors, as well as Nature Ways and Park Connectors.

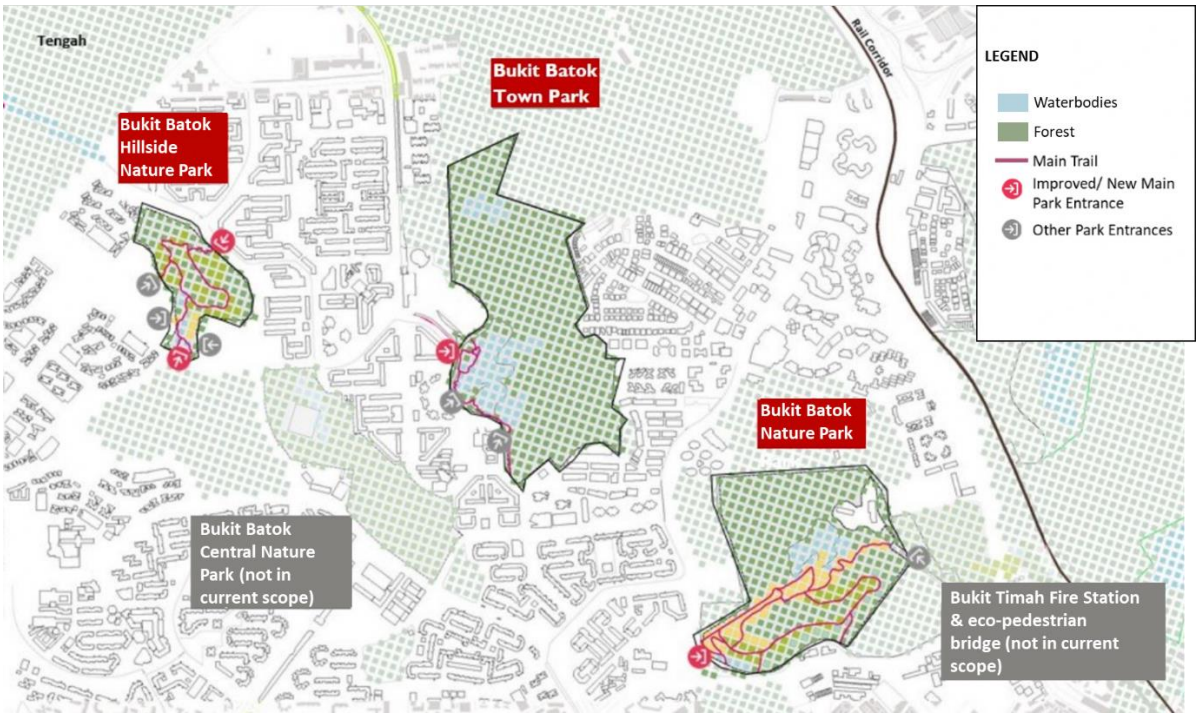


Figure 2-1: Overview of Proposed BBNC

Note: at the time of reporting the eco-pedestrian bridge shown in Figure 2-1 is indicative, and is subject to change pending further discussion.

2.2 Proposed Development of the Project

2.2.1 Overview

The proposed BBNC will comprise of the following key features: the former BTFS / Visitor Pavilion, the eco-pedestrian bridge, observation decks, boardwalks and nature trails at BTFS, BBNP, BBTP and BBHNP (Figure 2-1).

As the proposed alignment for the eco-pedestrian bridge was still under discussion at the time of reporting, this Impact Assessment Report will only present the proposed development features of BBNP, BBTP and BBHNP. The proposed developments at BBNP, BBTP and BBHNP are further detailed in the subsequent paragraphs.

2.2.1.1 BBNP

BBNP will be refurbished to upgrade the existing trails and amenities of BBNP, as well as improve the overall connectivity of BBNP to BTNR and BBNC. Key improvements include plaza nodes, a refurbished carpark, a toilet, and refurbishment of existing trails, such as the forest discovery trail, the proposed trails (Figure 2-2), with their features further expanded on below.

Figure 2-2: Overview of the Proposed Development of BBNP

Carpark

The carpark will be refurbished to include a pick-up/ drop-off shelter for visitors, which will serve as an entrance to BBNP through the proposed trails towards quarry and stream loop (Figure 2-3). There will also be buffer planting along the edges of the carpark. The carpark will also have an area for bicycle parking.

Figure 2-3: Proposed Carpark Redevelopment

Proposed Trails towards Quarry

The enhanced proposed trails towards quarry will span the refurbished carpark to the boardwalk along the quarry pond, with a total length of 840 m. The proposed trails towards quarry will begin at the carpark, where there will be a new path constructed from the newly refurbished carpark connecting to the main existing track into BBNP. The path will lead from the pick-up/ drop-off shelter at the carpark, pass an entrance shelter, to a ramp that connects to the main road into BBNP.

The proposed trails towards quarry will then follow the existing road into BBNP, passing the plaza, ultimately leading to the quarry. The existing lookout point at the quarry pond will also be re-developed into an approximately 100 m long, 2 m wide boardwalk loop as part of the proposed trails towards quarry. The existing cobblestone and road trail will be demolished and replaced with a boardwalk. The boardwalk will be undulating, with ramps, to provide a unique elevational experience for users, and have viewing decks with seating. There will also be strategic dense planting along the boardwalk.

BBNP Plaza & Play Area

The plaza will consist of the refurbished toilet and pavilion, exercise plazas, a foot reflexology path, a fitness corner, a play area, a nature trail and a quarry look-out (Figure 2-4). The existing toilet will have its shed, footpath and taps, ramp, water coolers, tiling and sanitaryware demolished, and replaced. The pavilion will also have its roof, columns, and roller shutter demolished. The refurbished pavilion will include a closed-circuit television (CCTV) and a utility room, water points, benches, and vending machines.

The exercise plazas will be a series of open spaces with differing capacities, intended for various mass activities, such as qi gong, dancing, or yoga. The plaza nodes will be approximately 75 square meters (m^2), 100 m^2, and 450 m^2. Adjacent to the exercise plazas, will be the fitness corner, and a newly constructed foot reflexology trail. The existing playground will also be repackaged into a play area.

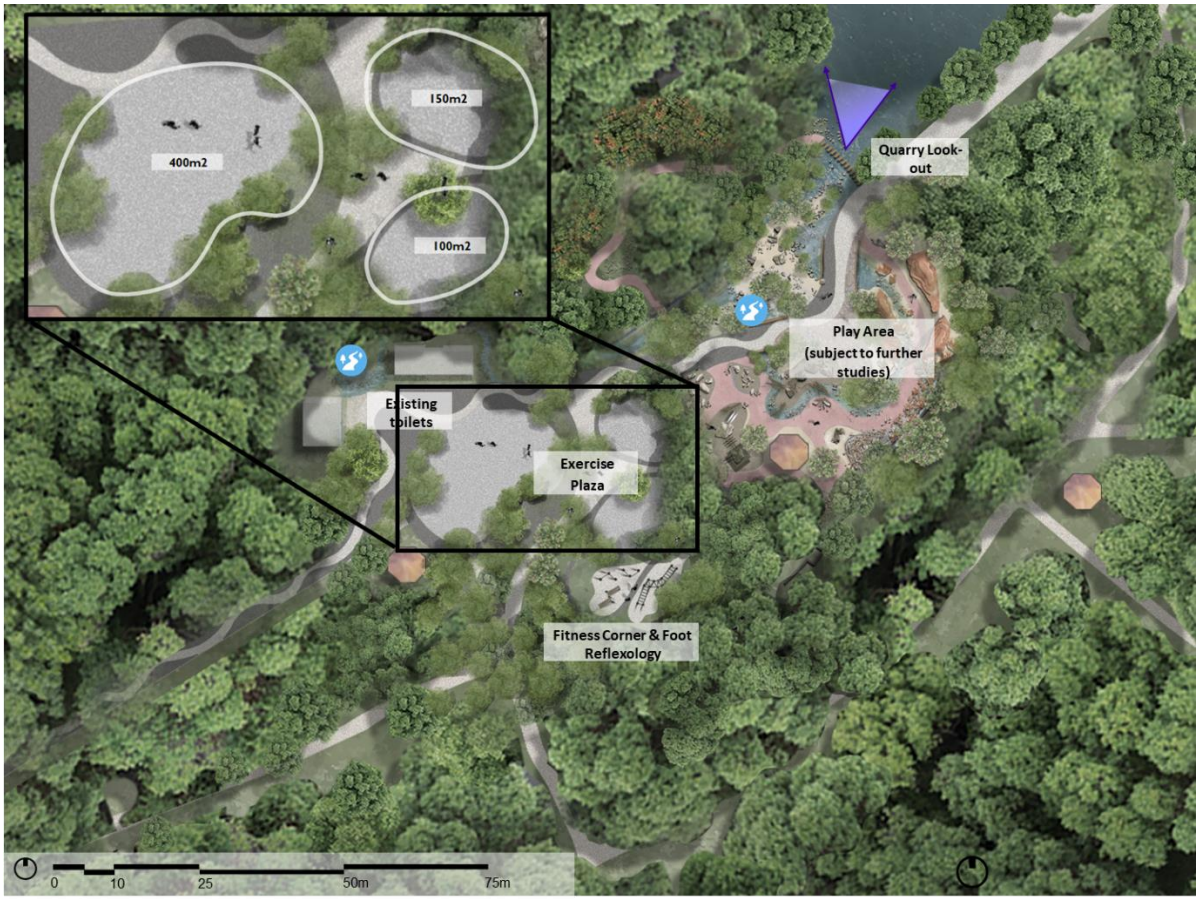


Figure 2-4: Overview of BBNP Plaza & Play Area

Proposed Trails

The heritage trail is an existing trail along BBNP that will span approximately 500 metres (m). Slope stabilization works will be carried out along the heritage trail, with micro piling and soil nails. The slope stabilization works here were deemed necessary to prevent further damage to habitats and plants of high ecological value at the base of the slope, and (3) provide safe access for future park visitors.

The forest discovery trail is an existing trail within BBNP that will span approximately 700 m.

The existing stream loop will be refurbished and will span from the entrance shelter at the refurbished carpark, to the existing shelter F in BBNP. The stream loop will be approximately 1400 m long, and start at the entrance shelter, where it will run adjacent to the existing streams and a new cascading water feature. It will connect to an existing naturalised stream in BBNP. The existing BBNP stream, located along the southern boundary of Area B1/C1, will be extended to meet the cascading water feature, and enhanced with naturalised stream edges. The stream loop will join up

with the existing forest track, which leads to the existing road in BBNP, ultimately ending at the existing shelter F.

2.2.1.2 BBTP

The existing BBTP will be refurbished with a courtyard, the Little Guilin Experience trail and viewing decks (see **Figure 2-5**).

Figure 2-5: Overview of the Proposed Development of BBTP

Arrival Node

The newly developed arrival node will be circular in semi-circular building with metal roof, fronting a landscaped courtyard, surrounded by a retaining wall, and sheltered walkways with green roofs. The courtyard arrival node will house the toilet amenities, mechanical and electrical (M&E) rooms, and cleaner rooms along the circumference of the courtyard. It will serve as the main entrance into BBTP for visitors entering from Bukit Batok Avenue 5. Slope forming works will be carried out at the arrival node prior to construction works, which will consist of the cutting of slope and installation of sheet piles.

Proposed Trail

The proposed trail will span the newly constructed courtyard at the arrival node, to the existing trail along the southwest of the Little Guilin Quarry. The trail will be approximately 670 m long and consist of an elevated boardwalk. A portion of the boardwalk will be a newly constructed 2 m wide floating pontoon boardwalk over the Little Guilin Lake which connects to the existing trail. The existing trail along the southwest of Little Guilin will be refurbished to a 2.2 m wide pathway, with

seating areas and alcoves. The boardwalk will connect the entrances to the arrival node, courtyard, viewing decks, and existing alcoves. There will be two new viewing decks constructed along the boardwalk, southwest of the Little Guilin Quarry. One of the viewing decks will be situated along the quarry lake edge, while the other viewing deck will be right after the courtyard.

2.2.1.3 BBHNP

The previously developed BBHNP, which was then closed, will be redeveloped to have a new arrival node, trails, and enhancements of the streams (Figure 2-6).

Figure 2-6: Overview of the Proposed Development of BBHNP

Arrival Node

The arrival plaza will consist of an entrance shelter, toilet, a storage area, a bin centre, and amenities (Figure 2-7). The constructed wetlands and stream ponds, expanded more upon the following section, will also be situated in the arrival node. The arrival node will serve as an entrance for visitors entering the park from Bukit Batok West Avenue 5.

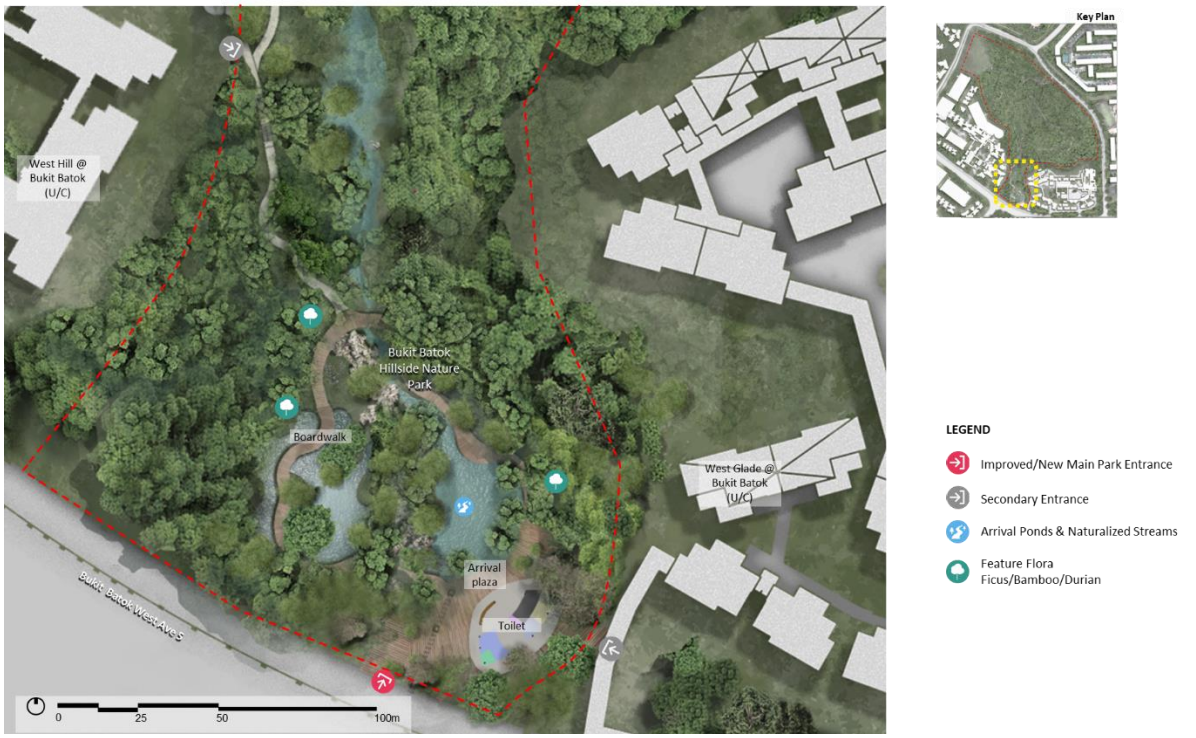


Figure 2-7: Arrival Node at BBHNP

Stream enhancement

The existing stream in BBHNP runs from the spring inlet at the top of BBHNP to the arrival node, where it transitions into a marsh, and drains into a PUB box culvert. The stream will be enhanced with rocky cascades, gentle cascades and play cascades to allow visitors to appreciate and learn of the existing stream ecology. The marsh will be enhanced into constructed wetlands and stream ponds at the arrival node with play elements (Figure 2-7). The ponds will include elements such as stepping stones, a pond crossing, a boardwalk, and cantilevers.

Stream and Fern Trail

The stream and fern trail will be 500 m long and stretch from the arrival node to the top of the hill, where it connects with the Nature Trail. The stream and fern trail will run alongside the enhanced stream and the large ferns that grow next to the stream. The trail will consist of loose concrete pavers and exposed aggregate under the shelter, before transitioning to bound aggregate and pre-cast concrete block steps with rope railings as it runs up BBHNP.

Nature Trail (Under Study)

The nature trail will be a trail connecting the entrance at West Hill @ Bukit Batok, to the existing trail around BBHNP, and the entrance at Bukit Batok West Avenue 2. It will be 1,500 m long and connect to the top of the Stream and Fern trail. There will be an entrance plaza with a map of BBHNP and signage at the entrance at Bukit Batok West Avenue 2. The trail will feature the existing bamboo clusters, and Tembusu trees. The existing GFRC at the entrance of Bukit Batok West Avenue 2 will be demolished and removed. The existing unstable wooden shelter, collapsed pergola and boardwalk along the trail will also be removed from site.

2.2.2 Proposed Phasing and Hoarding Plan

The proposed hoarding plan for BBNP, BBTP, and BBHNP are presented in Figure 2-8 to 2-12.

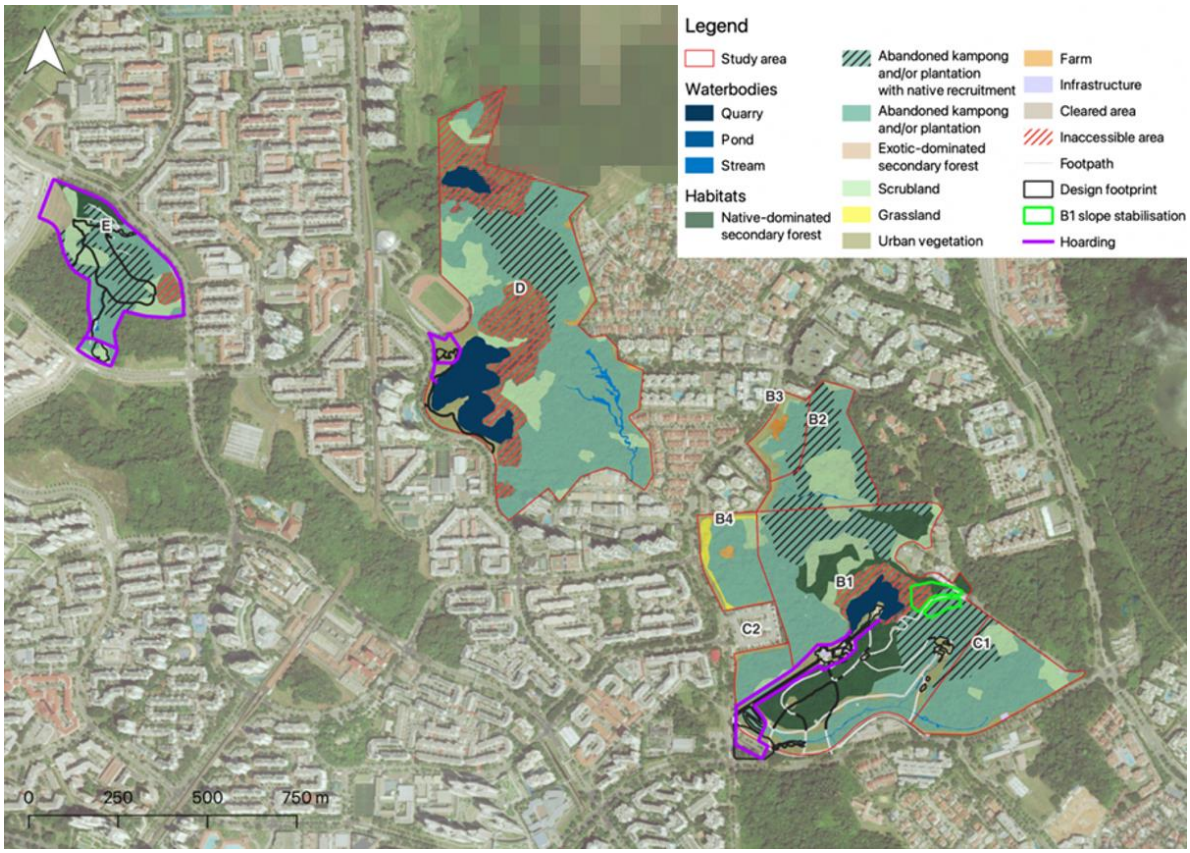


Figure 2-8: Overall Proposed Hoarding Plan

The construction works at the proposed BBNP will be carried out in two (2) phases i.e., Phase 1A which involves Proposed trails towards quarry and existing trails construction from month 1 to month 24, and Phase 1B which involves Car Park construction from month 19 to month 24. Construction works at the proposed BBTP and BBHNP will be carried out over a single phase over a period of 24 months.

Both BBNP and BBTP are expected to continue to be partially opened to public throughout the construction phase. At BBNP, at least one loop of the park trail will continue to be opened to the public. During the last 6 months of construction, the whole park will be closed.

The existing trail beside the PCN, located along the western boundary of the Little Guilin, BBTP will also remain accessible through the construction period. The hoarding of the existing trail at BBTP will not be more than 100 m at one time.

Hoarding to be used for the project will meet the requirements of BCA's Guidelines on Hoarding Provisions for Landed Development. The hoardings will be least 1.8-m high, made of hard materials and will be embedded at least 300 mm into the ground.

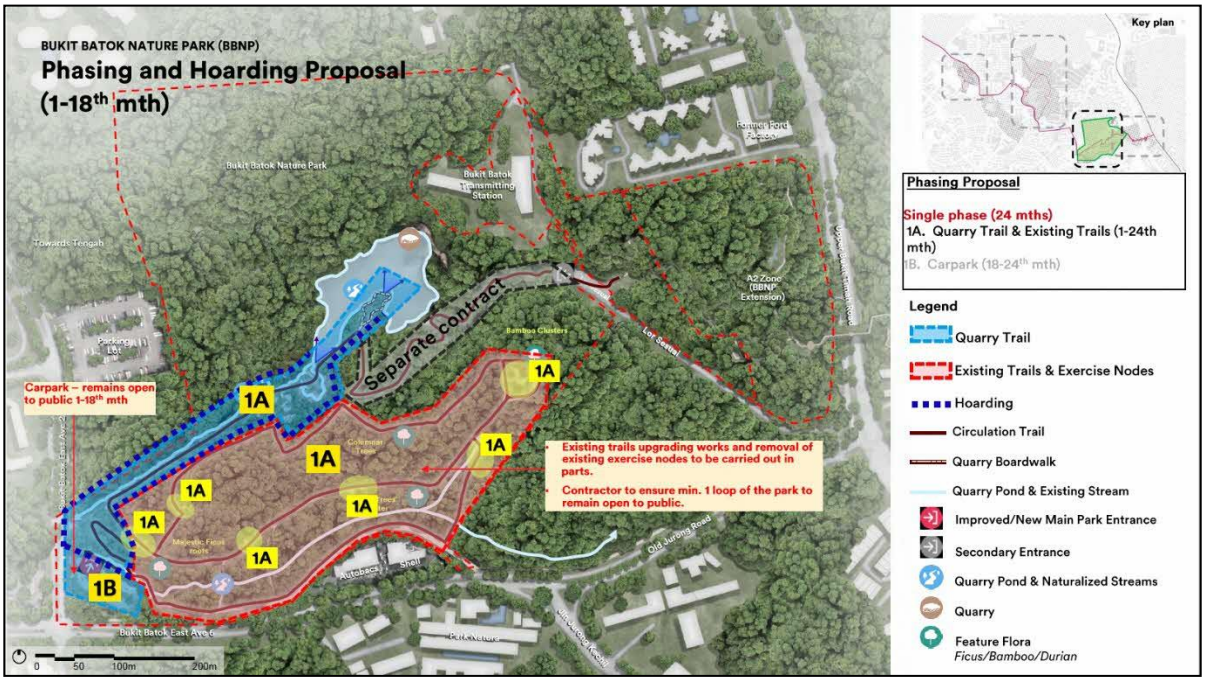


Figure 2-9: Proposed BBNP Hoarding Plan (Phase 1A)

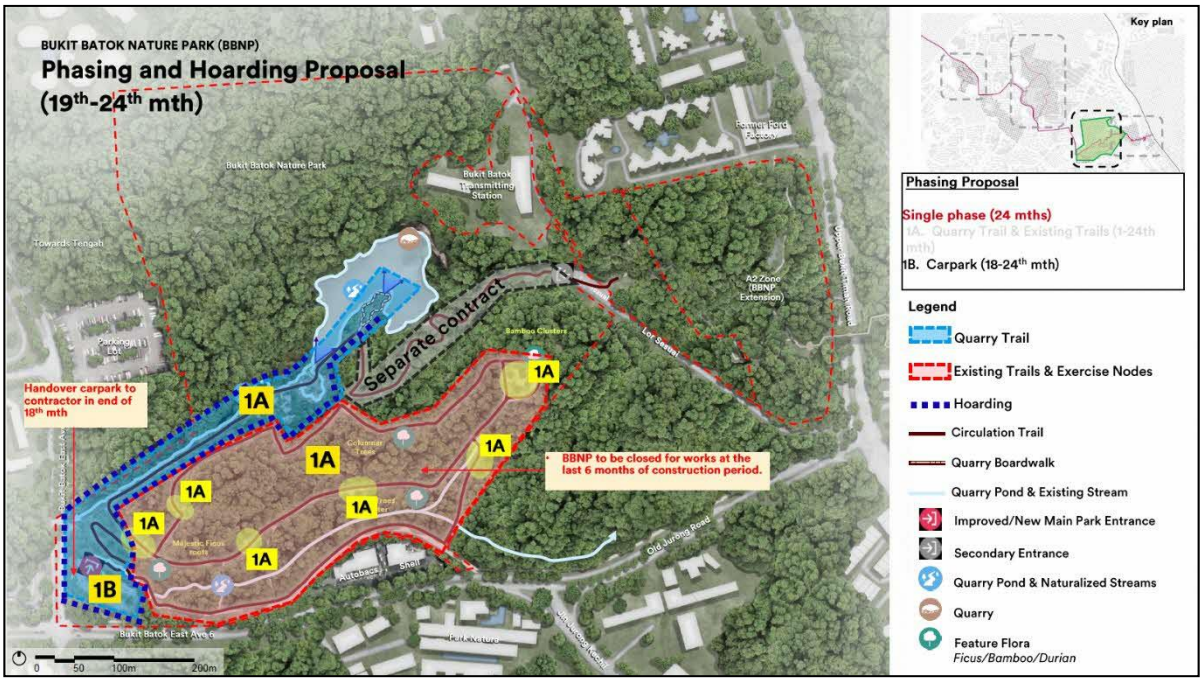


Figure 2-10: Proposed BBNP Hoarding Plan (Phase 1B)

Figure 2-11: Proposed BBTP Hoarding Plan

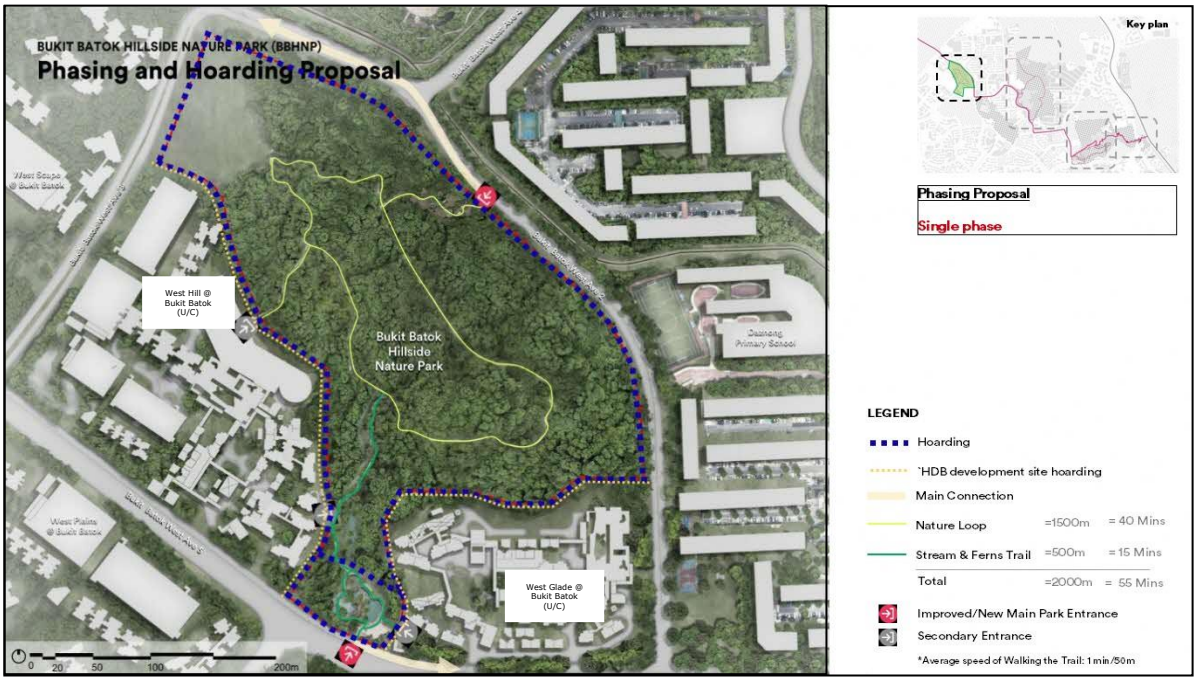


Figure 2-12: Proposed BBHNP Hoarding Plan

2.2.3 Operational Phase

The Project will be managed by NParks.

2.2.4 Indicative Development Schedule

Construction of the Project will be commissioned in separate packages; these include the upgrading and construction works at BBNP, BBTP, and BBNP. As indicated in previous subsections, both BBNP and BBTP are expected to continue to be partially opened to public throughout the construction phase. The construction activities are anticipated to occur over approximately 24 months.

2.3 Conservation Approach for Project Site

The flora design concept for the Project will be integrated and aligned to the conservation philosophies of NParks, as well as the design intent of the Project which is to provide for forest conservation and an understanding of the history of the Study Area. NParks has conveyed that the approach to be adopted for this development would be a combination of in-situ conservation (where

design allows) and ex-situ conservation approach (whereby plants of conservation significance or significant trees would be transplanted and conserved elsewhere on the Site or other conservation site). As such, the key principles to be adopted for the development include:

- Combination of in-situ conservation (where design allows) and ex-situ conservation approach (whereby plants of conservation significance or significant trees would be transplanted and conserved elsewhere on the site or other conservation site);
- Sensitive placement of boardwalk and nature trails, localized construction work areas and work access as well as the conservation of the woodland and stream areas found on the site, where possible;
- Limiting the usage of heavy machinery on the site, where practicable.

2.4 Consideration of Alternatives to the Project

As part of the EIA process, a review of the need for the project and consideration of alternatives was carried out. Alternatives to carrying out the project are summarised as follows:

1. Not carrying out the Development of the proposed Project

   BBNP, BBTP and BBHNP, which are located wihtin the proposed BBNC is strategically situated between BTNR and the Tengah Forest Corridor. The nature parks and trails between parks serves as an important steppingstone for wildlife moving between Tengah and BTNR, which is connected to the greater Central Catchment Nature Reserve nature area through the eco-link bridge across the Bukit Timah Expressway. The proposed BBNC would improve ecological connectivity between areas rich in biodiversity and facilitate the exchange of genetic material between the two areas, with sensitive enhancements taken to limit the impact of development on the existing wildlife. Various other habitat enhancement measures would also facilitate movement within BBNC. Not carrying out the project would limit the possible range expansion and long-term health of our wildlife populations. Furthermore, BBHNP and BBNP contain ecologically rich streams which have eroded embankments, the development of the Site would cater for minimally intrusive restoration works of the stream banks and enhance the quality of the stream habitats. Not enhancing the existing habitats within the development could result in further deterioration.

2. Not constructing the courtyards, plazas, activity nodes, enhanced streams and ponds, nature trails and boardwalks

   Not constructing the courtyards, plazas, activity nodes, enhanced streams and ponds, nature trails and boardwalks could reduce the scale of the Project, minimising environmental impacts on the surrounding residential and woodlands such as noise and vibration and dust emissions. However, these facilities are necessary to provide nature-based recreational options for the public to alleviate visitorship pressure from the main Bukit Timah Nature Reserve and can be sensitively designed in alignment with and conducive to the overall vision of the Site.

2.5 Overview of Design Options

The Project is currently being developed by LAUD Architects Pte Ltd (LAUD) as the main architect and Henning Larsen (HL) as the landscape architect together with NParks. A Main Contractor will be awarded the Contract to develop the Project. The design and construction method to be proposed by the Main Contractor shall be in accordance with the approved design objectives, all applicable regulatory requirements, and the recommendations of this EIA.

3. RELEVANT REGULATORY FRAMEWORK, INTERNATIONAL STANDARDS, AND GUIDELINES

3.1 Overview of the Regulatory Framework

The relevant national policy and regulatory framework and guidelines relevant to the Study are described in the following sections of the Inception Report, while the relevant criteria will be identified in the EIA Report.

3.2 National Policies, Plans and Strategies

3.2.1 Sustainable Singapore Blueprint

The Sustainable Singapore Blueprint 2015, first released in 2009, contains a series of environmental goals to be met by 2030. There are five thrusts under the blueprint:

- "Eco-Smart" Endearing Towns;
- A "Car-Lite" Singapore;
- Towards A Zero Waste Nation;
- A Leading Green Economy; and
- An Active and Gracious Community.

The conservation of Singapore's natural heritage to realize a City in a Garden was one of the key objectives under the Sustainable Singapore Blueprint. Singapore pledges to continue to build on, protect and reinforce its natural heritage. As part of this initiative, Singapore plans to conserve and raise awareness on the importance of biodiversity research.

3.2.2 National Biodiversity Strategy and Action Plan

Developed in 2009, the National Biodiversity Strategy and Action Plan (NBSAP) provides a framework to guide the conservation and sustainable use of Singapore's biodiversity resources. In fulfilling Singapore's obligations as a signatory to the United Nations Convention on Biological Diversity, the goals of the NBSAP mirror that of the Convention. Strategies have been developed with the intention to establish both policy frameworks and specific measures to ensure better planning and co-ordination in the sustainable use, management, and conservation of the nation's biodiversity.

These strategies are as follows:

- Strategy 1: Safeguard our Biodiversity;
- Strategy 2: Consider Biodiversity Issues in Policy and Decision-making;
- Strategy 3: Improve Knowledge of Our Biodiversity and the Natural Environment;
- Strategy 4: Enhance Education and Public Awareness; and
- Strategy 5: Strengthen Partnerships with All Stakeholders and Promote International Collaboration.

Of particular note is Strategy 2 which details the need to account for biodiversity issues when making decisions in the existing administrative framework. In the consideration of biodiversity issues during the early stages of project planning, designing, construction and operation, the EIA serves as a planning instrument to incorporate environmental (including biodiversity) concerns in decision-making.

3.2.3 Nature Conservation Master Plan

The Nature Conservation Master Plan (NCMP), released in 2015, provides a framework for Singapore's biodiversity plans for the subsequent five years. There are four aspects within in the master plan, as follows:

- Conservation of Key Habitats;
- Habitat Enhancement, Restoration and Species Recovery;
- Applied Research in Conservation Biology and Planning; and
- Community Stewardship and Outreach in Nature.

Of particular significance is the Conservation of Key Habitats aspect which relates to the safeguarding and strengthening of Singapore's core biodiversity areas, securing and enhancing buffer areas, enhancing and managing additional nodes of greenery throughout the nation, developing ecological connections, and integrating nature with the urban landscape.

3.2.4 Land Use Plans

The Long-Term Plan (previously known as Concept Plans, and last reviewed in 2021) is a strategic land use and transportation plan that provides the broad directions to guide Singapore's physical development over the next 40–50 years. In line with the broad strategies laid out in the Long-Term Plan, the Master Plan (currently the Master Plan 2019, and reviewed every five years) serves as the statutory plan that guides the physical development of Singapore and sets out the land uses and development intensities for every part of the island. Prepared by the URA and other relevant government agencies, these two plans serve as the overarching framework that ensures that public and private developments are carried out in accordance with prescribed guidelines.

Special and Detailed Control Plans have also been developed by the URA as detailed local area plans for physical development. In particular, the Parks and Waterbodies Plan (Special and Detailed Controls Plan) serves to clearly demarcate the boundaries and alignments of the existing and proposed parks, open spaces, interim greens, park connectors, promenades, nature reserves, nature areas and waterbodies. Under the Parks and Waterbodies Plan, Singapore's nature areas are subjected to administrative safeguards.

3.3 Environmental Legislation, Codes and Guidelines

3.3.1 Overview

Environmental Acts deal with the administrative aspects of the environmental laws while subsidiary regulations under each Act are focused on the implementation of the law. The regulations provide the details such as the standards, record keeping requirements, and criteria to be met.

Controlling government authorities also publish Codes of Practice (COPs) which summarise the key aspects of legislation in a simpler form. They generally contain additional technical details not found in the Acts or subsidiary regulations and are expected to be complied with by the controlling authorities.

In addition, Spring Singapore publishes 'Singapore Standards' which are nationally recognised documents, established by consensus. The standards comprise functional or technical requirements in the form of specifications for materials, codes of practice, terminologies, or guides. Compliance to Singapore Standards is voluntary. However, they become mandatory when used by government authorities in regulations or administrative requirements for safety, environmental and health issues. These documents can also become regulations if and when gazetted by the Parliament.

The environmental legislation, codes and guidelines which are applicable to the Projects are summarised in Table 3-1 and Table 3-2 below.

3.3.2 Environmental Protection and Management Act

The primary environmental legislation is the Environmental Protection and Management Act (EPMA) 2002, as amended, and the secondary environmental legislation are the Environmental Protection and Management Regulations. The EPMA and its Regulations provide a comprehensive legislative framework for the control and management of environmental pollution and the allowable national discharge standards in Singapore.

The nearest statutory equivalent to a requirement for EIA is found in Section 36 of the EPMA, which relates to the need to carry out a study on environmental pollution control for activities which may cause substantial pollution of the environment or increase the level of such pollution.

The requirements of Pollution Control Studies under the Pollution Control Department of the NEA are described in the *Central Building Plan Department Guideline on Pollution Control (PC) Study*. The PCS covers an assessment of the following environmental aspects:

- Air Pollution Control;
- Water Pollution Control;
- Noise Pollution Control;
- Management of Hazardous Chemicals;
- Toxic Wastes Management;
- Recycling and Resources Conservation; and
- Prevention of Land Contamination.

3.3.3 National Parks Board Act, National Parks and Trees Act and Regulations

The National Parks Board Act establishes that the functions of National Parks Board (NParks) are as follows (Part III, Section 6):

- To control, administer and manage the national parks and nature reserves;
- To plan, design, develop, manage and maintain public parks;
- To provide, manage and maintain park and recreational infrastructure and facilities in the national parks, nature reserves and public parks;
- To propagate, protect and preserve the animals, plants and other organisms of Singapore and, within the national parks, nature reserves and public parks, to preserve objects and places of aesthetic, historical or scientific interest;
- To provide and control facilities for the study of and research into matters relating to animals, plants and other organisms in Singapore and the physical conditions in which they live;
- To exhibit objects illustrative of the life sciences, applied sciences, history, technology and industry;
- To promote the study, research and dissemination of knowledge in botany, horticulture, biotechnology, arboriculture, landscape architecture, parks and recreation management and natural and local history;
- To provide, manage and promote recreational, cultural, historical, research and educational facilities and resources in national parks, nature reserves and public parks and encourage their full and proper use by members of the public;
- To advise the Government on all matters relating to nature conservation and the planning, development and management of public parks; and
- To carry out such other functions and duties as are imposed upon the Board by or under this Act or any other written law.

The Parks and Trees Regulations govern the management and control of nature reserves, national parks and public parks. The regulations set out the following prohibited acts within national parks, nature reserves and public parks (Part II, Section 4, Para 1):

- No person shall, except with the approval of the Commissioner and in accordance with the terms and conditions of such approval, carry out any of the following activities within any public park:
  - cut, collect or displace any tree or plant or any part thereof;
  - affix, set up or erect any sign, shrine, altar, religious object, shelter, structure or building;
  - clear, break up, dig or cultivate any land;
  - use or occupy any building, vehicle, boat or other property of the Board;
  - wilfully drop or deposit any dirt, sand, earth, gravel, clay, loam, manure, refuse, sawdust, shavings, stone, straw or any other matter or thing from outside the public park;
  - capture, displace or feed any animal;
  - disturb or take the nest of any animal;
  - collect, remove or wilfully displace any other organism;
  - use any animal, firearm, explosive, net, trap, hunting device or instrument or means whatever for the purpose of capturing any animal;
  - carry or have in the person's possession any explosive, net, trap or hunting device; and
  - erect any post, rail, fence, pole, booth, stand, stall or other structure.

Table 3-1: Summary of Relevant Environmental Legislation, Regulations, and Standards

Topic	Title	Date	Description/Relevance to the EIA
Environmental Protection	Environmental Protection and Management Act	2002 (Last amended 2023)	The Act provides a comprehensive legislative framework for the control and management of environmental pollution and the allowable national discharge standards in Singapore. Provisions for each environmental aspect are established in each of the following parts: Part IV: air pollution control Part V: water pollution control Part VI: land pollution control Part VII: hazardous substances control Part VIII: noise control
	Environmental Public Health Act	2002 (Last amended 2023)	The Act establishes the regulatory framework for most of the issues related to environmental public health including waste management, noise, food hygiene, crematoria, public cleansing etc.
Air Quality	Environmental Protection and Management (Vehicular Emissions) Regulations	2008 (Last amended 2023)	The Regulations establish the standards and tests for vehicular exhaust emissions and noise emissions (as specified in the Schedules) and the re-examination and rectification notices.
	Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations	2012	The Regulations establish the import, use and examination of off-road diesel engines. Standards for exhaust emission for off-road engines are listed in the Schedule.
Noise Pollution	Environmental Protection and Management (Control of Noise at Construction Sites) Regulations	2008 (Last amended 2011)	The Regulations specify the maximum permissible level of noise at different types of affected premises, noise monitoring requirements, prohibitions at specific sites during certain time periods and penalties involved should the person fail to comply. The maximum permissible limits are provided in the Schedule.

Topic	Title	Date	Description/Relevance to the EIA
	Environmental Protection and Management (Vehicular Emissions) Regulations	2008 (Last amended 2023)	The Regulations establish the standards and tests for vehicular exhaust emissions and noise emissions (as specified in the Schedules) and the re-examination and rectification notices.
Hazardous Substances Management	Environmental Protection and Management (Hazardous Substances) Regulations	2008 (Last amended 2023)	The Regulations specify rules for dealing with the import, storage, use, sale, supply, and transport of hazardous substances within Singapore. Approval from the NEA is required for the transport of hazardous substances exceeding the quantities specified in the Schedule.
	Workplace Safety and Health (Asbestos) Regulations 2014	2014	The Regulations specify the protocols for ascertaining presence of asbestos or asbestos-containing materials at the workplace, provisions for working with asbestos and removal of asbestos. The Regulations requires that the collection and removal of asbestos has to be undertaken only by an NEA-licensed Asbestos Removal Contractor. The list of approved Asbestos Removal Contractors are provided by NEA.
Waste Management	Environmental Public Health (Toxic Industrial Waste) Regulations	2000 (Last amended 2022)	The Regulations establish provisions for the toxic industrial waste generator and collector, procedures for the applications for licenses, regulations on the import, transport, and storage of toxic industrial waste (TIW), and provisions for the emergency action plan. The Regulations requires that the collection and removal of TIW has to be undertaken only by an NEA-licensed TIW Collector. The list of the TIW controlled by this Regulation are provided in the Schedule.
	Environmental Public Health (General Waste Collection) Regulations	2000 (Last amended 2019)	The Regulations establish provisions for the transportation and disposal of general waste

Topic	Title	Date	Description/Relevance to the EIA
Surface Water Quality	Environmental Protection and Management (Trade Effluent) Regulations	2008 (Last amended 2011)	The Regulations establish the nature and type of trade effluents to be discharged, maximum concentrations of substances, and control mechanisms and methods of analysis. The nature of the trade effluent discharged must comply with the standards and concentrations of substances as specified in this Regulation. [Note: If trade effluent is discharged into the sewer, it is regulated by the Sewerage and Drainage Act (SDA)].
	Sewerage and Drainage Act	2020 (Last amended 2021)	The Act incorporates provisions on sewerage and drainage matters, introduces new provisions for better management and maintenance of sewerage and land drainage systems, and the discharge of trade effluents into the public sewer. A Code of Practice for Surface Water Drainage is issued under this Act.
	Sewerage and Drainage (Surface Water Drainage) Regulations	2007	The Regulations specify the requirements for plans, drawings, designs, prohibitions and approved works on surface water drainage in Singapore. A Code of Practice for Surface Water Drainage is issued under these Regulations.
	Sewerage and Drainage (Trade Effluent) Regulations	2007 (Last amended 2022)	The Regulations establish the nature and type of trade effluents to be discharged to the public sewer, maximum concentrations of substances, pre-treatment, monitoring and control mechanisms, and methods of analysis. The Regulations maintain restrictions on certain parameters of the trade effluent and substances that can be discharged as effluent. The maximum concentrations of the substances in the trade effluent are provided in the Schedule of the Regulations.
Flora and Fauna Protection	Parks and Trees Act	2006 (Last amended 2020)	The Act covers all planting, maintenance and conservation of trees and plants within national parks, nature reserves, tree conservation areas, heritage road green buffers and other specified areas. The purpose, management, care and control of national parks and nature reserves and the flora and fauna therein are also provided.
	Parks and Trees Regulations	2006 (Last amended 2022)	The Regulations provide for the management and control of national parks, nature reserves, public parks and green margins and streetscapes in Singapore.
	Wildlife Act	1965 (Last amended 2020)	The Act stipulate the prohibition to kill, take or keep any wild animal or bird other than for six birds specified in the Schedule. This Act also includes the prohibition of importation of wild animals and birds.

Topic	Title	Date	Description/Relevance to the EIA
Management of Vectors and Pesticides	Control of Vectors and Pesticides Act	2020 (Last amended 2022)	The Act stipulate the destruction of vectors and the control of vector-borne diseases and to provide for the control and management of the sale and use of pesticides and vector repellents.
Fire Safety	Fire Safety Act	2020 (Last amended 2021)	The Act covers the issues relating to fire hazards, fire prevention, control of fire safety, and the storage and transport of petroleum and flammable materials. Part VI of this Act establishes the requirements for the control, storage, import, transport of Petroleum and Flammable Materials.
	Fire Safety (Petroleum and Flammable Materials) Regulations	2008 (Last amended 2023)	The Regulations provide for the management and control of import, storage, dispensing and transport of petroleum and flammable materials. The Schedule provides a list of flammable materials to be regulated and the quantities that require a transport license.

Table 3-2: Summary of Relevant Environmental Codes and Guidelines

Topic	Title	Date	Description/Relevance to the EIA
Environmental Protection	SS 593:2013 Code of Practice for Pollution Control	2013	The code of practice specifies the recommended pollution control requirements and good practices to safeguard clean air, land and water and a quality living environment. It also includes the management of land contamination and remediation.
	Code of Practice for Environmental Control Officers for Specified Construction Sites	2000 (Last amended 2022)	The code of practice describes the roles and responsibilities of the Environmental Control Officers and contractors in the management of environmental health issues that may arise at construction worksites. This includes management aspects such as vector control, noise control and waste management.
Noise Pollution	SS602:2014 Code of Practice for Noise Control on Construction and Demolition Sites	2014	The code of practice lists the best practice noise control measures to be adopted in the execution of construction and demolition works. It also provides information on estimation of noise from sites, methods of monitoring, prediction of construction noise levels, noise control techniques, and selection of quieter construction equipment and methods.

Topic	Title	Date	Description/Relevance to the EIA
Waste Management	Code of Practice for Licensed General Waste Collectors	Revised 2008 (Last amended 2019)	The code of practice provides guidelines on good practice methods for general waste collection. This includes licencing requirements and the proper methods of collection, transportation and disposal of general waste.
	SS 603: 2014 Code of practice for hazardous waste management	2014	The code of practice sets out the procedures and practices for safe management and handling of hazardous wastes generated from industrial, institutional and other work activities. It also sets out the requirements for collection, transportation, storage, treatment and disposal of hazardous wastes. (Note: Previously known as CP100).
Surface Water Quality	Active, Beautiful, Clean Waters (ABC) Design Guidelines	Revised 2018	The aim of the ABC Waters Programme is to integrate the environment, water and communities to create new community spaces and to encourage lifestyle activities to flourish in and around waters. The ABC Design Guidelines encourage public and private sectors to explore ways to implement ABC Waters design features and integrate waterways within their developments to enhance the environment.
	Code of Practice on Surface Water Drainage	Revised 2013	The code of practice is issued under Section 32 of the Sewerage and Drainage Act. It specifies the minimum engineering requirements for surface water drainage for new developments. It also specifies the earth control requirements to be adopted for construction activities.
	Guidebook on Erosion and Sediment Control at Construction Sites	Revised 2018	The guidebook provides the erosion and sediment control measures to be adopted at construction sites. This guidebook details the standards and practices to be implemented by contractors to curb the pollution of waterways.
Flora and Fauna Protection	Handbook on Tree Conservation & Tree Planting Provision for Development Projects	2018	The handbook seeks to provide a guide to architects and professional engineers on the statutory provisions and technical requirements on greenery provision, tree planting and tree conservation for development projects in Singapore, as well as on procedures for submitting development plans to NParks for clearance (NParks, 2011)

3.4 International Protocols, Conventions and Guidelines

Singapore has ratified or acceded to numerous multilateral treaties on the environment. Although these international conventions and/or protocols are legally binding on each of the parties, they do not take precedence over national laws. Instead, they provide a framework to be respected by each party, which has to adopt its own domestic legislation to ensure that the international conventions and/or protocols are implemented at the national level. The relevant international environmental protocols and/or conventions, ratified by the Republic of Singapore, are identified below.

3.4.1 United Nations Framework Convention on Climate Change

Singapore is a party to the United Nations Framework Convention on Climate Change (UNFCCC), which is an international treaty that serves as a framework for international cooperation to combat climate change. Singapore ratified the UNFCCC in 1997 and acceded to the Kyoto Protocol in 2006. The Kyoto Protocol, the key international agreement that aims to slow down man-made emissions of greenhouse gases, is currently in its second commitment which Singapore ratified in 2014.

In 2009, Singapore also pledged to reduce greenhouse gas emissions by 16% below business-as-usual levels by 2020. More recently, Singapore has pledged its commitment to the 2015 Paris Agreement, which marks the latest step in the evolution of the UN climate change regime and builds on the work undertaken under the Convention. As part of the agreement, Singapore has stated its intention to reduce its emissions intensity by 36% from 2005 levels by 2030 and stabilise emissions with the aim of peaking around 2030.

3.4.2 UN Convention on Biological Diversity

The United Nations Convention on Biological Diversity (CBD), an international legal instrument for the conservation and sustainable use of biological diversity, was signed by Singapore in 1992. In fulfilling Singapore's obligations as a signatory to the CBD, the National Biodiversity Strategy and Action Plan (NBSAP), the primary instrument for the implementation of the Convention at the national level, has been developed.

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

Singapore is a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which is an international agreement aimed at ensuring that the trade of wild animals and plants does not threaten their survival. Singapore ratified CITES in 1987. Species that are protected under CITES are listed in Appendices to the Convention. Singapore is home to several plants and animal species that are protected under CITES, most of which can be found in Singapore's nature reserves.

3.4.4 World Health Organization Guidelines

Although Singapore has not adopted any ambient air quality standards, the National Environment Agency (NEA) makes reference to the World Health Organization (WHO) criteria in reporting the status of the air quality in Singapore. The primary aim of the WHO guidelines is to provide a basis for protecting public health from adverse effects of air pollution and for eliminating, or reducing to a minimum, those contaminants of air that are known or likely to be hazardous to human health and well-being. The WHO guidelines are intended to provide background information for use in making assessments of risk, rather than strict standards. They aim to provide a basis for setting standards or limit values for air pollutants by setting levels below which exposure for a given period of time does not constitute a significant health risk. The WHO air quality guideline criteria for particulate matter, nitrogen dioxide and sulphur dioxide will be used in the assessment of air quality impacts.

4. DESCRIPTION OF ENVIRONMENT

4.1 Project Site and Surroundings

4.1.1 Project Site

The proposed Project is located towards the central West of Singapore, within the planning area of Bukit Batok. The Study Area consists of mostly secondary forest situated within BBNP, BBTP, BBHNP, and surrounding forest patches. It includes several forest streams and three (3) quarry lakes, namely Poh Kim Quarry, Little Guilin, and Seng Chew Quarry. The Study Area has undulating terrain that is steep at some areas. The total land area of the Study Area is approximately 107.6 ha.

The Study Area is situated between the larger forested areas of the Central Nature Park Network to the east and Tengah Forest Corridor to the west; the area is mostly surrounded by residential land uses. Although currently fragmented, the proposed Project site serves as an ecological stepping-stone corridor for fauna moving between these two (2) forested areas.

The Project Site and site surroundings overlaid on OpenStreetMap is shown in Figure 4-1 while the Parks and Waterbodies Plan designations are shown in Figure 4-2.

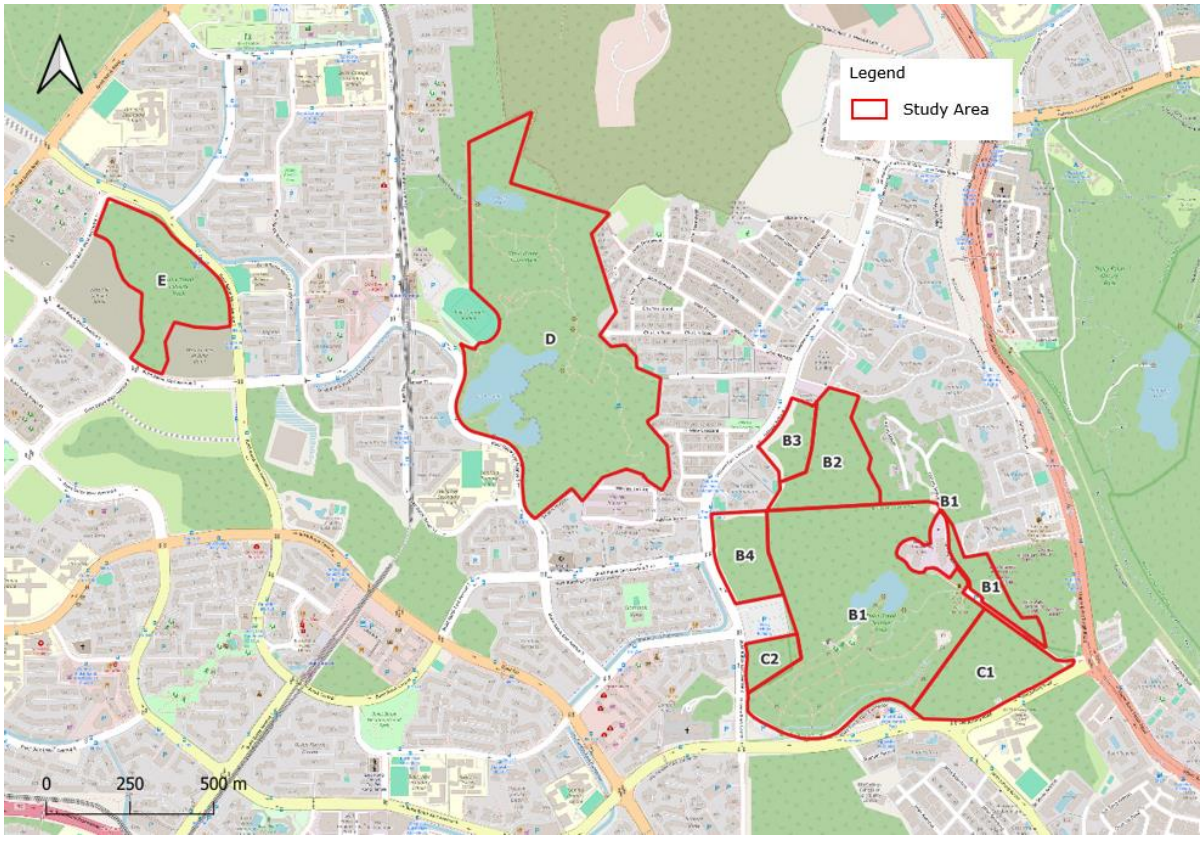


Figure 4-1: Project Site Overlain on OpenStreetMap

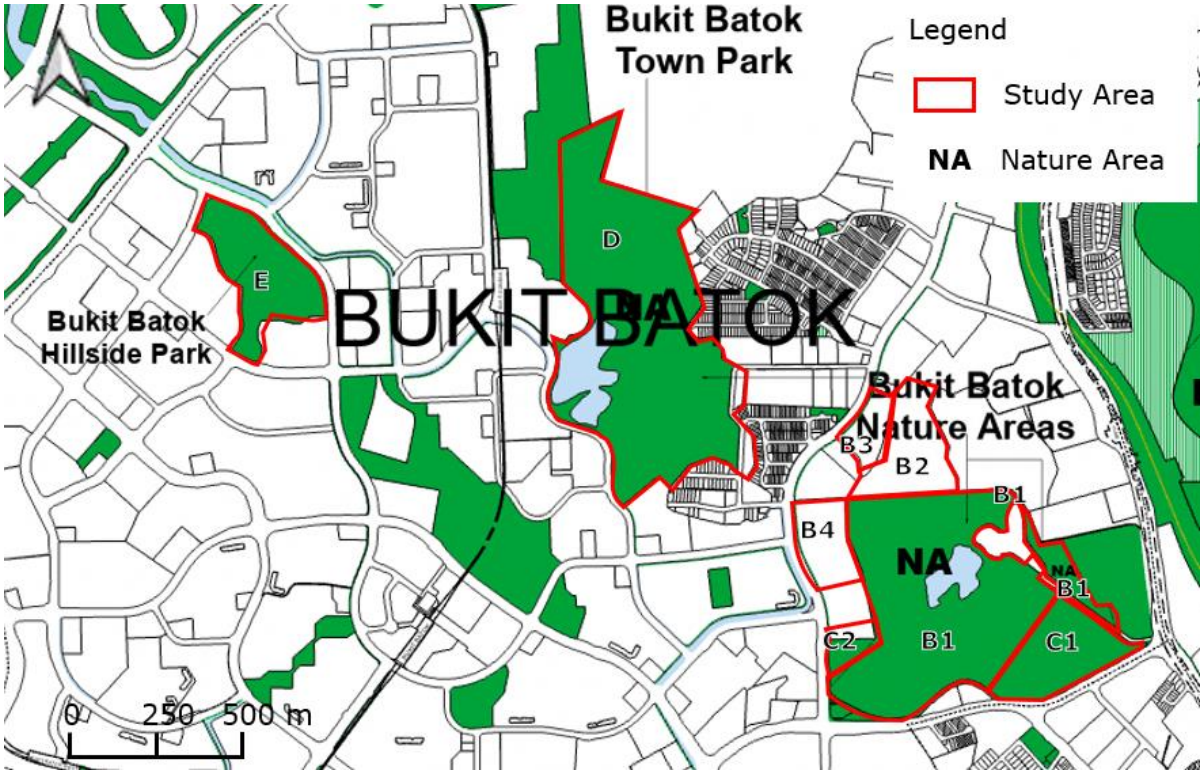


Figure 4-2: Project Site overlaid on the Parks and Waterbodies Plan

The overall Study Area is broken up into 8 smaller Study Areas. The land area (ha), ownership and description of the smaller study areas are summarised as follows:

Table 4-1: Study Area Breakdowns (as of 10 May 2023)

Study Area	Land Area (ha)	LOT Number	Parcel Ownership	Description
B1 BBNP	33.9	MK10-04223A MK10-00455X	NParks	Parcel occupied by the existing BBNP, including Poh Kim Quarry
B2	8.9	MK 10-02264A MK 10-02466W	Formerly HDB, now owned by SLA	Parcel located north of BBNP
B3		MK 10-02466W	Formerly HDB, now owned by SLA	Parcel located north of BBNP, adjacent to Hillview Avenue
B4	4.2	Part of MK10-04223A	Formerly HDB, now owned by SLA	Parcel located west of BBNP, adjacent to Bukit Batok East Avenue 2
C1	7.7	Part of MK10-04223A	SLA	Parcel bounded by BBNP, Old Jurong Road, and Lorong Sesuai
C2	1.8	Part of MK10-04223A	Formerly HDB, now owned by SLA	Parcel bounded by BBNP and Bukit Batok East Avenue 2
D BBTP	41.6	MK10-03228W	NParks	Parcel occupied by the existing BBTP, including Little Guilin and Seng Chew Quarry
E BBHNP	9.5	MK10-03230M MK10-05308V	HDB SLA	Parcel occupied by the existing BBHNP. The PUB water reservoir is also located within the boundaries of the area.

The ownership map of the respective Study Areas as of 10 May 2023 is presented in Figure 4-3.

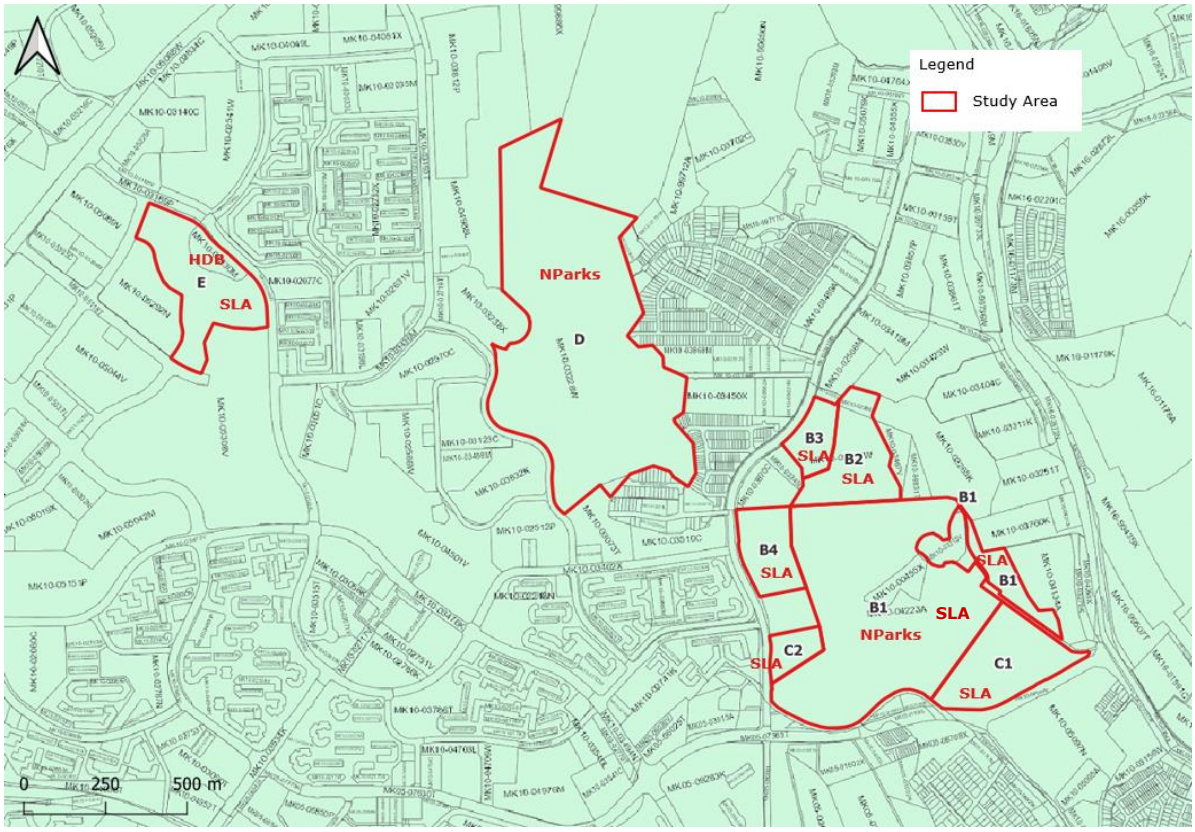


Figure 4-3: Ownership of the Respective Study Areas (as of 10 May 2023)

4.2 Site and Surrounding Land Use

According to the URA's Master Plan 2019, the Study Areas are generally zoned as "Park", "Residential" and "Reserve Sites", while the surrounding areas are generally zoned as "Residential". The land use designations as per the URA Master Plan are illustrated in Figure 4-4.

Based on Ramboll's visual observations from the Study Area boundary, public right-of-way, a limited review of publicly available information, a general determination of the nearby sensitive land uses, including wetland, parks, nature reserves, forests, residential areas (high-rise or landed), hospitals, schools, institutions of higher learning, homes for the aged sick etc., located adjacent to the Study Area is described in Table 4-2.

An overview of the Study Area and the sensitive receptors identified adjacent to the Study Areas is presented in Figure 4-5.

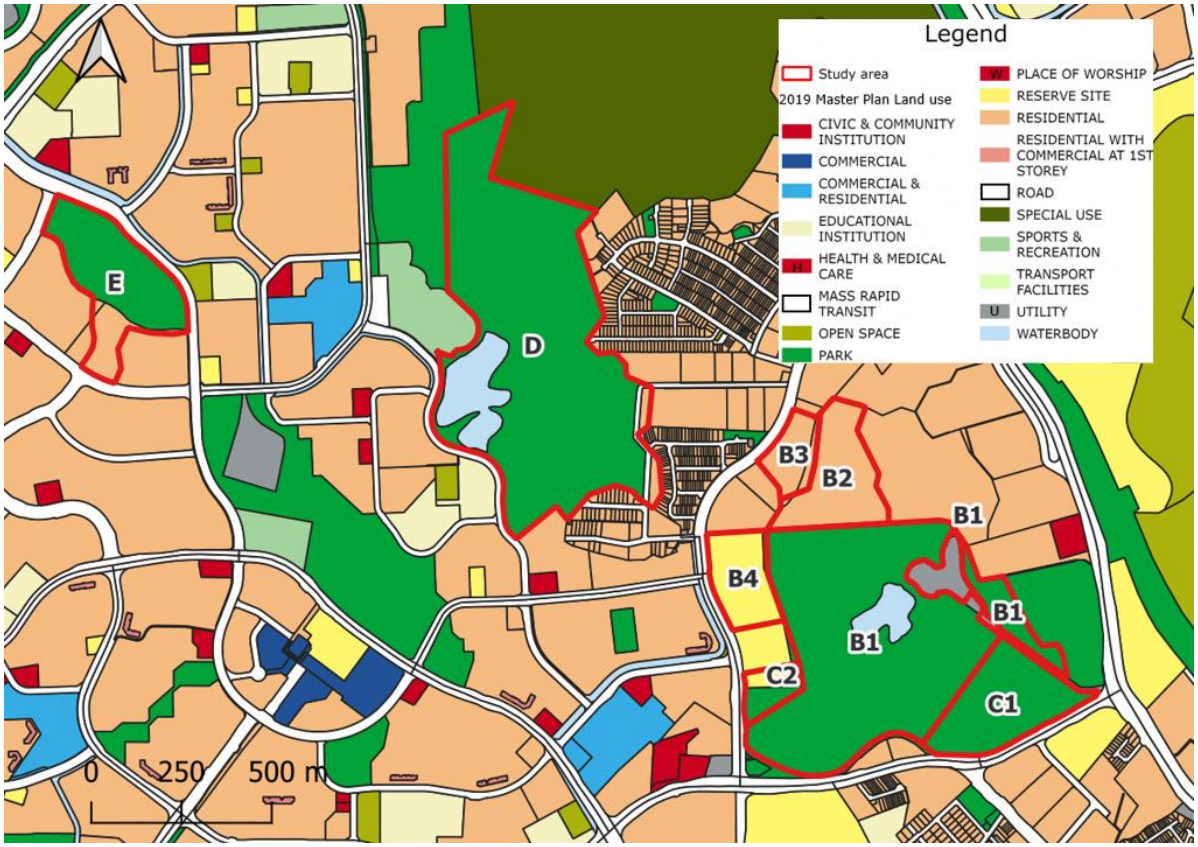


Figure 4-4: Project Site overlaid on URA Master Plan 2019

Table 4-2: Adjacent Sensitive Land Use

Study Area	Sensitive Receptor ID	Description	Land Use	Direction and Approximate Distance (m)
B1 BBNP	SR5	Park Natura	High-rise residential	100-m south
	SR6	Shamah Terrace	Landed residential	100-m south
	SR7	St Mary of the Angels Church	Place of worship	115-m west
B2	SR8	Park Palais	High-rise residential	Adjacent north
	SR9	Lorong Sesuai	Landed residential	Adjacent east
B3	SR10	Meralodge	High-rise residential	Adjacent southwest
	SR11	Hillview Apartment	High-rise residential	Adjacent northwest
B4	SR12	BLK 259 HDB Bukit Batok East	High-rise residential	60-m west
	SR13	The Petals	High-rise residential	Adjacent north
	SR14	Hillview Cres	Landed residential	60-m northwest
C2	SR15	BLK 266 HDB Bukit Batok East	High-rise residential	70-m west
D BBTP	SR16	Regent Heights	High-rise residential	Adjacent south
	SR17	BLK 510 HDB Bukit Batok	High-rise residential	40-m west
	SR18	Hillgrove Secondary School	School	15-m west

Study Area	Sensitive Receptor ID	Description	Land Use	Direction and Approximate Distance (m)
	SR19	Lianhua Primary School	School	160-m west
	SR20	Guilin View	High-rise residential	40-m west
	SR21	BLK 524 HDB Bukit Batok	High-rise residential	35-m west
	SR22	BLK 383 HDB Bukit Batok West	High-rise residential	125-m northwest
	SR23	Hillview Court	Landed residential	Adjacent east
	SR24	The Hilloft	Landed residential	Adjacent east
	SR25	Chu Yen St/Chu Lin Rd	Landed residential	Adjacent east
	SR26	Hilltop Grove	High-rise residential	Adjacent east
	SR27	Merawoods	High-rise residential	Adjacent east
E BBHNP	SR28	West Plains@Bukit Batok	High-rise residential	35-m southwest
	SR29	Bukit Batok Home for the Aged	Homes for the aged	50-m northwest
	SR30	BLK 425 HDB Bukit Batok West	High-rise residential	40-m north
	SR31	BLK 315 HDB Bukit Batok	High-rise residential	30-m northeast
	SR32	Dazhong Primary School	School	30-m east
	SR33	BLK 306 HDB Bukit Batok	High-rise residential	30-m east

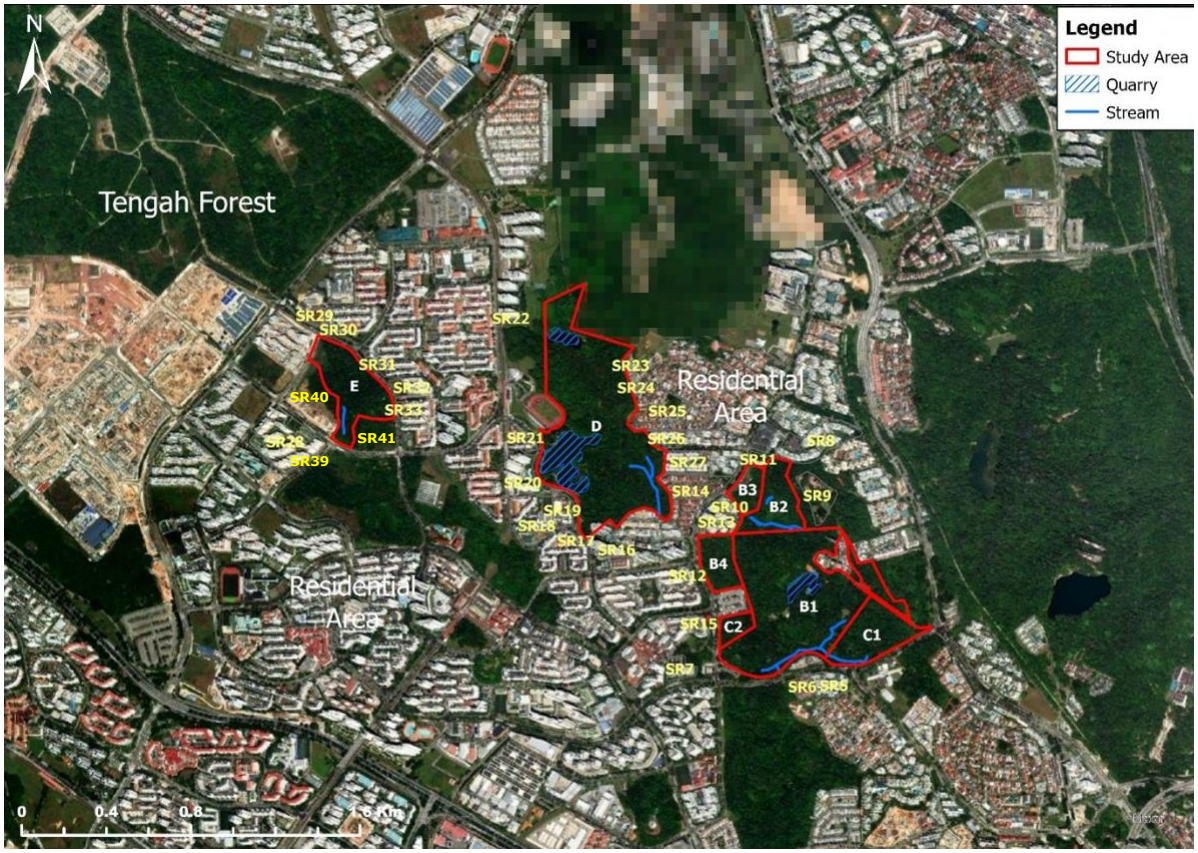


Figure 4-5: Overview of Study Area and the Nearby Sensitive Receptors

4.2.1 Central Nature Park Network

The Central Nature Park Network is a network of public parks and green spaces located in the central region of Singapore. The Central Nature Park Network provides ecologically inter-dependent habitats for the flora and fauna of the Bukit Timah Nature Reserve and the Central Catchment Nature Reserve, and is also integral to the network of ecological connectivity that is being established throughout the island.

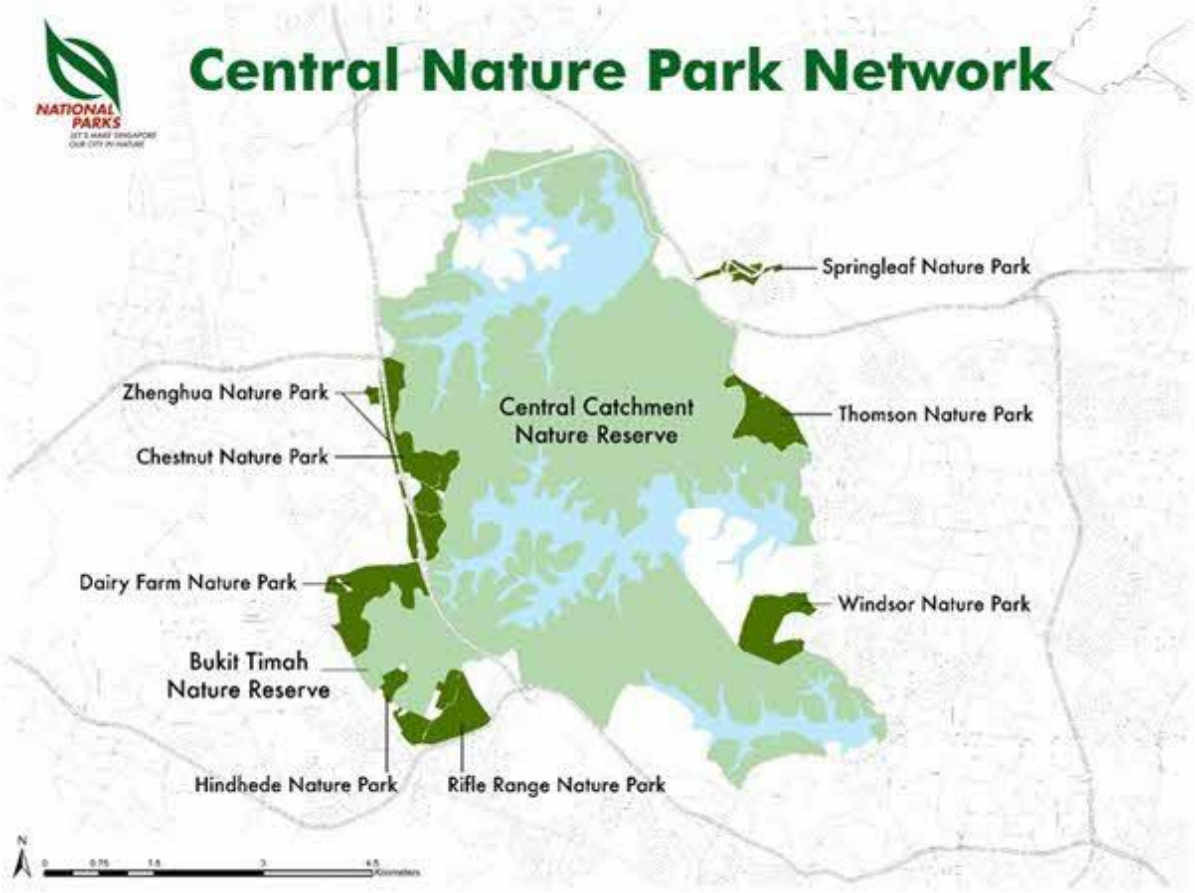


Figure 4-6: Map of Central Nature Park Network (NParks, 2023a)

4.2.2 Bukit Batok Nature Park

BBNP is a public park that covers an area of 36 ha and is a popular destination for outdoor enthusiasts and nature lovers. The park is home to a scenic quarry lake, formerly known as the Poh Kim Quarry, that provides a tranquil and peaceful setting for visitors to relax and enjoy the natural surroundings. The park is also located near to a memorial plague at the base of the stairs as a tribute to the soldiers and victims of World War II. The park features several amenities, including a walking trail, a fitness corner, and a children's playground. The park is also well-known for its rich biodiversity, and visitors can expect to encounter a variety of flora and fauna during their visit. It is particularly popular with birdwatchers, who come to observe the many species of birds that can be found in the area.

Figure 4-7: Map of BBNP (NParks, 2023b)

4.2.3 Bukit Batok Town Park

Bukit Batok Town Park (BBTP), also known as Little Guilin or Xiao Guilin, covers an area of around 42 ha and features a tranquil lake that is surrounded by cliffs and lush vegetation. It is named after

the resemblance of the granite rock formations in the park to the scenic landscapes of Guilin in China. There are several walking trails in the park that offer visitors the opportunity to explore the area and enjoy the scenic views. The park is also adjacent to Bukit Gombak Hill to its east, and Bukit Panjang Hill and Seng Chew Quarry to its north.

Figure 4-8: Map of BBTP (NParks, 2022)

4.2.4 Bukit Batok Hillside Nature Park

BBHNP is currently not opened to the public. It is a rugged urban jungle situated on a hilly terrain with old hiking paths, which include an abandoned boardwalk, pergola structure, and shelter, along with old wells. The park also has a stream approximately 185 m in length that runs down southwards. The site is an important node for wildlife to travel between Tengah and Bukit Batok.

4.2.5 Seng Chew Quarry

Seng Chew Quarry is an abandoned granite quarry located northeast of Bukit Gombak MRT and north of BBHNP. The quarry does not have designated pathways or amenities; the quarry is currently not open to public.

4.2.6 Rail Corridor

Singapore's Rail Corridor is a 24-kilometer (km) long stretch of former railway land that runs from the north of Singapore to the south (NParks, n.d.). It was formerly part of the Malaysian railway network and was used for transporting goods and people between Singapore and Malaysia. The Rail Corridor is a continuous green passage that links various parks, nature reserves, and other green spaces throughout Singapore, enabling wildlife movement and recreational activities for members of the public. It offers visitors a chance to explore Singapore's natural environment and historical landmarks, including bridges, viaducts, and station buildings. The corridor is also home to a rich variety of flora and fauna, making it a popular destination for nature lovers and birdwatchers. In addition to its recreational value, the Rail Corridor is also an important part of Singapore's history and heritage. Efforts are being made to preserve and showcase its unique cultural and historical significance.

Figure 4-9: Overview of Rail Corridor at Bukit Timah area (Lee, 2021)

4.2.7 Tengah Forest Corridor

Tengah Forest Corridor is a 60 ha corridor that is bounded by Choa Chu Kang to the northeast, Jurong East and Jurong West to the south, Bukit Batok to the east and the Western Water Catchment to its west and north. Areas within the site have been reserved for development plans for a future HDB town.

4.2.8 Surrounding residential, commercial, and industrial areas

The surrounding residential areas are mainly comprised of high-rise flats and condominiums, with some landed properties and terrace houses as well. The site is near several commercial areas that provide residents with access to shopping, dining, and entertainment options. The most prominent of these commercial areas is the Bukit Batok Central, which is home to several shopping malls, supermarkets, restaurants, and cafes. The West Mall and Bukit Batok MRT station are located within Bukit Batok Central. The site is also near several industrial estates, including the Bukit Batok Industrial Park and the Hillview Industrial Estate. These estates are home to a variety of manufacturing, warehousing, and logistics companies.

4.2.9 Developments in the Vicinity of the Project Site

The existing, committed, and planned and known potential developments in the vicinity of 2 km from the Project Site have been identified. These are listed in **Table 4-3** and shown in **Figure 4-10.**

Table 4-3: Developments in the Vicinity of the Project Site

Identified Development	Responsible Party	Status	Development Timeframe	Description
Residential and Public				
Tengah	HDB	Construction	2023 – beyond 2030	Under the Tengah Master Plan 2019, Tengah is set aside for development will have residential, educational institution, and commercial buildings with other public utilities and amenities such as roads, parks, schools, places of worship, health and medical care clinics, and community halls. The Environmental Management and Monitoring Plan was completed on 28 March 2023. The community is divided into five residential districts, each with a unique theme and flavour.
Jurong Innovation District	JTC	Planning	2023 – beyond 2030	Occupying 600 ha and part of Singapore's West Region redevelopment, Jurong Innovation District Is one of the three new business areas in the West. This hub is envisioned as an industrial district for advanced manufacturing, supporting an ecosystem of manufacturers, technology providers, researchers, and education institutions. When fully developed, Jurong Innovation District is expected to create over 95,000 new jobs.
Road widening at Bukit Batok East Avenue 6	LTA	Construction	2021 – 2024	No further information available.
Bukit Batok West Glades Built-To-Order Project	HDB	Construction (paused)	2023 – 2028	The 3-ha area bounded by Bukit Batok West Avenue 2 to the East and Bukit Batok West Avenue 5 to the south, southeast of the BBHNP, was zoned for 'Residential' and 'Park' in URA's Master Plan since 2003. The proposed development will comprise of the construction of 5 residential buildings of about 14-24 storeys per building.

Identified Development	Responsible Party	Status	Development Timeframe	Description
Bukit Batok West Hill Built-To-Order Project	HDB	Construction	2022 – 2026	The 4.5-ha area southwest of the BBHNP, bounded by Bukit Batok West Avenue 8 to the West and Bukit Batok West Avenue 5 to the south, was zoned for 'Residential' and 'Park' in URA's Master Plan since 2003. The project comprise of the construction of 9 residential buildings, each with about 13-17 storeys per building.

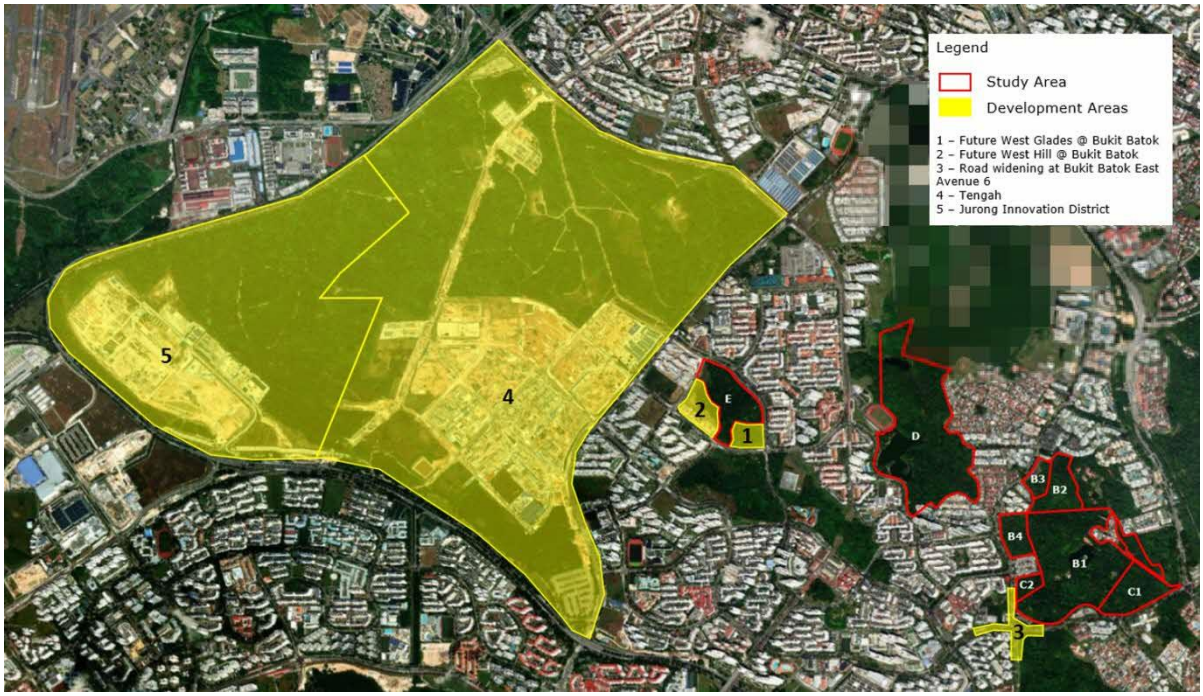


Figure 4-10: Developments in the Vicinity of the Study Areas

4.3 Land Use History

In the early 19th century, Bukit Batok comprised mainly rubber plantations. These plantations were subsequently cleared or overtaken by sundry cultivation (Neo et al., 2013). In the 1960s, the cleared areas developed into young secondary forest and the hills were converted to quarries for the excavation of norite rocks. BBNP, BBTP, and BBHNP were established as public parks since 1988, 1984, and 1980s/1990s, respectively. In 2007 and in the 2000s, the nature trails in BBTP and BBHNP were closed permanently, respectively, although certain sections remain open to the public (e.g., Little Guilin). The land use histories of each of the Study Areas are detailed in Table 4-4.[1] The study areas are further described in the subsequent sections.

4.3.1 BBNP / Study Areas B1, B2, B3 and B4

BBNP falls under Study Area B1. Based on the 1953 topographic map, Study Area B was generally covered by unclassified tree cultivations with scattered buildings / structures and roads in the vicinity of the Poh Hin or Poh Kim Granite Quarry. The granite quarry, located at the western side of Bukit Batok (Hill 345) within Study Area B1 started operations in the 1940s. The southern part of Study Area B1 was also marked as a public park. The southwestern corner of Area B1 was covered

[1] Surveyor-General, Federated Malay States and Straits Settlements, 1924; Survey Production Centre, Southeast Asia, 1945; Surveyor-General, Malaya, 1953; Chief Surveyor, Singapore, 1969; Singapore Mapping Unit, 1982, 1987, 1992, 2000, 2008). Adapted from Neo et al. (2013)

by shrubs/lalangs in 1975. Reportedly, the Poh Hin Granite Quarry ceased its operations sometime between the 1970s and 1980s. Study Area B was then marked as grassland in 1993 and the disused quarry was subsequently converted to the BBNP in 1988. Most of the clustered structures, observed in the previous year's topographic maps were no longer evident in 1993, which coincides with the closure of the Poh Hin Granite Quarry. Study Area B was marked as a park in 2005. Access roads were also evident towards the southwestern corner to Area B1. The site setting remained generally unchanged since 2005.

4.3.2 Study Areas C1 and C2

No prior industrial operations were observed for Study Areas C1 and C2. Both Study Areas C1 and C2 were occupied by scattered structures, appeared to be houses / kampong and roads in the 1950s. Based on the 1953 topographic map, both Study Areas C1 and C2 appeared to be used for unclassified and mixed true cultivation. Scattered structures previously observed in the 1953 plan were no longer evident in the 1963 map. In 1974. the present-day Old Jurong Road was observed constructed along the southern boundary of Area C1 while the present-day Hillview Park Connector was evident along the western boundary of Study Area C2. In 1983, more clustered structures were evident towards the north-western boundary of Study Area C1. In 1993, both C1 and C2 were marked as grassland, and both areas were subsequently converted to the BBNP in 1988. The site setting of both Study Areas C1 and C2 has remained generally unchanged (vegetated/forested) since 1993.

4.3.3 BBTP / Study Area D

BBTP, which falls under Study Area D was formerly used for rubber plantation with scattered buildings / structures and roads in the 1940s. The Gammon Granite Quarry (present-day Little Guilin) and Seng Chew Quarry most likely had started operations in the 1940s and were evident in the 1953 and 1966 topographic maps, respectively. Other than the quarries, the surrounding areas' land use remained unchanged and were used for rubber plantation till sometime between 1987 and 1993. The Seng Chew Quarry ceased its operations in the 1970s while the Gammon Granite Quarry ceased its operations in 1984. The Gammon Granite Quarry and its surrounding area were subsequently converted to the BBTP on the same year. The site setting has remained generally unchanged since then.

4.3.4 BBHNP / Study Area E

The proposed BBHNP is located under Study Area E. No prior industrial operations were observed for Study Area E. Study Area E was formerly used for rubber plantation with scattered buildings / structures and roads in the 1940s and 1950s, and parts of the Study Area was covered by *belukar* in the 1950s. Scattered structures and roads were evident to the south-southwestern corner of the study area in the 1963 topographic map. The land use was generally dominated by rubber plantation until sometime around 1983 and 1987. The Study Area was then turned into the BBHNP in the late 1980s or early 1990s before the nature trail was then disused in the 2000s. The site setting has remained generally unchanged since then.

A compilation of the historical maps of the respective Study Areas are presented in **Appendix 1**.

Table 4-4: Land Use Histories of each Study Area

Year	Study Area				
	BBNP / B	**C1**	**C2**	**BBTP / D**	**BBHNP / E**
1924	Rubber plantations	Rubber plantations	Rubber plantations	Rubber plantations	Rubber plantations
1945	Quarry (Poh Kim Granite Quarry), rubber plantations, jungle	Rubber plantations, jungle, clustered buildings / structures	Rubber plantations, jungle, scattered buildings / structures	Quarries (Gammon Granite Quarry and Seng Chew Quarry), rubber plantations, scattered buildings / structures, belukar	Rubber plantations
1953	Quarry, unclassified tree cultivation, scattered buildings / structures, roads, public park	Public park, tree cultivation, scattered buildings / structures, roads	Unclassified tree cultivation, scattered buildings / structures, roads, public park	Belukar*, quarries, scattered buildings / structures, rubber plantations	Rubber plantations, belukar*
1969	Quarry, sundry tree cultivation, shrubland, scattered buildings / structures, roads, public park	Public park, clustered buildings / structures, roads	Scattered buildings / structures, roads, public park	Sundry tree cultivation, quarries, rubber plantations, scattered buildings / structures,	Scattered buildings / structures,
1982	Sundry tree cultivation, scattered buildings / structures, roads, disused quarry (ceased operations in the late 1970s/early 1980s)	Public park, scattered buildings / structures, roads	Scattered buildings / structures, roads, public park	Disused Seng Chew Quarry (ceased operations in 1970), Gammon Granite Quarry, rubber-dominated vegetation	Rubber-dominated vegetation, clustered buildings / structures
1987	Sundry tree cultivation, scattered buildings / structures, roads, disused quarry, public park (converted to the BBNP in 1988)	Public park (converted to the BBNP in 1988), scattered buildings / structures, roads	Scattered buildings / structures, roads, public park (converted to the BBNP in 1988)	Sundry tree cultivation, disused Gammon Granite Quarry (ceased operations in 1984 and converted to BBTP on the same year), rubber-dominated vegetation	Public park (BBHNP) with clustered buildings / structures
1992	Grassland and Public park (BBNP)	Grassland, public park (BBNP), roads	Grassland, public park (BBNP)	Public park, disused quarry, grassland	Public park
2000	Public park and roads	Public park	Public park	Public park (BBTP), disused quarry	Public park (nature trail closed)
2008	Public park and roads	Public park	Public park	Public park (nature trail closed in 2007), disused quarry	Closed public park

4.4 Topography

4.4.1 Sources of Information

The following information was reviewed to characterise the topography at the Project Site:

- Publicly available maps by the Singapore Government (OneMap), including historical maps;
- 1975 Topographic Map; from the National Archives of Singapore;
- Satellite images from Google Earth™; and
- Topographical plans by Lew Registered Surveyor, completed as part of the Biodiversity and Environmental Baseline Study for the proposed BBNC for NParks.

Primary data gathering was also undertaken through site walkovers to observe the topographical features in the field.

4.4.2 Topography of Project Site / Study Area

4.4.2.1 BBNP / Study Area B1, B2, B3, B4, C1 and C2

The topography around Poh Kim Quarry is steep and undulating, with an upward slope to the northeast, towards the Bukit Batok Transmitting Station with elevation up to approximately 100 m SHD. The Study Area has a steep downward slope to the west and the south. Regional topography is generally hilly to the South and slopes gently downward to the west. The on-site elevation ranges from approximately 14 m SHD near the southwestern corner to 22 m SHD to the south, and approximately 100 m SHD towards the northeast.

Study Areas B2 and B3, which are located to the north of Study Area B1, are relatively hilly, and has a downward slope from the northeast (approximately 55 m SHD) towards the southwest (approximately 15 m SHD).

Study Area C1, located further south of the Bukit Batok Transmitting Station, has the highest elevations towards its northern portion (approximately 68 m SHD) and the lowest elevations towards its southern boundary (approximately 27 m SHD).

The elevation at Study Area C2 is generally low lying, with elevations ranging from approximately 15 m SHD (northwest) to 24 m SHD (southeast to east). Study Area B4 is also low lying; the study area has the highest elevations towards the northeast (approximately 28 m SHD), and slopes gently towards the east (approximately 16 m SHD).

4.4.2.2 BBTP / Study Area D

Study Area D is relatively hilly, with an upward slope starting off gentle from the south and southwest before getting steeper near the north to northeast. The elevation around Little Guilin is the highest towards its east at about 88 m SHD, while the elevation around Seng Chew Quarry is the highest towards its northeast and eat at about 100 to 110 m SHD. Regional topography slopes upward to the northeast of the area and is relatively flat for the rest of the surrounding areas. The on-site elevation ranges from approximately 16 m SHD at the south, near to the outflow of the earth stream, to approximately 110 m SHD towards the far north of the Study Area.

4.4.2.3 BBHNP / Study Area E

Elevations at Study Area E are the highest at its centre-north (at about 62 m SHD) and at its southeastern portion (at about 65 m SHD). The site generally slopes downwards towards the south and north to northeast, where the elevations ranges from 20 m to 25 m SHD.

5. EIA APPROACH AND METHODOLOGY

5.1 Overview of Assessment Methodology

The EIA methodology used in the Study is drawn from local and international good practice. It has been applied by Ramboll to EIA studies in Singapore and follows internationally recognised standards.

Ramboll's EIA Methodology adheres to the following approach:

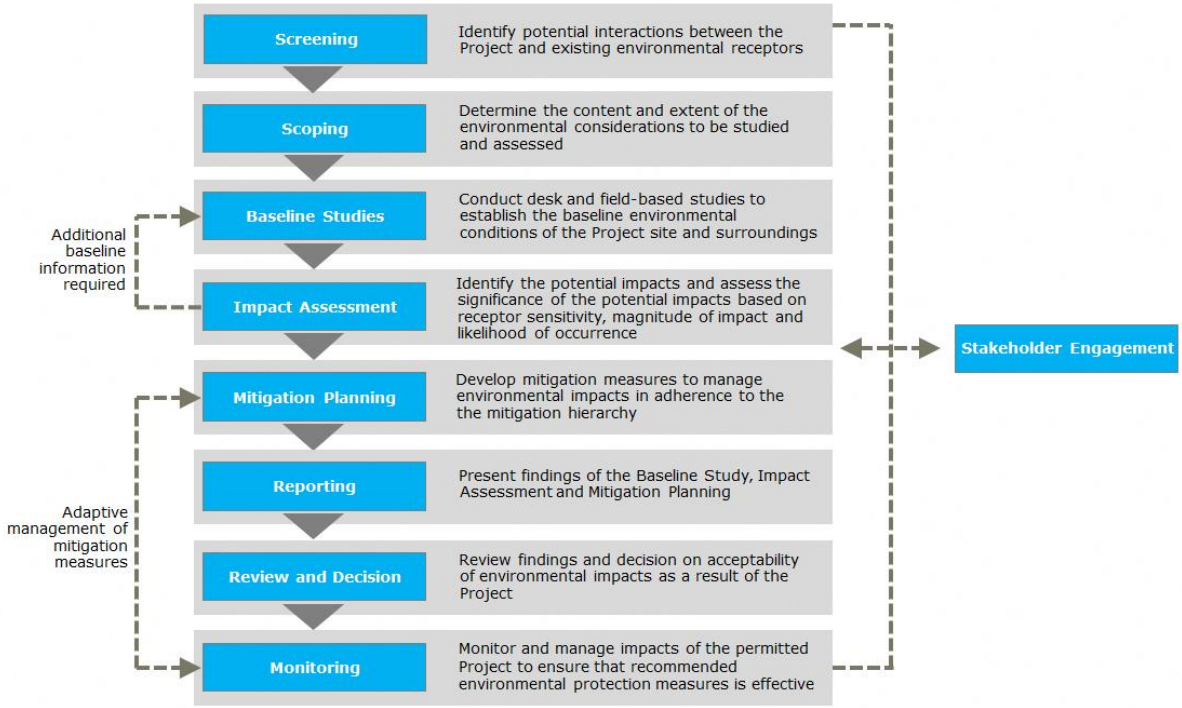


Figure 5-1: Ramboll's EIA Methodology

The steps in the EIA Methodology are described in the subsequent sections below.

5.2 Screening

Screening was first undertaken to determine whether an EIA was required for the development project based on an initial identification of potential interactions between the proposed Project and existing physical and biological environmental receptors. Undertaking screening early in the EIA process facilitated the incorporation of environmental considerations into the development of the proposed development design and construction.

Screening Phase Outcome: NParks has determined that an EIA is required to assess the nature and extent of environmental impacts arising from the construction and operation of the proposed Project.

5.3 Scoping

Scoping is the process of determining the content and extent of the environmental considerations to be studied in the EIA. The scoping process aims to identify the types of activities arising from the development and the potential environmental impacts to be assessed in the EIA.

The scoping phase was conducted by a combination of the following:

- Review of existing information about the proposed development project, development site and surrounding environmental conditions;
- Engagement with relevant Agencies to ensure that they are provided the opportunity to input to the impact identification, mitigation and monitoring process; and
- 'Source-Pathway-Receptor' Analysis: Identification of potentially significant environmental impacts is also undertaken through a structured consideration of the potential sources of impact, the pathways through impacts may affect the environment and humans (e.g. transport of emissions/discharges through the environment) and the nature of receptors (e.g. humans, flora and fauna etc.) that may be impacted.

Although scoping can be considered as a discrete stage in the EIA process which ends with issue of the terms of reference for the EIA, the activity of scoping continues throughout, so that the scope of work can be amended in the light of new information or as a result of engagement with the Agencies.

As part of the Scoping Phase, NParks developed the Terms of References for the Biodiversity and Environmental Studies for BBNC, including the EIA, which was then published under the tender for this contract NPARKS/N/5/2021.

5.3.1 Interest Group Issue Mapping

As part of the scoping exercise, Ramboll conducted a review of publicly available information on the views and particular concerns of interest groups with respect to development projects similar in nature to the proposed Project. This enabled the identification of possible concerns of these groups with regards to the proposed Project. The following sources of information were reviewed:

Table 5-1: Interest Group Issue Mapping

Stakeholder	Description	Sources of Information
Environmental Interest Groups		
Nature Society (Singapore)	NSS is a non-government, non-profit organisation dedicated to the appreciation, conservation, study and enjoyment of the natural heritage in Singapore, Malaysia and the surrounding region.	https://www.nss.org.sg/
The Long and Winding Road	The Long and Winding Road is a non-political, non-profitable hobby created to relive memories of Singapore and showcases personal experiences and photography which details changes of a location / area through the passage of time.	https://thelongnwindingroad.wordpress.com/about/
Media Resources		
Media resources	Various media publications will be reviewed for views on development in Bukit Batok, where the proposed development is located at.	Straits Times, Channel News Asia
Historical References		

Stakeholder	Description	Sources of Information
Records of the National Archives of Singapore (oral archives)	Oral archives of Singapore with historical and cultural references	http://www.nas.gov.sg/nas/

5.4 Baseline Study

The objective of the Baseline Study is to characterise the pre-development environmental conditions of the Study Area and surroundings in order to establish a baseline against which future pollution, emissions, incidents, or complaints can be assessed. Secondary (desktop) data collection and primary data collection (field surveys) were undertaken in order to establish the baseline pre-development environmental conditions.

The steps involved in the baseline environmental study are presented below:

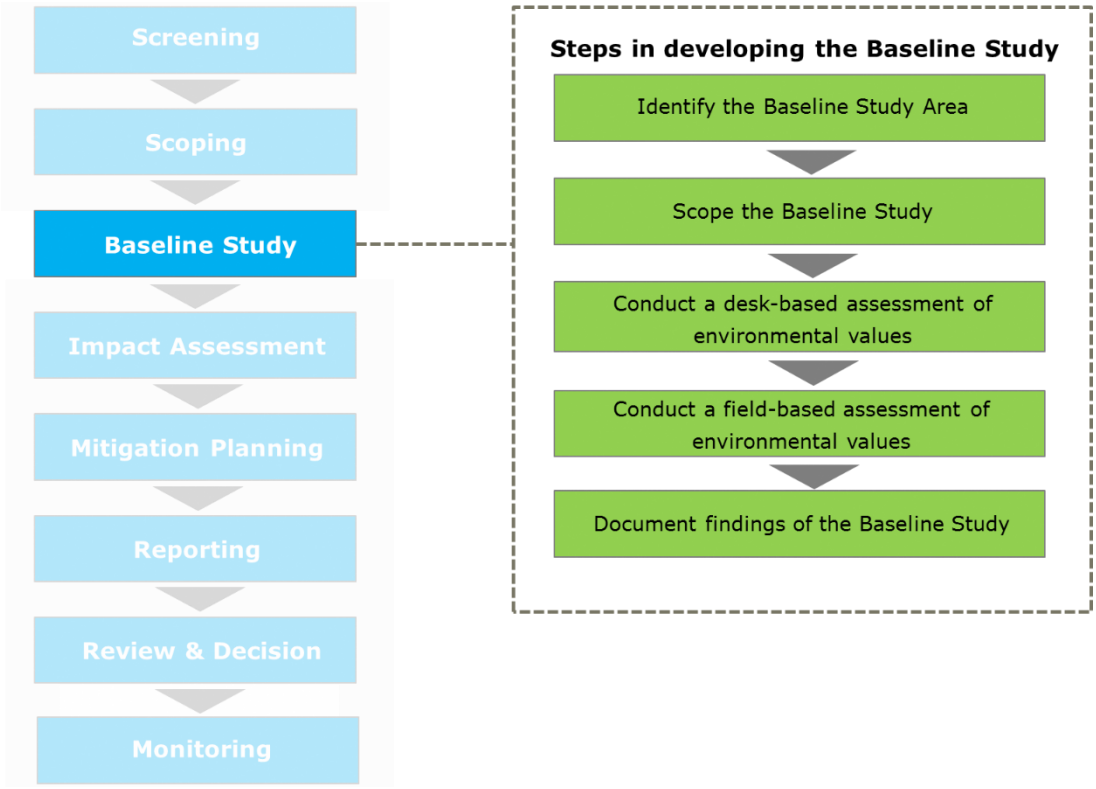


Figure 5-2: Ramboll's Baseline Study Methodology

The following environmental conditions were characterised:

Physical Environment

- Air-borne noise;
- Ambient air quality;
- Water quality;
- Sediment Quality; and
- Soil Quality.

Biological Environment

- Habitat type and size;
- Flora and fauna species present and any potentially occurring fauna species of conservation significance;
- Locations of flora species of conservation significance, large plant specimens, and other plant specimens of value;
- Locations of fauna species of conservation significance;
- Locations, health, and structural stability of trees, single-stemmed palms, strangling *Ficus* species of ≥ 1.0 m girth or spread;
- Forest regeneration trends;
- Ecological connections and gaps; and
- Areas of high conservation value.

5.5 Impact Assessment

The impact assessment (IA) methodology used in the Study comprises a systematic approach to:

- Identify / predict potential environmental impacts;
- Characterise the magnitude / intensity of the identified impacts;
- Characterise the sensitivity of the receptors;
- Based on the magnitude of the impact and sensitivity of the receptor, determine the consequences of the potential impact(s); and
- Based on the consequences of potential impact(s) and likelihood of occurrence, determine the significance of the potential impact(s).

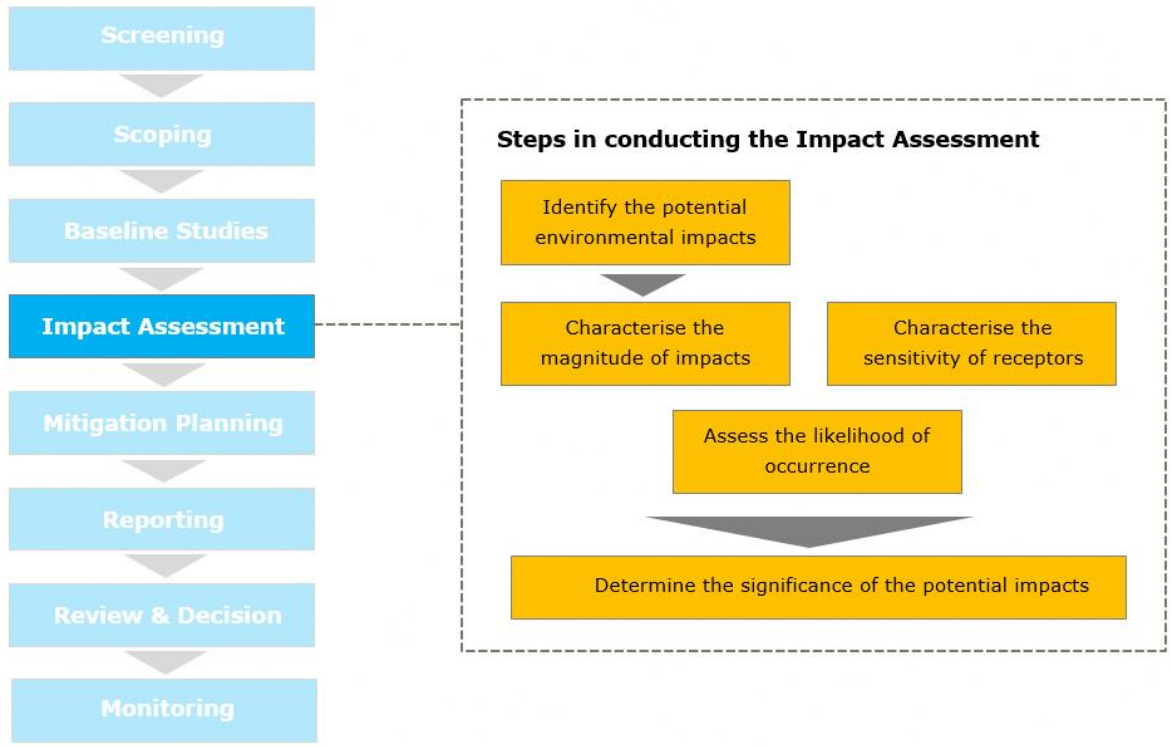


Figure 5-3: Ramboll's Impact Assessment Methodology

The assessment of potential environmental impacts on the surrounding environment took into consideration the magnitude of the potential impacts, the sensitivity of the receptor and the likelihood of occurrence in order to determine the significance of the potential impacts.

5.5.1 Impact Identification Methodology

The first step in the environmental impact identification process was to identify the activities associated with the proposed Project which could interact with the environment (referred to as the "Project Activities"). The Study considered Project Activities during the preconstruction/site development phase, the construction phase and the operational phase.

Once the Project Activities were identified, and the surrounding environment was characterised, the potential interaction between the Project Activities and the surrounding environment was assessed in order to determine the potential environmental impacts arising from the Project(s).

An environmental impact is defined as a change to the existing environmental conditions that is caused either directly or indirectly by the Project(s).

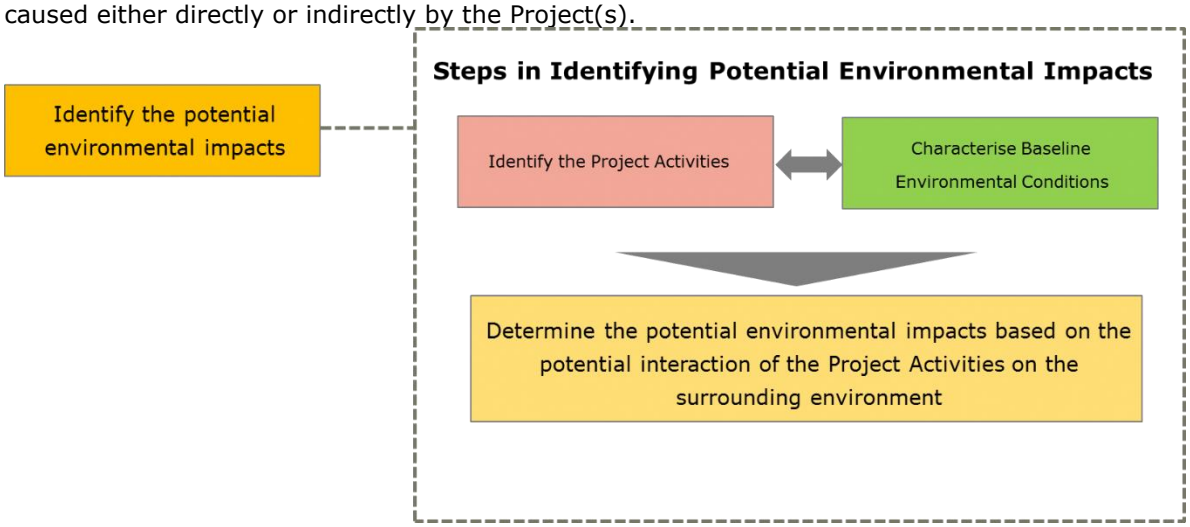


Figure 5-4: Ramboll's Potential Impact Identification Methodology

Potential impacts were categorised as follows:

- Direct Impact: Impacts that result from a direct interaction between one or more Project Activity and the surrounding environment;
- Indirect Impact: Impacts that result from one or more non-Project related activities that are encouraged to happen as a consequence of the Project; and
- Cumulative Impact: Impacts that result from the incremental impact of the Project(s) when added to other existing, planned, and/or reasonably predictable future projects and developments that are not be directly associated with the Project(s).

Once the impacts were identified, the magnitude of the impact as a result of the project was determined.

5.5.2 Characterise the Impacts Intensity

The impacts magnitude / intensity (which could be either beneficial or adverse) was characterised as follows: negligible, low, medium, or high (refer to Table 5-2). Characterisation of the impacts intensity considers the following factors:

- The scale of the impact (e.g., large scale, small scale);
- Extent - How widely the impact is spread (e.g., on-site, local, regional);
- Permanence - Whether impacts are reversible (e.g., vegetation clearance replaced by landscaping), or irreversible (e.g., loss of critical species or habitat at that location);
- Duration – Whether impacts are short-term (e.g., occur only during the construction period), long term (e.g., occur throughout the operational life); and
- Flora species attributes (e.g., tolerance to change in microclimatic conditions, ethnobotanical values influencing susceptibility to poaching)
- Fauna species attributes (e.g., mode of locomotion, perception by humans as nuisances or threats, sensitivity to light, sensitivity to human disturbance, susceptibility to poaching)

For habitat receptors, the following five (5) assumptions were made in defining the impact zones of direct and indirect impacts during the construction phase:

1. Habitats within 30 m from the worksites involving heavy machinery (e.g., BBNP Main Entrance, BBNP Plaza and Play Area, BBNP slope stabilisation works, BBHNP Arrival Node and Wetland, BBTP Main Entrance) are assumed to experience the greatest extent of construction impacts.
2. Habitats within 10 m from the worksite for the BBHNP secondary entrance and removal of existing pergola and GFRCs are assumed to experience the greatest extent of construction impacts.
3. Habitats within 5 m from the worksites involving manual construction (e.g., boardwalks, trails, stream edge enhancement, rain garden) are assumed to be possibly impacted by the construction works.
4. Habitats that may be affected by site clearance for purposes other than the proposed construction works (e.g., erection of site offices, temporary staging grounds, material storage yards) were not considered in the assessment.
5. Positive impacts associated with terrestrial habitat enhancement plans were not considered in the assessment as the extent and locations of such works were not available at the time of assessment. Instead, terrestrial habitat enhancement is considered as recommended mitigation measures in this report.

For flora species receptors, the following six (6) assumptions were made in defining the impact zones during the construction phase:

1. Plant specimens within 30 m from the worksites involving heavy machinery (e.g., , BBNP Main Entrance, BBNP Plaza and Play Area, BBNP slope stabilisation works, BBHNP Arrival Node and Wetland, BBTP Main Entrance) are assumed to experience the greatest extent of construction impacts. Forest edge effects may be experienced by species more sensitive to microclimatic changes more than 30 m away from the worksites; these are considered during the species-specific impact evaluation.
2. Plant specimens within 10 m from the worksite involving some heavy machinery (e.g., BBHNP secondary entrance, removal of existing Pergola at BBHNP) are assumed to be impacted directly by the construction works.
3. Plant specimens within 5 m from the worksites involving manual construction and minimal soil cut and fill (e.g., boardwalks, trails, stream edge enhancement, rain garden) are assumed to be possibly impacted by the construction works.
4. For tree/strangler species that are not bamboos or of conservation significance (i.e., common native or exotic species), the total specimen count was taken from arboriculture survey data (**Appendix 2**).
5. No existing trees will be removed for the construction of the BBNP Plaza and Play Area.

6. Plant specimens that may be affected by site clearance for purposes other than the proposed construction works (e.g., erection of site offices, temporary staging grounds, material storage yards) were not considered in the assessment.

Table 5-2: Description of Impact Intensity

Impact Intensity	Typical Descriptors
Negligible	• Very minor or no loss or detrimental alteration to one or more characteristics, features or elements
Low	• Short-term measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements
Medium	• Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements
High	• Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements • Large scale or major improvement of resource quality; extensive restoration or enhancement; major improvement of attribute quality (Beneficial)

Where necessary, impact-specific intensity descriptors were developed, as detailed below for the various component of the Study (refer to Table 5-3 to Table 5-14).

Table 5-3: Impact Intensity Criteria for Noise (Human Receptors)

Impact Intensity	Typical Criteria (Noise)
Negligible	• Predicted noise levels are less than 3 dB(A) above the relevant limits/ thresholds
Low	• Predicted noise levels are 3 to less than 5 dB(A) above the relevant limits/ thresholds
Medium	• Predicted noise levels are between 5 to 10 dB(A) above the relevant limits/ thresholds
High	• Predicted noise levels are more than 10 dB(A) above the relevant limits/ thresholds

Table 5-4: Impact Intensity Criteria for Noise (Ecological Receptors)

Impact Intensity	Typical Criteria (Noise)
Negligible	• Predicted noise levels are less than 3 dB(A) above the baseline background noise
Low	• Predicted noise levels are 3 to less than 5 dB(A) above the baseline background noise
Medium	• Predicted noise levels are between 5 to 10 dB(A) above the baseline background noise
High	• Predicted noise levels are more than 10 dB(A) above the baseline background noise

Table 5-5: Impact Intensity Criteria for Air Quality for Construction Phase

Impact Intensity	Typical Criteria (Air)
Negligible	• Earthworks with total site area <500 m^2 • Soil type with large grain size (e.g. sand) • Total material moved <5,000 tonnes
Low	• Earthworks with total site area 500 m^2 to 2,500 m^2 • Soil type with large grain size (e.g. sand) • Total material moved 5,000 to 20,000 tonnes
Medium	• Earthworks with total site area 2,500 m^2 to 10,000 m^2 • Moderately dusty soil type (e.g. silt) • Total material moved 20,000 to 100,000 tonnes
High	• Earthworks with total site area > 10,000 m^2 • Potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size) • Total material moved 100,000 tonnes

Table 5-6: Impact Intensity Criteria for Air Quality for Operational Phase

Impact Intensity	Typical Criteria (Air)
Negligible	• No increase in air quality levels in the vicinity of proposed development
Low	• Small scale increase in air quality levels in the vicinity of proposed development
Medium	• Medium scale increase in air quality levels in the vicinity of proposed development
High	• Large scale increase in air quality levels in the vicinity of proposed development

Table 5-7: Impact Intensity Criteria for Surface Hydrology and Water Quality

Impact Intensity	Typical Criteria (Surface Hydrology and Water Quality)
Negligible	• No changes distinguishable from natural variability, or changes that are non-measurable or below detection limits. • No modifications to baseline drainage and hydrological characteristics, i.e. no or negligible impacts to peak flow or flow rate both upstream and downstream of planned works • Impacts to water quality that are below applicable limits
Low	• Project discharges (planned or unplanned) do not exceed effluent quality standards or cause breaches of quality standards in the receiving waterbody • An event where the water quality, quantity and condition of the receiving waterbody is predicted to recover rapidly through natural processes and the duration of impact is short-term (<6 months) • Some modifications to baseline drainage and hydrological characteristics, although the changes to peak flow or flow rate both upstream and downstream of planned works are expected to be limited, with low risk of erosion • Change to the geomorphology which will have upstream and downstream impacts resulting in temporary local degradation e.g. in channel construction activities
Medium	• An event where the water quality, quantity and condition of the receiving waterbody is likely to recover through natural processes and the impact is predicted to be medium-term (6 to 12 months) • Large modifications to baseline drainage and hydrological characteristics, with measurable changes to peak flow or flow rate both upstream and downstream of planned works, and medium risk of erosion

Impact Intensity	Typical Criteria (Surface Hydrology and Water Quality)
	• Change to the geomorphology which will not affect the entire water course, but have upstream and downstream impacts resulting in local degradation e.g. permanent works to banks such as piers, localised channel straightening or culverting
High	• An event where the potential for natural recovery of water quality, hydrology, quantity and/or physical disturbance through natural processes is limited and the impact is predicted to be long-term (>1 year) • Spatially and temporally extensive modifications to baseline drainage and hydrological characteristics, with significant changes to peak flow or flow rate both upstream and downstream of planned works, resulting in high erosion risk • Major changes to geomorphology e.g. channel straightening or channelization which affect all or majority of the watercourse

Table 5-8: Impact Intensity Criteria for Soil and Sediment Quality

Impact Intensity	Typical Criteria (Soil and Sediment Quality)
Negligible	• None of the construction / operational activities identified will cause soil and/or sediment contamination on site.
Low	• Small scale localised soil and/or sediment contamination which is not likely to extend beyond the Study Area and possible to remediate.
Medium	• Medium scale soil and/or sediment contamination which is likely to extend beyond the Study Area but possible to remediate within the construction period timeframe.
High	• Large scale soil and/or sediment contamination which is likely to extend beyond the Study Area and may require large scale remediation

Table 5-9: Impact Intensity Criteria for Ecology (Habitats) during Construction

Impact Intensity	Loss of Habitat	Formation of Edge Effects	Habitat Degradation (Terrestrial Habitats)	Habitat Degradation (Aquatic Habitats)
Negligible	The habitat does not overlap with the worksites	The habitat does not overlap with the worksites	The habitat type does not overlap with the impact zone	No reduction in surface water quality
Low	≤ 10% of the habitat overlaps with the worksites	≤ 10% increase in perimeter to area ratio of the habitat due to the worksites	≤ 10% of the habitat type overlaps with the impact zone	Some reduction in surface water quality
Medium	10–40% of the habitat overlaps with the worksites	10–40% increase in perimeter to area ratio of the habitat due to the worksites	10–40% of the habitat type overlaps with the impact zone	Considerable reduction in surface water quality
High	> 40% of the habitat overlaps with the worksites	> 40% increase in perimeter to area ratio of the habitat due to the worksites	> 40% of the habitat type overlaps with the impact zone	Extensive reduction in surface water quality

Table 5-10: Impact Intensity Criteria for Ecology (Flora Species) during Construction

Impact Intensity	Mortality	Decline in Plant Health and Survival
Negligible	Less than 10% of all plant specimens of this species are within the worksites	Less than 10% of all plant specimens of this species are within the impact zone of the worksites
Low	10–50% of all plant specimens of this species are within the worksites	10–50% of all plant specimens of this species are within the impact zone of the worksites
Medium	50% or more of all plant specimens of this species are within the worksites	50% or more of all plant specimens of this species are within the impact zone of the worksites
High	All plant specimens of this species are within the worksites	All plant specimens of this species are within the impact zone of the worksites

Table 5-11: Impact Intensity Criteria for Ecology (Fauna Species) during Construction

Impact Intensity	Loss of/ Reduction in Habitats and Food Sources	Accidental Injury or Mortality	Human-wildlife Conflict	Loss of/ Reduction in Ecological Connectivity for Faunal Movement	Light Disturbances	Human Disturbances
Negligible	No loss of habitat, raptor nests, or roosts	Species with negligible susceptibility to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc,) and roadkills	Species that are not perceived as nuisances or threats by construction personnel: – Odonates – Butterflies – Most birds – Aquatic species	Terrestrial species Not dependent on connected habitats for dispersal and able to traverse urban infrastructure Aquatic species No change to waterbody	Species that are not sensitive to changes in light levels: aculeate hymenopterans, most aquatic species	Species that are not sensitive to human presence
Low	Loss of <10% of habitat or roosts	Species with low susceptibility to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills	Species that are possibly perceived as both nuisances and threats by construction personnel, less tolerant of human presence and urban environments: – Some reptiles – Most amphibians – Most bats	Terrestrial species Slightly dependent on connected habitats for dispersal and adaptable to traverse urban infrastructures if needed Aquatic species Minimal changes in waterbody that may affect connectivity for aquatic species	Species that are slightly sensitive to changes in light levels: odonates, butterflies	Species that are slightly sensitive to human presence
Medium	Loss of 10–40% of habitat or roosts	Species that are mobile but possibly susceptible to accidental injury/mortality from construction activities (large vehicles,	Species that are typically perceived as nuisances and possibly as threats by construction personnel, highly tolerant of human	Terrestrial species Dependent on connected habitats for dispersal Aquatic species	Species that are sensitive to changes in light levels: diurnal birds, reptiles, and mammals	Species that are sensitive to human presence

Impact Intensity	Loss of/ Reduction in Habitats and Food Sources	Accidental Injury or Mortality	Human-wildlife Conflict	Loss of/ Reduction in Ecological Connectivity for Faunal Movement	Light Disturbances	Human Disturbances
		excavation, piling, etc.) and roadkills	presence and urban environments, and frequently implicated in human-wildlife conflict: – Smooth otter – Aculeate hymenopterans	Some changes in waterbody that may affect connectivity for aquatic species		
High	Loss of >40% of habitat, raptor nests, or roosts	Species with high susceptibility to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills	Species that are typically perceived as both nuisances and threats by construction personnel, highly tolerant of human presence and urban environments, and are frequently implicated in human-wildlife conflict: – Long-tailed macaque – Some snakes	Terrestrial species Highly dependent on connected habitats for dispersal Aquatic species Considerable changes in waterbody that may affect connectivity for aquatic species	Species that are extremely sensitive to changes in light levels: nocturnal, crepuscular fauna	Species (including nesting birds) that are extremely sensitive to human presence

Table 5-12: Impact Intensity Criteria for Ecology (Habitats) during Operation

Impact Intensity	Habitat Degradation (Terrestrial Habitats)	Habitat Degradation (Aquatic Habitats)	Changes in Microclimatic Conditions	Introduction of Exotic Species (Aquatic Habitats)
Negligible	The habitat type does not overlap with the impact zone of the development	No reduction in surface water quality	The habitat does not overlap with the impact zone of the development	The habitat is already exotic-dominated such that introduction of exotic species has no impact on the habitat
Low	≤ 10% of the habitat type overlaps with the impact zone of the development	Some reduction in surface water quality	≤ 10% of the habitat overlaps with the impact zone of the development	The habitat is already exotic-dominated such that introduction of exotic species has some impact on the habitat
Medium	10–40% of the habitat type overlaps with the impact zone of the development	Considerable reduction in surface water quality	10–40% of the habitat overlaps with the impact zone of the development	Introducing exotic species will change the balance of exotic versus native species within the habitat
High	> 40% of the habitat type overlaps with the impact zone of the development	Extensive reduction in surface water quality	> 40% of the habitat overlaps with the impact zone of the development	Introducing exotic species will be detrimental to the native-dominated habitat

Table 5-13: Impact Intensity Criteria for Ecology (Flora Species) during Operation

Impact Intensity	Poaching
Negligible	Plant specimens of this species are unlikely to be stolen (i.e., not charismatic, no ethnobotanical value), and/or are too big to remove (e.g., large trees)
Low	Few plant specimens of this species could become stolen (i.e., most plant species are without any ethnobotanical value or are common ornamental plants), and are of small to medium sizes, which can be removed.
Medium	Some plant specimens of this species could become stolen (i.e., plant species with ethnobotanical value and/or common ornamental plants), and are of small to medium sizes which can be removed
High	Most plant specimens of this species could become stolen (i.e., orchids, pitcher plants), and are of small to medium sizes, which can be removed

Table 5-14: Impact Intensity Criteria for Ecology (Fauna Receptors) during Operation

Impact Intensity	Poaching	Accidental Injury or Mortality	Human-wildlife Conflict	Loss of/ Reduction in Ecological Connectivity for Faunal Movement	Light Disturbance	Human Disturbance
Negligible	Species with negligible susceptibility to poaching	Species with negligible susceptibility to accidental injury/mortality from operation activities, roadkills, and collision with buildings	Species that are not perceived as nuisances or threats by members of the public: – Odonates – Butterflies – Most birds – Aquatic species	Terrestrial species Not dependent on connected habitats for dispersal and able to traverse urban infrastructure Aquatic species No change to waterbody	Species that are not sensitive to changes in light levels: aculeate hymenopterans, most aquatic species	Species that are not sensitive to human presence
Low	Species with low susceptibility to poaching; not commonly known to be traded as pets	Species with low susceptibility to accidental injury/mortality from operation activities, roadkills, and collision with buildings: – Birds with low susceptibility to collision with buildings – Volant species (e.g., odonates, butterflies, raptors and bats) – Aquatic species (most fishes, crabs, shrimps)	Species that are possibly perceived as both nuisances and threats by members of the public, less tolerant of human presence and urban environments: – Some reptiles – Most amphibians – Most bats	Terrestrial species Slightly dependent on connected habitats for dispersal and adaptable to traverse urban infrastructures if needed Aquatic species Minimal changes in waterbody that may affect connectivity for aquatic species	Species that are slightly sensitive to changes in light levels: odonates, butterflies	Species that are slightly sensitive to human presence
Medium	Species that are possibly susceptible to poaching; commonly traded as pets	Species that are mobile but possibly susceptible to accidental injury/mortality from operation activities and roadkills, and	Species that are typically perceived as nuisances and possibly as threats by members of the public, highly tolerant of human	Terrestrial species Dependent on connected habitats for dispersal Aquatic species	Species that are sensitive to changes in light levels: diurnal birds, reptiles, and mammals	Species that are sensitive to human presence

Impact Intensity	Poaching	Accidental Injury or Mortality	Human-wildlife Conflict	Loss of/ Reduction in Ecological Connectivity for Faunal Movement	Light Disturbance	Human Disturbance
		collision with buildings: – Birds that are possibly susceptible to collision with buildings (e.g., resident species with known records of bird-building collisions – All amphibians – Some mammals (e.g., squirrels, shrews)	presence and urban environments, and frequently implicated in human-wildlife conflict: – Smooth otter – Red junglefowl – Aculeate hymenopterans	Some changes in waterbody that may affect connectivity for aquatic species		
High	Species that are highly susceptible to poaching; listed on CITES Appendix I or II	Species with high susceptibility to accidental injury/mortality from operation activities and roadkills, and collision with buildings: – Birds with high susceptibility to collision with buildings (e.g., forest-edge frugivores, migratory species) – Reptiles – Some mammals (e.g., Sunda pangolin, long-tailed macaque, smooth otter)	Species that are typically perceived as both nuisances and threats by members of the public, highly tolerant of human presence and urban environments, and are frequently implicated in human-wildlife conflict: – Long-tailed macaque – Some snakes	Terrestrial species Highly dependent on connected habitats for dispersal Aquatic species Considerable changes in waterbody that may affect connectivity for aquatic species	Species that are extremely sensitive to changes in light levels: nocturnal, crepuscular fauna	Species (including nesting birds) that are extremely sensitive to human presence

5.5.3 Characterise the Sensitivity of Receptors

The sensitivity of a receptor is related to both its perceived value and its vulnerability to impacts. Due to the range of potential receptors it is important to use a consistent and easily applied set of criteria for assigning sensitivity. For the purposes of the impact assessment, the sensitivity of receptors has been characterised as follows: high, medium, low, or negligible. Each receptor sensitivity level is accompanied by a sensitivity descriptor (refer to Table 5-15).

Table 5-15: Description of Sensitivity of Receptors

Sensitivity	Typical Descriptors
Priority 3 / Low	• Low importance and/or rarity, local value

Sensitivity	Typical Descriptors
Priority 2 / Medium	• Medium importance and rarity, regional value, limited potential for substitution
Priority 1 / High	• High importance and/or rarity, national value, and/or limited potential for substitution

Where necessary, receptor-specific sensitivity descriptors (refer to **Table 5-16** to **Table 5-23**) were developed. For ecological receptors, their sensitivity levels were determined through an assessment of ecological value as described in the paragraphs below.

Habitats and species recorded or deemed probable during the baseline study were assessed for their ecological value. Habitats and species accorded with higher ecological value were regarded of greater importance for conservation. Those of high ecological value were assigned the Priority 1 sensitivity level, while those of moderate or low ecological value were assigned the Priority 2 or 3 sensitivity levels, respectively.

Habitats
The ecological value assessment framework for habitats is based on the distinguishing features of the habitats, including species richness, irreplaceability, rarity in the national context, and the degree to which the habitats support species rarely found in other habitats (Table 5-21) (Crosher et al., 2019).

All habitats were accorded an ecological value, i.e., high, medium, or low, based on the criteria in Table 5-20.

Flora
All plant species were first accorded with a tentative ecological value, i.e., high, medium, or low, based on the basic framework (Table 5-22):

- High ecological value (Priority 1): Species of conservation significance;
- Medium ecological value (Priority 2): All other native species; and
- Low ecological value (Priority 3): Exotic and cryptogenic species.

For species that were tentatively assigned Priority 2 (i.e., all other native species) or Priority 3 (i.e., exotic and cryptogenic species), their ecological values were evaluated individually based on the criteria listed in Table 5-23. The evaluation of individual species served to either maintain, raise or reduce the pre-assigned ecological value. The following paragraphs detail how each criterion was considered in the evaluation:

Local and national distribution (native species only): The ecological value of native plant species takes into consideration the local and national distribution of the plant species. Local distribution—i.e., occurrence of specimens of native plant species at one or multiple locations within the Study Area— are first assessed for all native species.

Following that, the national distribution of the plant species was assessed. A plant species is considered to have a restricted national distribution if specimens of the species can mostly be found in certain forest patches of generally higher ecological value, such as the primary and old growth secondary forests of the nature reserves in Singapore, or offshore islands. On the other hand, a plant species is regarded as nationally widespread if specimens of the plant species occur at several secondary forest patches throughout Singapore.

Generally, plant species with restricted local and national distribution will have their ecological value raised. Plant species with widespread local distribution but restricted national distribution, or vice versa, will maintain their pre-assigned ecological value. On the other hand, plant species with widespread local and national distribution will result in the reduction of their pre-assigned ecological value.

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 was 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.

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; and (2) keystone fig (*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 which 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 species.

Fauna

All recorded faunal species and probable faunal species of conservation significance were accorded an ecological value based on their conservation significance and origin (Table 5-24).

Table 5-16: Sensitivity Criteria for Noise

Sensitivity	Typical Criteria (Noise)
Priority 3 / Low	Human Receptors • Type of affected buildings: Buildings other than those mentioned under Priority 1 and Priority 2 Ecological Receptors • Species that are less affected by airborne noise and are not of Conservation Significance
Priority 2 / Medium	Human Receptors • Type of affected buildings: Residential buildings located less than 150 m from the construction site where the noise is emitted Ecological Receptors • Species that are less affected by airborne noise but are of Conservation Significance
Priority 1 / High	Human Receptors • Type of affected buildings: Hospitals, schools, institutions of higher learning, homes for the aged sick, etc. Ecological Receptors • Species that use sound for communication, foraging and breeding or are known to have their behaviours disrupted by sound or are of Conservation Significance

Table 5-17 Sensitivity Criteria for Air Quality

Sensitivity	Typical Criteria (Air)
Priority 3 / Low	Human Receptors • Locations where human exposure is transient[1] Nature Areas • Locally designated sites • Areas of specific ecological interest, not subject to statutory protection
Priority 2 / Medium	Human Receptors • Locations where the people exposed are workers[2], and exposure is over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day)[3] Nature Areas • Nationally designated sites
Priority 1 / High	Human Receptors • Locations where members of the public are exposed over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day) Nature Areas • Internationally designated sites

Notes:

1*- In accordance with the Institute of Air Quality Management ("IAQM") guidance, there are no standards that apply to short-term exposure, e.g. one or two hours, but there is still a risk of health impacts, albeit less certain.

2*- Notwithstanding the fact that the air quality objectives and limit values do not apply to people in the workplace, such people can be affected to exposure of PM_{10}. However, they are considered to be less sensitive than the general public as a whole because those most sensitive to the effects of air pollution, such as young children are not normally workers. For this reason workers are included in the medium sensitivity category.

3*- This follows Department for Environmental Food and Rural Affairs guidance as set out in Local Air Quality Management-Technical Guidance published in 2009.

Table 5-18: Sensitivity Criteria for Water Resources and Quality

Sensitivity	Typical Criteria (Water Resources and Quality)
Priority 3 / Low	• A heavily modified waterbody (channelized, dredged, straightened) • A water resource with a high ecological value as a natural habitat (ref. Table 5.21) or have low value uses.
Priority 2 / Medium	• A modified but naturalised river, which has been modified in certain aspects only • Some modification of channel morphology • A water resource with a medium ecological value as a natural habitat (ref. Table 5.21) or medium value uses e.g. irrigation, livestock
Priority 1 / High	• Variation in flow is close to natural characteristics • Channel morphology is unmodified and in connectivity with its floodplain • A water resource with a high ecological value as a natural habitat (ref. Table 5.21) or high value uses e.g. fisheries, potable water supply

Table 5-19: Sensitivity Criteria for Soil and Sediment Quality

Sensitivity	Typical Criteria (Soil and Sediment)
Priority 3 / Low	Human Receptors • Locations where human exposure is transient[1] Nature Areas • Locally designated sites • Areas of specific ecological interest, not subject to statutory protection
Priority 2 / Medium	Human Receptors • Locations where the people exposed are workers, and exposure is over a time period relevant to a human health risk Nature Areas • Nationally designated sites
Priority 1 / High	Human Receptors • Locations where members of the public are exposed to soil / sediment over a time period relevant to a human health risk Nature Areas • Internationally designated sites

Table 5-20: Sensitivity Criteria for Habitats. Refer to Table 5-21 for Criteria for Assessing Ecological Value

Sensitivity	Typical Criteria (Habitats)
Priority 3 / Low	Low ecological value: Habitats that are common and/or easy/not desirable to recreate for biodiversity with (very) low species richness of flora and fauna and/or unique species (overall ecological value score <6)
Priority 2 / Medium	Medium ecological value: Habitats that are uncommon and moderately difficult to recreate, with moderate species richness of flora and fauna and/or unique species (overall ecological value score 6–7)
Priority 1 / High	High ecological value: Habitats that are (moderately) rare and impossible/very difficult to recreate, with (very) high species richness of flora and fauna and/or unique species (overall ecological value score >7)

Table 5-21: Criteria for Assessing the Ecological Value of Habitats

Criterion	Definition	Classification			
		High (Score 3)	Medium (Score 2)	Low (Score 1)	NA (Score 0)
Flora and fauna species richness	Terrestrial habitats The total number of flora (vascular plant) and fauna (bird, butterfly, odonate, amphibian, reptile, mammal) species that can be expected to occur in a particular habitat in Singapore, excluding introduced fauna species.	High flora and fauna species richness (>899 species)	Moderate flora and fauna species richness (600 to 899 species)	Low flora and fauna species richness (300 to 599 species)	Very low flora and fauna species richness (<300 species)
	Aquatic habitats The total number of flora (vascular aquatic plants including submerged, partially submerged, and floating species) and water-dependent fauna (bird, odonate, amphibian, reptile, mammal, decapod crustacean, fish, mollusc) species that can be expected to occur in a particular habitat in Singapore, excluding introduced fauna species	High flora and fauna species richness (>135 species)	Moderate flora and fauna species richness (90 to 135 species)	Low flora and fauna species richness (45 to 89 species)	Very low flora and fauna species richness (<45 species)
Irreplaceability	The difficulty of recreating or replacing the habitat to its ecologically optimal structure and species composition via human intervention, natural or accelerated succession within 30 years, with reference to known localities where such habitats have been successfully recreated in Singapore. This also takes into account re-establishing of habitat or ecosystem health, and ecological (biotic and abiotic) dynamics required to establish an effectively functioning habitat.	Impossible to recreate/ replace	Difficult to recreate/ replace	Easy to recreate/ replace	Not ideal to recreate/ replace for biodiversity

Criterion	Definition	Classification			
		High (Score 3)	Medium (Score 2)	Low (Score 1)	NA (Score 0)
Local rarity of habitat	Terrestrial habitats Area of habitat remaining as percentage of all vegetated areas in Singapore	Habitat is rare in Singapore (<5%)	Habitat is uncommon in Singapore (5–30%)	Habitat is common in Singapore (> 0%)	Habitat is ubiquitous in Singapore (e.g., buildings)
	Aquatic habitats The rarity of the habitat in Singapore	Habitat is rare in Singapore (e.g., freshwater swamp forest, hill stream, freshwater marsh, mangrove forest)	Habitat is uncommon in Singapore (e.g., forest/rural river, forest/rural stream, unmanaged soft-bank pond, quarry lake)	Habitat is common Singapore (e.g., naturalised river, naturalised stream, managed soft-bank pond, hard-bank pond, reservoir, rain garden, swale, biotope)	Habitat is ubiquitous in Singapore (e.g., concrete drain).
Unique flora and fauna species	Terrestrial habitats The total number of unique flora (vascular plant) and fauna (bird, butterfly, odonate, amphibian, reptile, mammal) species that can be expected to occur in a particular habitat in Singapore. Unique species are those that are not typically found in other habitats.	Supports a high number of unique flora and fauna species (>14 species)	Supports some unique flora and fauna species (10 to 14 species)	Supports few unique flora and fauna species (<10 species)	Does not support any unique flora and fauna species
	Aquatic habitats The total number of unique flora (vascular aquatic plants including submerged, partially submerged, and floating species) and water-dependent fauna (bird, odonate, amphibian, reptile, mammal, decapod crustacean, fish, mollusc) species that can be expected to occur in a particular habitat in Singapore. Unique species are those that are not typically found in other habitats.	Supports a high number of unique flora and fauna species (>34 species)	Supports some unique flora and fauna species (23 to 34 species)	Supports few unique flora and fauna species (<23 species)	Does not support any unique flora and fauna species

Table 5-22: Sensitivity Criteria for Ecology (Flora Species). Refer to Table 5-21 for Criteria for Assessing Ecological Value

Sensitivity	Typical Criteria (Ecology – Flora Species)
Priority 3 / Low	Low ecological value: - Common native species with widespread local and national distribution - Exotic and cryptogenic species
Priority 2 / Medium	Medium ecological value: - Common native species with either widespread local or national distribution - Species of conservation significance with widespread local and national distribution - All other native species
Priority 1 / High	High ecological value: - Species of Conservation Significance with either restricted local and/or national distribution - Common native species with restricted local and national distribution - Species of any origin associated with important fauna - Keystone species (*Ficus* spp.) - Species of conservation significance

Table 5-23 Criteria for Assessing the Final 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
Local distribution	Occurrence of specimens of native plant species at one or multiple locations within the Project Site
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 5-24: Sensitivity Criteria for Ecology (Fauna Species)

Sensitivity	Typical Criteria (Ecology – Flora Species)
Priority 3 / Low	Low ecological value: Exotic species
Priority 2 / Medium	Medium ecological value: All other native and migratory bird species, and species of indeterminate status
Priority 1 / High	High ecological value: Species of conservation significance

5.5.4 Determine the Consequences of the Potential Impact

Combining both the sensitivity of a receptor and the impact intensity in a matrix enables an assessment of the consequences of a potential impact to be determined. For the purposes of the impact assessment, the consequences of impacts has been characterised as follows: negligible, very low, low, medium and high (Table 5-25).

Table 5-25: Impact Consequences Matrix

		Impact Intensity			
		Negligible	**Low**	**Medium**	**High**
Sensitivity of Receptor	**Priority 3**	Negligible	Very Low	Very Low	Low
	Priority 2	Negligible	Very Low	Low	Medium
	Priority 1	Very Low	Low	Medium	High

5.5.5 Determine the Likelihood of Occurrence

Likelihood is estimated on the basis of experience and/or evidence that such an outcome has previously occurred. The likelihood criteria for habitat and flora species receptors are further defined for each impact type according to Table 5-26 to Table 5-30. Impacts resulting from routine/planned events (normal operations) are classified under Continuous Likelihood.

Table 5-26: Likelihood Criteria

Likelihood Criteria	Definition
Not Expected to Occur	Would be unlikely or not expected to occur during construction or operational activities.
Less Likely/ Rare	Would less likely/ rarely occur during construction and operational activities.
Possible/ Occasional	Would possibly/ occasionally occur during construction and operational activities.
Likely/ Regular	Would likely to occur or would occur on a regular basis during construction and operational activities.
Certain/ Continuous	Would be certain to occur or would occur continuously during construction and operational activities.

Table 5-27: Likelihood Criteria for Ecology (Habitats) during Construction

Impact Likelihood	Loss of Habitat	Formation of Edge Effects	Habitat Degradation[1] (Terrestrial Habitats)	Habitat Degradation[1] (Aquatic Habitats)
Not Expected to Occur	The habitat does not overlap with the worksites	The habitat does not overlap with the worksites	NA	NA
Less likely/ Rare	NA	The worksites are small (e.g., trails, boardwalks) and/or are not expected to change vegetation structure significantly to effect changes in microclimatic conditions (e.g., minimal tree or vegetation removal)	NA	NA

Impact Likelihood	Loss of Habitat	Formation of Edge Effects	Habitat Degradation[1] (Terrestrial Habitats)	Habitat Degradation[1] (Aquatic Habitats)
Possible/ Occasional	NA	The worksites are of considerable size (e.g., single lane roads) and/or is expected to change some vegetation structure significantly to effect changes in microclimatic condition (e.g., some tree or vegetation removal)	NA	NA
Likely/ Regular	NA	The worksites are large (e.g., buildings, multiple lane roads) and/or are expected to change vegetation structure significantly to effect changes in microclimatic conditions (e.g., extensive tree or vegetation removal)	NA	NA
Certain/ Continuous	The habitat overlaps with the worksites	NA	NA	NA

Notes:

1*- The likelihood of habitat degradation is presumed to be Less Likely, based on the assumption that all minimum controls are adequately and properly implemented.

Table 5-28: Likelihood Criteria for Ecology (Flora Species) during Construction

Impact Likelihood	Mortality	Decline in Plant Health and Survival
Not Expected to Occur	No plant specimens of this species are within the worksites	No formation of forest edges (i.e., construction activities are full underground and/or in existing built-up areas outside the forest); plant specimens remain in their original forested habitats
Less likely/ Rare	NA	NA
Possible/ Occasional	No count data of this species is available, but there could be specimens within the worksites	Formation of some forest edges in a mix of forested, scrubland, and urban vegetation areas; plant specimens previously in forested areas now exposed to some edge habitats
Likely/ Regular	NA	Formation of new forest edges (i.e., some or complete clearance within forested areas); plant specimens previously in forested areas now fully exposed to edge habitats
Certain/ Continuous	Plant specimens of this species are within the worksites	NA

Table 5-29: Likelihood Criteria for Ecology (Habitats) during Operation

Impact Likelihood	Habitat Degradation (Terrestrial Habitats)	Habitat Degradation (Aquatic Habitats)	Changes in Microclimatic Conditions	Introduction of Exotic Species
Not Expected to Occur	Developed area is not accessible to public. Surrounding natural habitats are not accessible to public		Development is largely green and human activity is limited (e.g., Nature Park)	NA
Less likely/ Rare	Developed area is designed with the intention for the public to use or visit. Surrounding natural habitats are accessible but public use is restricted/controlled		Development involves the building of urban structures but will be heavily landscaped (e.g., urban park)	Developed area is not accessible to public. Aquatic habitats are not accessible to public
Possible/ Occasional	Developed area is designed for members of the public to visit. Surrounding natural habitats are accessible and have infrastructure for the public to use, such as boardwalks (but people can still stray off track)		Development involves the building of structures that are designed to release heat, light, noise or dust (e.g., ventilation shafts)	Developed area is designed with the intention for the public to use or visit. Aquatic habitats are accessible but public use is restricted/controlled
Likely/ Regular	Developed area and surroundings are designed for large groups of people to live or work in the long run. Surrounding natural habitats are easily accessible and do not have infrastructure for the public to use, such as boardwalks (thus public are off track)		Development involves the building of extensive pavements, structures, and other infrastructure with surfaces that absorb and retain heat, and constantly produce dust and noise disturbances (e.g., residential estate)	Developed area is designed for members of the public to visit. Aquatic habitats are accessible
Certain/ Continuous	NA		NA	Developed area and surroundings are designed for large groups of people to live or work in the long run. Aquatic habitats are easily accessible

Table 5-30: Likelihood Criteria for Ecology (Flora Species) during Operation

Impact Likelihood	Poaching
Not Expected to Occur	Specimens are clustered/spread out, and are inaccessible (e.g., restricted area, fenced) to members of public
Less likely/ Rare	Specimens are clustered/spread out, and are accessible to members of public
Possible/ Occasional	Specimens are spread out, and accessible to members of public
Likely/ Regular	Specimens are clustered/only one specimen was recorded in the Study Area, and accessible to members of public
Certain/ Continuous	NA

5.5.6 Determine the Significance of the Potential Impact

The significance of each impact was determined by assessing the impact consequence against the likelihood of the impact occurring using the Impact Significance Assessment Matrix. A risk-based matrix was used for summation of consequence and likelihood, as presented in Table 5-31.

Table 5-31: Risk-based Matrix Determining Impact Significance

Consequence / Likelihood	Negligible	Very Low	Low	Medium	High
Not Expected to Occur	Negligible	Negligible	Negligible	Minor	Minor
Less Likely/ Rare	Negligible	Negligible	Minor	Minor	Minor
Possible/ Occasional	Negligible	Minor	Minor	Moderate	Moderate
Likely/ Regular	Minor	Minor	Moderate	Moderate	Major
Certain/ Continuous	Minor	Minor	Moderate	Major	Major

Each impact significance level is accompanied by a description of the context in which it is applied, is provided in Table 5-32.

Table 5-32: Context of Impact Significances

Significance Category	Context
Negligible	An impact of **negligible significance** is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.
Minor	An impact of **minor significance** is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small and/or the resource/receptor is of low sensitivity /vulnerability/ importance. In either case, the magnitude should be well within applicable standards.
Moderate	An impact of **moderate significance** has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.
Major	An impact of **major significance** is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would ensure into the long-term or extend over a large area. However, for some aspect there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

Ref: Cross Island Line C1001 SI Final Report Volume I Box A

5.6 Mitigation Planning

Ramboll adhered to the framework of the mitigation hierarchy (avoid, minimise, restore, and further measures to compensate), which serves as a prioritised set of possible management responses to anticipated impacts. The mitigation hierarchy is described below:

Ramboll adhered to the framework of the mitigation hierarchy (avoid, minimize, restore, and additional measures to compensate), which serves as a prioritized set of possible management responses to anticipated impacts. The mitigation hierarchy is described below,

Avoidance: measures taken to avoid creating impacts from the outset, such as careful spatial or temporal placement of elements of infrastructure, in order to completely avoid impacts on certain components of biodiversity.

Minimisation: measures taken to reduce the duration, intensity and / or extent of impacts (including direct, indirect and cumulative impacts, as appropriate) that cannot be completely avoided, as far as is practically feasible.

Rehabilitation/restoration: measures taken to rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to impacts that cannot be completely avoided and/ or minimised.

Further Measures: measures taken to mitigate any residual significant, adverse impacts that cannot be avoided, minimised and / or rehabilitated or restored (i.e. residual impact), in order to aim for no net loss or a net gain of biodiversity. This can take the form of positive management interventions such as restoration of degraded habitat, arrested degradation or averted risk, protecting areas where there is imminent or projected loss of biodiversity.

An EMMP has been prepared based on the findings of the Study. The objective of the EMMP is to ensure that the environmental protection measures recommended for pollution control are effectively implemented, and that a monitoring plan is in place to enable compliance with NEA and other relevant environmental monitoring requirements.

An array of mitigation measures can be utilised to reduce the potential environmental impacts of the proposed Project. However, careful assessment of the choice of mitigation measures will need to be made following further engineering studies, the proposed Design Scheme, and EMMP Implementation Plan.

6. ENVIRONMENTAL BASELINE

This section describes the findings of the environmental and biodiversity baseline studies for BBNP BBTP and BBHNP, conducted between February 2022 and April 2023.

6.1 Noise

A baseline ambient noise monitoring survey was conducted between 19 April 2022 and 21 May 2022 at four (4) locations across BBNP, BBTP and BBHNP, namely N3 through N6, to establish the ambient baseline noise levels in the Study Area (Figure 6-1). The baseline ambient noise monitoring locations were placed at areas near the boundaries of study areas, forested locations, and areas of potential future park development construction work.

The noise monitoring was conducted using a Type 1 Sound Level Meter. The noise surveys were carried out to determine the minimum and maximum range of noise level in decibels (dBA). This data was then further segmented to noise quality over specified hours in a day (i.e., day, evening, and night) for further analysis. The noise data was logged every 1 second for seven (7) consecutive days at fast response at A weighting over the frequency of 10 hertz (Hz) to 20 kilohertz (kHz). The 1 second data was then used to calculate the sound pressure level (Leq) at 5min (Leq 5 min), 1-hour (Leq 1 h), and 12-hour (Leq 12 h) equivalent readings at each location. Continuous monitoring for one week provided information on the weekly / daily variations in noise levels. Ambient noise levels were measured in dB(A) (Resolution: 0.1 dB(A)).

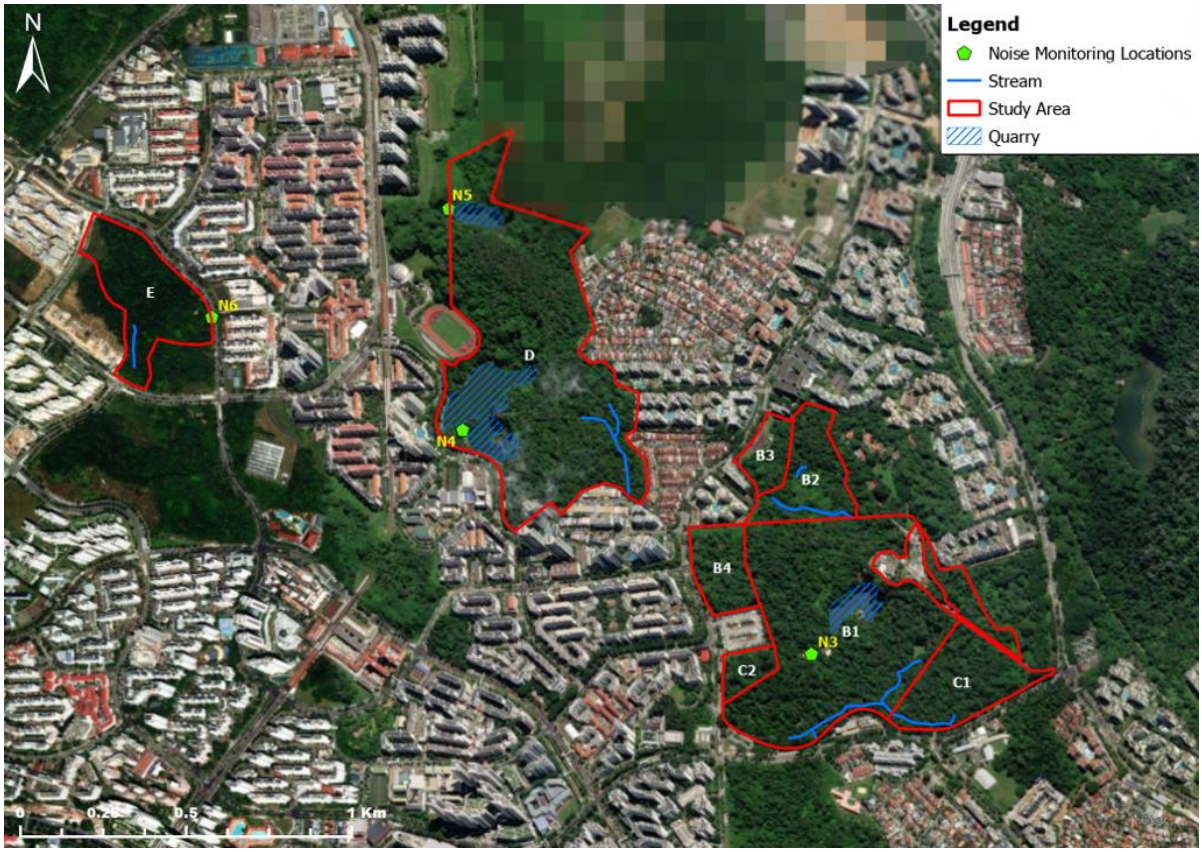


Figure 6-1: Ambient Noise Monitoring Locations

The maximum monitored noise levels recorded during the evening (7 pm – 10 pm) ranged from 62.9 dB(a) to 69.0 dB(a) which are well below the maximum permissible noise level (evening time)

of 70 dB(a). During night-time (10 pm – 7 am), the maximum monitored noise levels at all locations exceeded the maximum permissible noise level (night-time) of 55 dB(A). These readings are most likely associated with the background wildlife and weather noise within the Study Area. The maximum and minimum noise levels are summarised in **Table 6-1.**

Table 6-1: Minimum and Maximum Monitored Ambient Noise Levels in dB(A) at Study Area

Period	Minimum Monitored Noise Level dB(A)				Maximum Monitored Noise Level dB(A)				NEA Maximum Permissible Noise Level dB(A)	
	N3	N4	N5	N6	N3	N4	N5	N6	N3	N4 – 6
Day (7am – 7pm)	45.4	49.2	44.7	54.2	67.9	70.0	69.4	68.3	90	90
Evening (7pm – 10pm)	42.1	48.8	44.2	59.0	68.9	62.9	66.8	69.0	70	70
Night (10 pm – 7 am)	42.1	43.5	42.6	58.1	68.9	57.2	60.9	69.2	70	55

6.2 Ambient Air

A baseline ambient air quality monitoring survey was conducted between 7 July 2022 and 9 November 2022 at four (4) locations across BBNP, BBTP and BBHNP, namely A3 through A6, to establish the the ambient baseline air quality levels within the Study Area (Figure 6-2). The baseline ambient air monitoring locations were placed at areas near the boundaries of study areas, forested locations, and areas of potential future park development construction work.

Air quality parameters, including nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), ozone (O_3), PM_{10}, and $PM_{2.5}$ were recorded using an AQMesh whilst Total Volatile Organic Compound (TVOC) were recorded using an EcoMesure air monitor. Ambient air monitoring was carried out continously over 24 hours, at least 7 days at each monitoring locations.

The air quality parameters measured at the site during the Study were compared against Singapore's NEA Air Quality Targets (AQTs). Overall, the air quality at all locations were within acceptable range; no exceedances of NEA's AQTs were observed and TVOC concentrations were recorded averaging below 0.6 parts per million (ppm) which is considered low and unlikely to cause any public health and environmental concerns. The maximum and average values of the monitoring parameters for ambient air monitoring stations at all locations are illustrated in Table 6-2 and Table 6-3.

Figure 6-2: Ambient Air Quality Monitoring Locations

Table 6-2: Air Quality Monitoring Results – Maximum/High Percentile Concentrations

Pollutant (unit)	Assessment Period	AQT	A3	A4	A5	A6	NEA West Area Data
NO_2 (µg/m^3)	1-hr	200	69.6	71.7	58.3	63.7	84
CO (mg/m^3)	1-hr	30	0.6	0.6	1.2	0.8	-
	8-hr	10	0.5	0.5	0.9	0.6	1.7
SO_2 (µg/m^3)	24-hr	20	6.1	6.1	6.1	6.1	25
PM_{10} (µg/m^3)	24-hr	50	27.1	29.5	30.6	31.2	49
$PM_{2.5}$ (µg/m^3)	24-hr	25	13.1	15.5	14.0	15.8	25
O_3 (µg/m^3)	8-hr	100	41.6	87.2	56.0	70.5	85
TVOC (ppm)	24-hr	-	0.282	0.283	0.283	0.282	-
Notes: Levels exceeding AQT are marked in red font while levels exceeding NEA West Area Data are underlined.							

Table 6-3: Air Quality Monitoring Results – Average Concentrations

Pollutant (unit)	Assessment Period	AQT	A3	A4	A5	A6	NEA West Area Data
NO_2 (µg/m^3)	1-hr	200	41.3	43.1	41.1	45	23.2
CO (mg/m^3)	1-hr	30	0.21	0.18	0.48	0.47	-
	8-hr	10	0.22	0.18	0.5	0.49	0.6
SO_2 (µg/m^3)	24-hr	20	6.1	6.1	6	6	7.5
PM_{10} (µg/m^3)	24-hr	50	22.9	24.7	26.8	26.1	20.9
$PM_{2.5}$ (µg/m^3)	24-hr	25	9.2	11.4	11.6	11.9	10.2
O_3 (µg/m^3)	8-hr	100	13.8	25.5	21.9	43	7.45
TVOC (ppm)	24-hr	-	0.281	0.284	0.283	0.281	-
Notes: Levels exceeding AQT are marked in red font while levels exceeding NEA West Area Data are underlined.							

6.3 Surface Hydrology, Water and Sediment Environment

6.3.1 On-site Water Body Locations

The water bodies observed within the Study Area are summarised in table below:

Table 6-4: Surface Water Body Locations

Study Area	Water Body ID	Water Body Type	Water Body Location	Stream Length (m)*	Stream Flow Direction
B1 Bukit Batok Nature Park	QB	Quarry Lake	Poh Kim Quarry, located near-centre of Study Area B1	-	-
B1 Bukit Batok Nature Park and C1	SB1a	Stream	One (1) stream with two (2) tributaries located near the southern edge of Study Areas B1 and C1	786	West
B2	SB2a	Stream	Located near the southern edge of Study Area B2	32	Southwest
	SB2b	Stream		251	West to northwest
D Bukit Batok Town Park	QD2	Quarry Lake	Little Guilin, located towards the southwestern portion of Study Area D	-	-
	QD1	Quarry Lake	Seng Chew Quarry, located towards the northern portion of Study Area D	-	-
	SD1a	Stream	Located towards the southeastern portion of Study Area D	445	South
E Bukit Batok Hillside Park	SE1a	Stream	Located towards the southern portion of Study Area E	125	South
Notes: * Stream lengths are indicative and are subject to weather condition.					

6.3.2 Surface Hydrology

Stream Mapping and Characterisation

Stream mapping and characterisation were conducted at 30-m intervals along the streams (excluding lined drains) at the same set of sampling points where surface water quality was sampled.

Biotic and abiotic characteristics of the stream at each sampling point were recorded. Biotic characteristics recorded included the dominant riparian flora species found, percentage coverage of riparian plants, percentage of canopy cover, and percentage coverage of leaf litter on the stream bed. Abiotic characteristics recorded included the stream's cross-sectional profile – mean depth of standing water, wetted width, full bank width, and mean stream velocity. Mean stream depth was derived by averaging depth measurements taken at three zones across the wetted width (left bank, middle, and right bank). Stream velocity was measured using the Xylem water flow probe FP111. Photographs were also taken of each sampling point.

For the purpose of informing stream enhancement potential, bank erosion hazard scores were also calculated for streams (Sholtes and Giordanengo, 2017). The scores were calculated based on the bank composition, bank angle, bank and riparian vegetation type and cover, evidence of active bank erosion and bed stability (bed composition and bed morphology). Each contributing factor was scored from one (1) to four (4), with four (4) indicating the highest risk of instability. The final hazard score, or risk of instability, is an aggregation of scores as a percent of the total score, with each factor having a weight of one (1) except active bank erosion which has a weight of two (2).

6.3.3 Stream Flow Velocity and Depth

The fastest flow was recorded in Stream SB2b located at Study Area B2, which went up to 1.2 m/s during dry weather. Stream SD1a in Study Area D and SE1a in Study Area E were generally greater in depth. Stream SD1a ranged from 1.5-25 cm during dry weather, and 0.8-37 cm during wet weather. Stream SE1a ranged from 0-24.5 cm during dry weather, but was also the shallowest

during wet weather, ranging from 5-5.5 cm. Comparatively, the streams in Study Areas B1 and B2 ranged from 0-20 cm during wet weather.

6.3.4 Stream Mapping and Characterisation

The descriptions of the waterbodies in the sections below are results from mapping and characterisation at 30-m intervals where possible (excluding quarry lakes), alongside other observations in the field. More details are provided in **Appendix 16**.

Study Area B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Within Study Areas B1 (west of Lorong Sesuai) and C1, there are one (1) stream and one (1) quarry lake.

Stream SB1a (786 m) flows from east to west and is fed by two tributaries, one in Study Area B1 and the other in Study Area C1. The stream is a slow-flowing and mostly closed-canopy forest stream with well-vegetated banks, including several bamboo clusters (Figure 6-3A). A short section of the stream is lined with concrete (Figure 6-3B) and is continuous with a lined drain further downstream. The stream is connected to two (2) culverts both upstream and downstream. A man-made well and other abandoned structures can also be found along the tributary located in Study Area C1. In general, the stream has a sandy-gravel bed substrate that is occasionally enforced by rocks. The banks along Stream SB1a varies from gentle to steep sloping and where steep, the stream banks have undergone moderate to heavy erosion, with bare soil, root exposure, tree falls and undercuts (Figure 6-6). Several native and non-native fauna occur in Stream SB1a, such as the dominant and non-native banded panchax (*Aplocheilus lineatus*), forest stream-dependent crescent threadtail (*Prodasineura notostigma*), and globally Vulnerable Asian softshell turtle (*Amyda cartilaginea).*

The quarry in Study Area B1 is known as the Poh Kim Quarry (QB). The quarry lake is a large waterbody surrounded mostly by exposed steep walls and overhanging vegetation (Figure 6-3C). Along the steep sides, signs of recent erosion and slope failure can also be observed. The edge near the lookout point is gentler and well-vegetated.

Within Study Area B2, there are two streams flowing from east to west, and both are continuous with the same lined concrete drain further downstream.

Stream SB2a (32 m) is a slow-flowing dense-canopy forest stream with steep and heavily eroded banks (Figure 6-4A; Figure 6-7). The main substrate for this stream is clay, and few fauna species were observed here.

Stream SB2b (251 m) is a moderate to fast flowing closed-canopy forest stream with well-vegetated banks (Figure 6-4B). It has a sandy-gravel substrate downstream while rocky bed mid and upstream. Risk of instability for Stream SB2b remains relatively minor (Figure 6-7). During periods of wet weather, the stream can also be fed by an ephemeral length, which extends into Study Area B1 and harbours another man-made well structure. Along both streams SB2a and SB2b, it is noteworthy that Schismatoglottis sp. was recorded, which could possibly be a new species of riparian-associated plant recorded in Singapore (awaiting confirmation from SING).

There are no waterbodies in Study Areas B3, B4 and C2.

Figure 6-3: Waterbodies in Study Area B1 and C1. (A) Closed-canopy Forest Stream SB1a; (B) Concrete-lined Section of SB1a; (C) Poh Kim Quarry QB

Figure 6-4: Waterbodies in Study Area B2. (A) Closed-canopy Forest Stream SB2a; (B) Closed-canopy Forest Stream SB2b

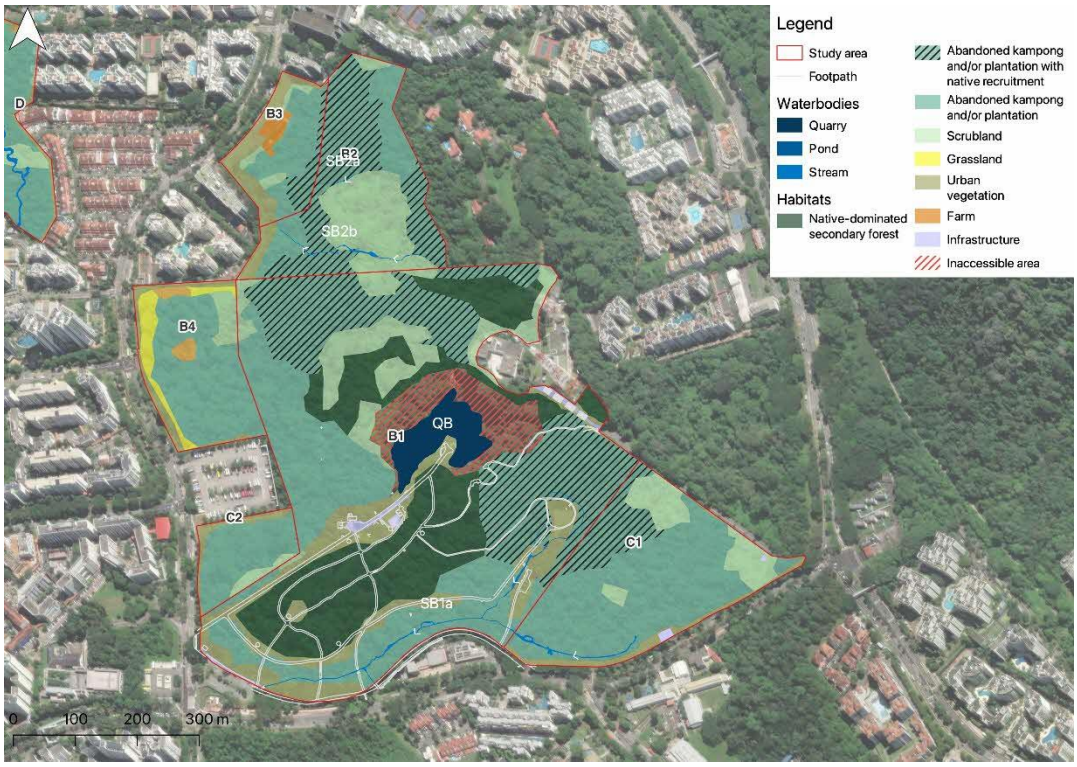


Figure 6-5: Locations of Waterbodies in Study Area B1 (West of Lorong Sesuai), B2, and C1

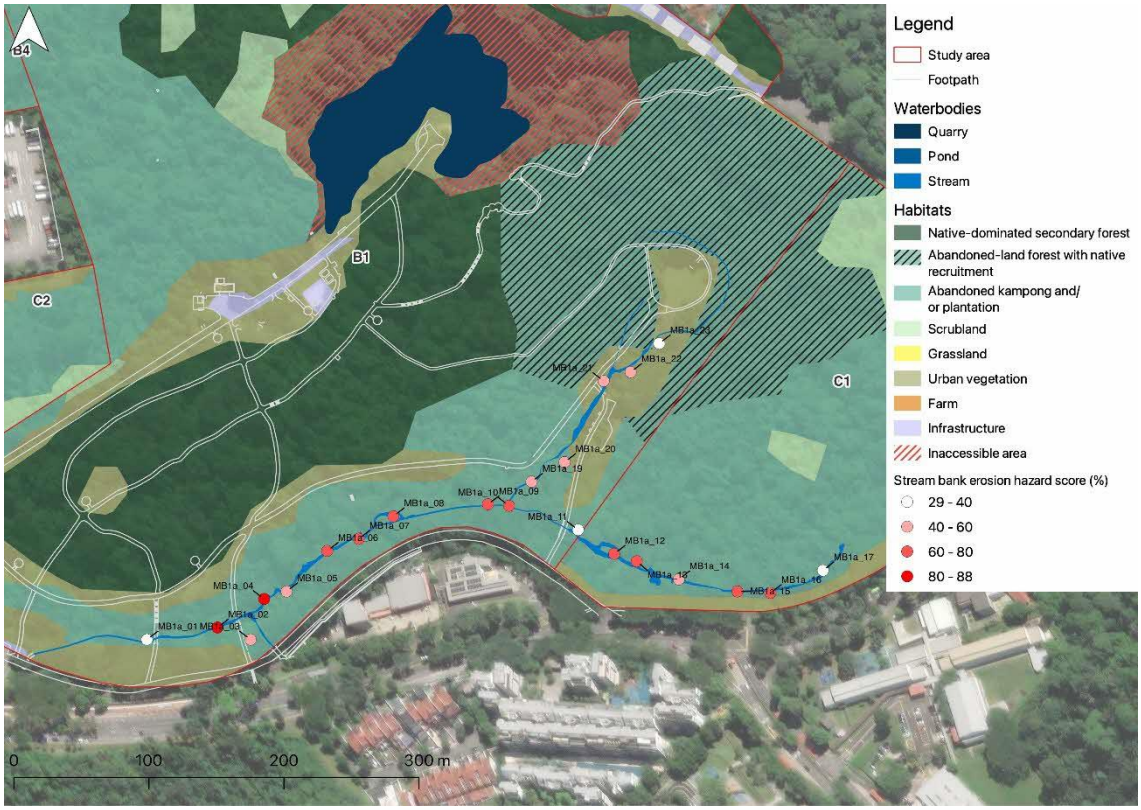


Figure 6-6: Stream Bank Erosion Hazard Scores for Stream SB1a in Study Areas B1 and C1

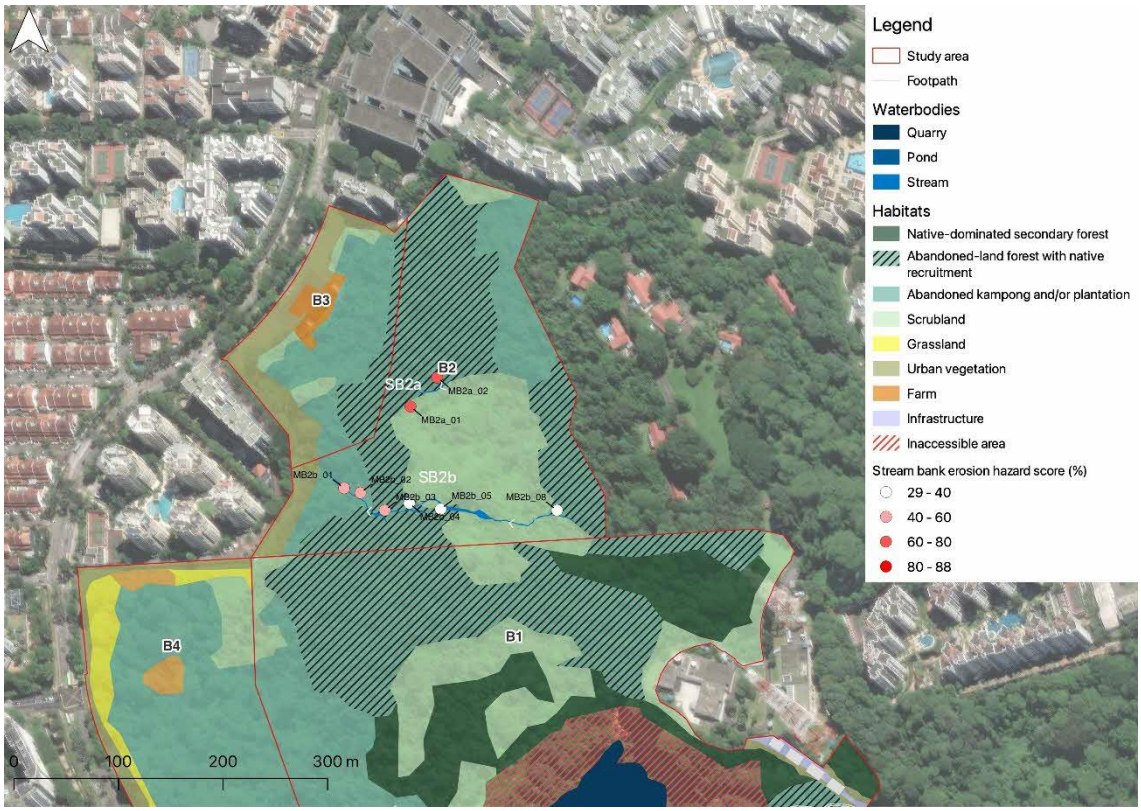


Figure 6-7: Stream Bank Erosion Hazard Scores for SB2a and SB2b in Study Area B2

Study Area D

Within Study Area D, there are one (1) stream and two (2) quarry lakes.

Stream SD1a (445 m) is a moderate-flowing and mostly closed-canopy forest stream that flows from north to south, and then out to a lined concrete drain downstream. While most of the stream is straight, slight meandering can be observed mid-stream. The stream banks are generally steep and although well-vegetated (Figure 6-8A), most areas have undergone moderate to heavy erosion, with bare soil, root exposure, tree falls, and undercuts (Figure 6-9). It has a clayey-sandy substrate downstream and sandy-gravel and rocky bed upstream, ideal for freshwater decapods like the maculate freshwater crab (*Parathelphusa maculata*) and *Macrobrachium pilimanus*. Interesting floristic findings include an extensive *Schismatoglottis* sp. population throughout the stream, an unidentified Hymenophyllaceae across the mid-stream and a few congregated clusters of *Diplazium tomentosum*.

The quarry lakes in Study Area D are known as the Seng Chew Quarry (QD1) and Little Guilin Quarry (QD2). The quarry lakes are large waterbodies surrounded mostly by exposed steep walls with overhanging vegetation (Figure 6-3B–C). In particular, there is evidence of recent erosion and slope failure at Seng Chew Quarry. The edges near the lookout points are gentler and well-vegetated, which provides a different microhabitat for fauna, including the forest-associated orange-striped threadtail (*Prodasineura humeralis*). Most of the other aquatic fauna residing in the quarry lakes are non-native.

Figure 6-8: Waterbodies in Study Area D. (A) Closed-canopy Forest Stream SD1a; (B) Seng Chew Quarry QD1; (C) Little Guilin Quarry QD2

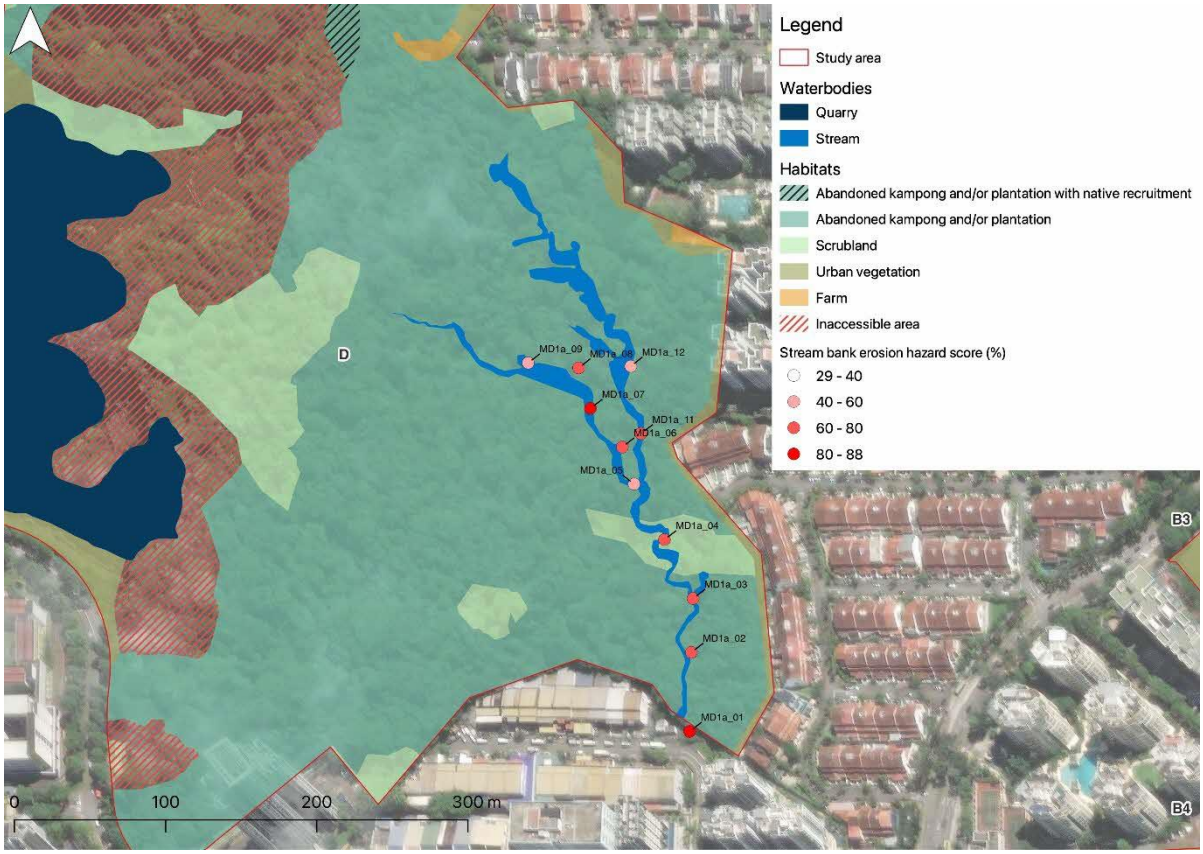


Figure 6-9: Locations of Waterbodies in Study Area D and Stream Bank Erosion Hazard Score for Stream SD1a

Study Area E

Within Study Area E, there is only one (1) stream. Stream SE1a (125 m) is a slow-flowing and mostly closed-canopy forest stream with gentle sandy banks that are well-vegetated or substantially covered with leaf litter (Figure 6-10A). The dominant vegetation along the stream are tree ferns (*Alsophila latebrosa*) and rubber trees (*Hevea brasiliensis*). A man-made well also lies directly mid-stream, and a forest clearing adjacent to the stream suggests past land use. During periods of wet weather, the low-lying areas further downstream becomes flooded to form an ephemeral pond (Figure 6-10B) harbouring non-native Siamese fighting-fish (*Betta splendens*). Overall, the risk of instability for Stream SE1a is relatively moderate due to its sandy substrate (Figure 6-11).

Figure 6-10: Waterbodies in Study Area E. (A) Closed-canopy Forest Stream SE1a; (B) Downstream Ephemeral Pond

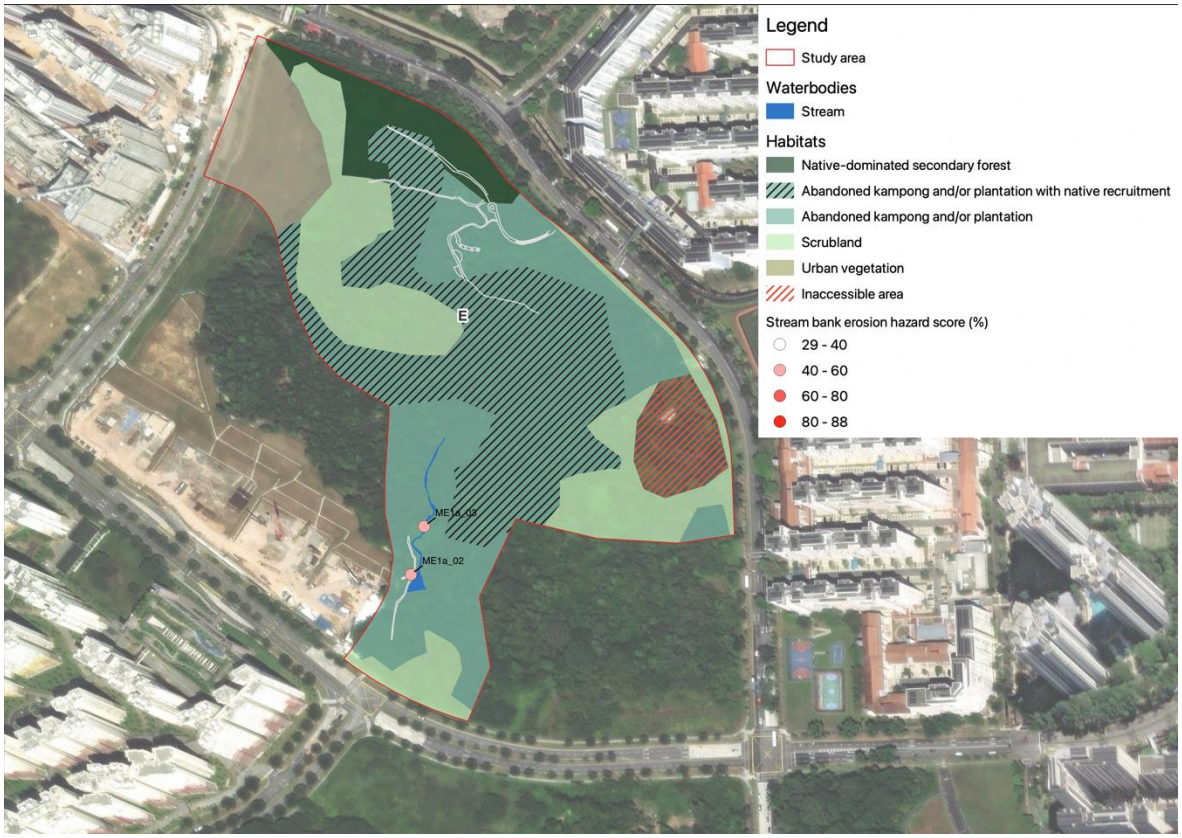


Figure 6-11: Locations of Waterbodies in Study Area E and Stream Bank Erosion Hazard Score for Stream SE1a

The bank erosion hazard score for streams located within BBNP, BBTP and BBHNP ranged from 29% to 88%. SB1a (BBNP), SB2a (near to BBNP; outside of the proposed development footprint), and SD1a (BBTP; outside of the proposed development footprint) reported bank erosion hazard scores exceeding 60%.

The locations, alignment, and stream bank erosion hazard scores of the waterbodies for the respective study areas are further detailed in **Appendix 16.**

6.3.5 Water and Sediment Quality Studies

Surface water and sediment quality studies were conducted at the streams, ponds and quarries within the Study Area to assess any environmental risks related to changes in water and sediment quality, or unusual water and sediment quality characteristics that exist pre-development.

Figure 6-12: Surface Water Quality Monitoring Locations

Figure 6-13: Sediment Quality Monitoring Locations

Surface Water Sampling

Surface water samples were collected from quarry lakes QD1, QD2, QB, and earth streams SB1a, SB2a, SB2b, SD1a and SE1a between 26 April 2022 and 3 November 2022.

Surface water quality surveys included in-situ and ex-situ measurement and collection of grab water samples for laboratory analysis. One (1) in-situ and ex-situ sample were collected from a strategic location within each quarry lake and pond while for earth stream sampling, in-situ and ex-situ sampling were carried out at 30-m and 60-m intervals, respectively.

In-situ water measurements were carried out using a Hanna Multiprobe HI9829 for analysis of parameters including temperature, pH, turbidity, conductivity, and Dissolved Oxygen (DO). Water quality parameters such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Nitrogen, Total Phosphorus, Oil & Grease, Cadmium (Cd), Copper (Cu), Zinc (Zn) and Lead (Pb) were analysed ex-situ by a Singapore Accreditation Council (SAC)-Singapore Laboratory Accreditation Scheme (SINGLAS)-certified laboratory.

Water samples were collected in both wet and dry conditions. Wet weather samples are defined as those taken within two (2) hours of significant rainfall (2.4 milimetres [mm]), whilst dry samples are those collected after over two (2) consecutive days of no rain in the area. Three (3) rounds of sampling events for in-situ samples, and two (2) rounds of sampling events for ex-situ samples have been planned for the quarry lakes, ponds and earth streams. The surface water sampling works, which were conducted over separate events, were carried out between 26 April 2022 and 3 November 2022.

Sediment Sampling

The sediment sampling included the collection of sediment samples from lakes, ponds and streams were collected from a shovel and/or a Van Veen grab sampler. The sampling works were carried out between 26 April 2022 and 19 May 2022. One (1) sediment sample was collected from each water body. Sediment samples were collected from seven (7) locations across the waterbodies at BBNP, BBTP and BBHNP. The sediment samples were tested for grain size analysis and heavy metals[2] by an SAC SINGLAS-certified laboratory.

6.3.6 Baseline Surface Water Quality

The surface water quality was compared to the allowable limits for trade effluent discharge to controlled watercourse as stipulated by the Environmental Protection and Management (Trade Effluent) Regulations (NEA trade effluent limit).

The measured in-situ water quality and ex-situ results and a comparison against their respective NEA trade effluent limits, where applicable, are summarized below:

- Temperature for quarries ranged between 26.28 and 31.52 ºC, while the temperatures measured at streams or ponds ranged between 25.49 and 28.13 ºC.
- Dissolved oxygen was relatively high at most points sampled (above 50% saturation), except during selected sampling events at SB1a11 (wet), SB1a12 (wet), SB1a13 (wet), SB1a14 (wet), SB1a15 (wet), SB1a16 (both dry and wet), SB1a17 (wet), SD1a01 (dry), SD1a05 (dry), SD1a08 (dry), SE1a01 (dry and wet), SE1a02 (dry), SE1a03 (dry), QD1 (Seng Chew Quarry)(dry) and QD2 (Little Guilin), where the DO saturations at these sampling points ranges from 19.0 to 49.5% TSS was observed to be relatively higher at SD1a and SE1a. Algae was also observed at SE1a.

[2] The heavy metal test suite comprises antimony, arsenic, barium, cadmium, chromium, copper, lead, manganese, mercury, molybdenum, nickel, and zinc.

- pH was within the limits of pH 6-9 at all points except the headwater points of SB1a01, SB1a07, SB1a15, SB1a16, SB1a17, SB1a23 and SE1a03. At these points, water was slightly acidic at pH 4.95 to 5.98.
- Total Dissolved Solids values were generally below 300 mg/L at all points sampled. This is well below the NEA trade effluent limit of 1,000 mg/L.
- Turbidity was generally below 350 FNU in all streams and quarries.
- Conductivity was generally below 400 µS/cm.
- Salinity of the on-site water bodies ranged between 0.035 PSU and 0.2417 PSU. As the streams sampled were all inland forest streams, salinity was expectedly low.
- Total nitrogen was at or below 1.5 mg/L in all streams. Although TN does not have an official limit (with reference to Allowable Limits for Trade Effluent Discharge to Watercourse or Controlled Watercourse), these values are considered low.
- Total phosphorus was below 0.1 mg/L in most streams. TP does not have an official limit, but the values recorded in this study are considered low.
- Total Suspended Solids concentrations exceeded the trade effluent limit of 30 mg/L in various stream points and seasons at SB1a01 (wet), SB1a04 (wet), SB1a08 (wet), SB1a10 (wet), SB1a22 (headwater during dry), SB2b01 (wet), SD1a (all points, dry), SD1a02 (wet) and SE1a02.
- Chemical Oxygen Demand (COD) values were well below the limit of 60 mg/L in all streams.
- Biochemical Oxygen Demand (BOD) values were well below the limit of 20 mg/L in all streams except for QD2 (Little Guilin). The quarry at Little Guilin recorded BOD at 24 mg/L, which exceeds the limit of 20 mg/L.
- Oil and grease was generally below the limit of 1.0 mg/L in all streams, quarries and ponds except for selected water sampling points at SB1a, SB2b, SD1a, QD2, and SE1a.
- There were no exceedances of heavy metals (Cd, Cu, Pb, Zn) in all streams and quarries.

Surface water quality were generally observed to be within the applicable criteria, although exceedances in oil and grease, and TSS were observed across selected points especially at SB1a and SD1a, which also reported high stream bank erosion hazard scores (>60%). Quarries were also observed to have slightly poorer water quality in terms of TDS and COD.

6.3.7 Sediment Quality

The analytical sediment results were assessed against the latest Dutch Ministry of Infrastructure and the Environment (formerly, Ministry of Housing, Spatial Planning and Environment's [MVROM]) Intervention Values for soil (Soil Remediation Circular 2013, referred to as the "Dutch Standards"). In addition, the health-based investigation levels for recreational land use (HIL C) prescribed in the National Environmental Protection (Assessment of Site Contamination) Measure (amended 2013) is used as supplementary screening criteria for heavy metals in sediment. HIL C is applicable to public open space such as parks and footpaths. HILs establish the concentration of a contaminant above which further appropriate health investigation and evaluation will be required. Levels slightly in excess of the HILs do not imply that a significant health risk is likely to be present.

Based on the sediment laboratory analytical results, there were no exceedances for other heavy metals in the sediment sampling sites as set out by the Dutch Standard, besides chromium at SQ1 (Poh Kim Quarry), SQ2 (Little Guilin), and SQ3 (Seng Chew Quarry). SQ1, SQ2 and SQ3 were collected from the former granite quarries. However, these detections were all well below the HIL C of 300 mg/kg.

Chromium can be naturally occurring in rocks and soil, and the mining activity or natural weathering of the rocks at the quarries could be a possible contributing factor to these detections. These detections could also be a result from the accumulation of heavy metal-containing run-offs from

the surrounding areas. It was noted that chromium in soil samples collected near to SQ2 and SQ3 also exceeded the Dutch Intervention Values (DIVs).

As the sediment samples were collected from quarry lakes that have restricted access, it is unlikely that there will be opportunities for the general public to come into contact with it. Thus, the potential risk to future receptors (visitors, construction workers) due to direct contact (dermal contact or incidental ingestion) with the contaminated sediment is considered low, considering it is unlikely that anyone will come into direct contact with the impacted sediments under normal circumstances. A summary of sediment grain size is presented in BBHNP / Study Area E
BBHNP, which falls within Study Area E is mostly underlain by Tengah Facies (Jt), which is muddy marine sandstone with occasional grit beds and conglomerates. It is also underlain by some Ayer Chawan Facies (Jac), well bedded marine muddy sandstone and mudstone, and Queenstown Facies (Jq), which is red to purple mudstone and sandstone with minor conglomerate.
Table 6-5.

6.4 Geology and Soil

The Geological Map of Singapore (2009) published by the Defence Science and Technology Agency was reviewed to characterise the geology and soil condition of the Study Area, as shown in Figure 6-14.

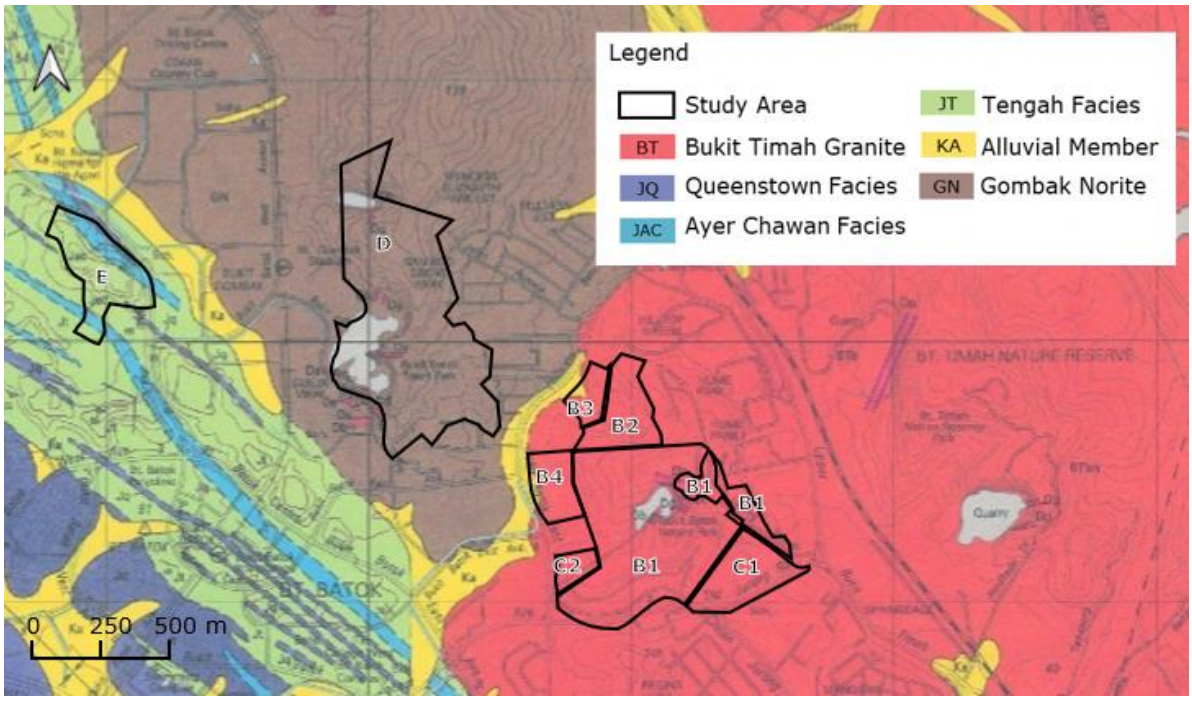


Figure 6-14: Geology of the Project Site and its Site Surroundings

6.4.1 BBNP / Study Area B1, B2, B3, B4, C1, and C2

These Study Areas are underlain with Bukit Timah Granite (BT), similar to most parts of Central Singapore. The granite varies from granite through adamellite to granodiorite, and several hybrid rocks are included within the formation. Study Area B1 is also underlain with some dyke rocks, granite porphyry (Dp), in particular and a small portion of the western boundary of Study Area B3 is also underlain with Alluvial Member (Ka) of the Kallang Formation, a variable terrestrial sediment ranging from pebble beds through sand, muddy sand and clay to peat.

6.4.2 BBTP / Study Area D

BBTP, which falls within Study Area D is mostly underlain by Gombak Norite (GN), a gabbroic and noritic rock, that shows metasomatic alteration close to the Bukit Timah Granite. The area is also underlain by a few dyke rocks, which are igneous rocks intruded into to Palaeozoic Formations and Bukit Timah Granite.

6.4.1 BBHNP / Study Area E

BBHNP, which falls within Study Area E is mostly underlain by Tengah Facies (Jt), which is muddy marine sandstone with occasional grit beds and conglomerates. It is also underlain by some Ayer Chawan Facies (Jac), well bedded marine muddy sandstone and mudstone, and Queenstown Facies (Jq), which is red to purple mudstone and sandstone with minor conglomerate.

Table 6-5: Summary of Sediment Grain Sizes

Sample I.D.	Diameter (mm)														Soil Type (%)				Sediment Type
	20.00	10.00	6.30	5.00	3.35	2.00	1.18	0.600	0.425	0.300	0.212	0.150	0.063	0.002	Clay	Silt	Sand	Gravel	
SQ1 (QB01)	64	58	40	35	28	23	18	13	11	8	6	5	4	1	1	39	19	41	Silty GRAVEL
SQ2 (QD201)	100	96	96	96	96	95	94	93	93	92	92	89	68	24	24	44	27	5	Sandy/Clayey SILT
SQ3 (QD101)	100	100	100	100	99	98	96	90	84	77	72	66	52	25	25	27	46	2	Silty/Clayey SAND
SQ4 (B101)	100	92	88	86	80	74	65	50	37	17	7	3	3	1	1	2	71	26	Gravelly SAND
SQ5 (B2b01)	100	96	90	87	81	70	59	46	38	27	20	12	5	1	1	4	65	30	Gravelly SAND
SQ6 (Dlc03)	100	100	97	96	94	90	86	82	78	69	61	49	41	1	3	38	49	10	Silty SAND
SQ7 (SE102)	100	100	100	100	100	100	100	98	90	60	36	12	4	4	4	0	96	0	SAND

6.4.2 Soil

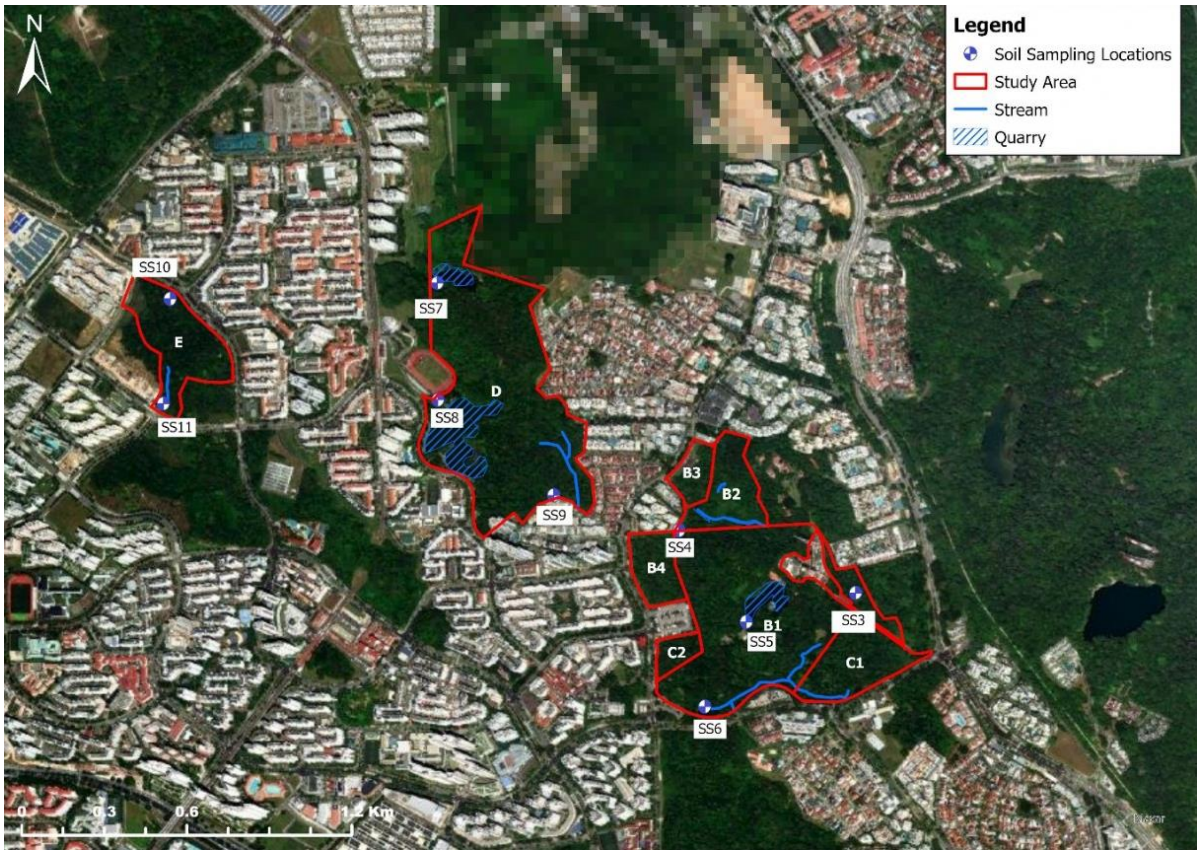


Figure 6-15: Shallow Soil Sampling Locations

A shallow soil sampling survey was conducted on 5 May 2023 to assess and establish the baseline condition of the shallow soil within the Study Area, with focus at areas which will proceed for development during the construction phase. A total of nine (9) shallow soil sampling points was advanced across BBNP, BBTP and BBHNP for the shallow soil sampling (Figure 6-15). The shallow soil sampling points targets areas of potential concerns, identified based on Ramboll's site reconnaissance and review of historical land use, and in consideration of the proposed development within the Study Area.

All soil sampling points were advanced to 0.5 metre (m) below ground surface (bgs) using a hand auger, a manual method, in order to target/sample the shallow soil profile within the Study Area. One (1) shallow soil sample was collected from each sampling location for the analysis of grain size distribution, asbestos and heavy metals [3]. Additional parameters, such as total petroleum hydrocarbon (TPH), volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) were also tested for soil samples collected from areas with historical industrial use. This includes soil samples collected from BBNP. One (1) round of sampling was carried out for each sampling location.

[3] The heavy metal test suite comprises antimony, arsenic, barium, cadmium, chromium, copper, lead, manganese, mercury, molybdenum, nickel, and zinc.

Based on the subsurface investigation conducted by Ramboll, soil profile encountered on-site generally consisted of sandy CLAY and silty SAND. There was no apparent evidence of staining or discoloration (visual and olfactory inspections) observed in the soil samples collected during the field activities. There were also no soil organic vapor values measured for any of the samples. This is consistent with Ramboll's visual and olfactory observations. The grain size for soil is summarised below..

Table 6-6: Summary of Grain Size Distribution Analysis

Sample I.D.	Diameter (mm)														Soil Type (%)				Soil Type
	20.00	10.00	6.30	5.00	3.35	2.00	1.18	0.600	0.425	0.300	0.212	0.150	0.063	0.002	Clay	Silt	Sand	Gravel	
SS3	100	100	100	100	100	100	98	95	92	87	83	77	69	47	47	22	31	0	Sandy CLAY
SS4	100	100	99	99	96	91	86	78	72	65	59	53	44	29	29	15	47	9	Clayey SAND
SS5	100	100	96	94	90	85	79	72	66	59	54	47	38	19	19	19	47	15	Clayey/Silty SAND
SS6	100	100	98	97	95	94	92	86	82	76	70	59	47	20	20	27	47	6	Silty SAND
SS7	100	84	84	84	83	82	80	77	76	73	71	66	54	16	16	38	28	18	Sandy SILT
SS8	100	91	91	89	88	84	81	78	76	74	71	68	59	21	20	39	25	16	Sandy SILT
SS9	100	93	92	91	91	87	79	71	66	60	56	51	46	21	21	25	41	13	Silty SAND
SS10	100	100	96	94	88	79	69	58	53	49	46	42	35	14	14	21	44	21	Silty/Gravelly SAND
SS11	100	89	81	77	74	68	63	60	58	53	47	37	30	2	2	28	38	32	Gravelly SAND
QAQC	100	100	100	99	98	96	92	88	85	82	78	73	57	29	29	28	39	5	Clayey SAND

The analytical soil results were assessed against the Dutch Standards and HIL C. Based on laboratory analytical results, the shallow soil sampling survey did not detect the presence of significant levels of hazardous substances or petroleum products for the parameters analysed in soil samples collected, except for SS11 (within BBHNP / Study Area E), which reported chromium and nickel concentrations exceeding the DIVs. Chromium was detected in all soil samples at concentrations ranging between 9.8 miligram per kilogram (mg/kg) and 304 mg/kg. There is no screening value specified for total chromium under the Dutch Standard. The detected concentrations were compared against the DIVs for Chromium (III) (180 mg/kg) and Chromium (VI) (78 mg/kg). The concentration of total chromium at SS3, SS7, SS8 and SS11 exceeded the DIV for Chromium (VI). All of the detections were well below the HIL C of 300 mg/kg, except for SS11, which was marginally higher than the HIL at 304 mg/kg;

The source(s) of chromium and nickel in the soil sample collected from SS11 cannot be conclusively known, although the detections could be attributed to the former road use at the area, which are commonly known to be present in road dust. The exceedance of soil DIVs for chromium and nickel does not necessarily indicate an unacceptable risk owning to the conservative nature of the screening level in relation of the current and future site setting (i.e., park). There is also low potential risk of exposure to construction/excavation workers and future visitors to the park too and thus no further action is recommended for the site at this time.

6.5 Ecology and Biodiversity

6.5.1 Flora

The field assessment for flora was carried out between 11 April 2022 and 30 November 2022, and consisted of: (1) habitat and vegetation mapping, (2) general walking floristic surveys, and (3) vegetation plot sampling.

Habitat and Vegetation Mapping

A preliminary vegetation map was first 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, forests, grasslands, or urban vegetation—were 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 Study Area with the aid of a GPS receiver (Garmin GPSMap® 64s). Photographs of the vegetated areas were also taken. The boundaries of each vegetation type were tracked on the GPS receiver and mapped out on Google Earth 7.1.2.2041. The classification of vegetation types was done with reference to NParks (2021).

General Walking Surveys

All plants observed in the Study Area during floristic surveys were identified to species whenever possible. A checklist of all the plant species recorded from the floristic surveys was compiled. The nomenclature and national conservation status follow that of Chong et al. (2009) and Lindsay et al. (2022). Other information on the plant species was also crosschecked with online databases, namely, the National Parks Board Flora and Fauna Web and Singapore Biodiversity Online.

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

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

Species of Conservation Significance

The geographic locations of plants of conservation significance—i.e., listed in Lindsay et al. (2022) as nationally Vulnerable, Endangered, Critically Endangered or Presumed Extinct (which indicates a rediscovery)—were marked using a Global Positioning System (GPS) receiver (Garmin GPSMap® 64s), which records locations with accuracy of ± 4 m, during floristic surveys. Where there were clusters of plants of conservation significance—i.e., more than one individual occurring within 5 m or less of another individual—the approximated centre of the area was marked using the GPS receiver.

Large Plant Specimens

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

Other Plant Specimens of Value

Locations of other plants that are of value but did not meet the minimum size requirement of large specimens, as detailed above, were also recorded using the GPS receiver. Examples of such specimens include bamboo clusters of < 3 m spread that may be important refugia for threatened bamboo bats, exotic albizia trees (*Falcataria moluccana*) with raptor nests, keystone species, amongst others.

Keystone species is defined as "important plants that other animals in the community depend heavily on" and the removal of these species would most likely cause an extirpation of dependent animals such as pollinators and seed dispersers (Lok et al., 2013; Mills et al., 1993). These specimens can fall under the categories mentioned above (i.e., species of conservation and large specimens) and trees and/or strangling species of ≥ 1.0 m girth which was recorded during tree mapping. Geographic locations of all keystone species were recorded using the GPS receiver (Garmin GPSMap® 64s) or/and Differential Global Positioning System (DGPS) receiver.

Vegetation Plot Sampling

One 20 × 20 m plot was set up for every 3 ha of spontaneous vegetation (i.e., forested area) that was accessible on foot (excluding areas of steep terrain).

Locations of vegetation plots were randomly generated, and the actual locations subsequently adjusted on-site based on accessibility and suitability, i.e., not covered in excessively dense vegetation and/or tree falls that would render the plot inaccessible. The locations of the actual vegetation plots are shown in Figure 6-16 and Table 6-7. All woody tree and shrub specimens as well as single-stemmed palms of ≥ 0.05 m girth were identified to species and their girths were measured. The number of specimens with < 0.05 m girth were counted, but the exact girths were not recorded. For *Ficus* stranglers and palm clusters, the circumference of each woody aerial root or stem, respectively, of ≥ 0.05 m stem diameter at breast height (DBH) was measured. All other plant species observed in the plots were also recorded.

The data from the vegetation plot sampling was used to visualise the differences among vegetation types using non-metric multidimensional scaling (NMDS) ordination. It was also used to understand the successional stages of forests to inform recommendations on habitat enhancement.

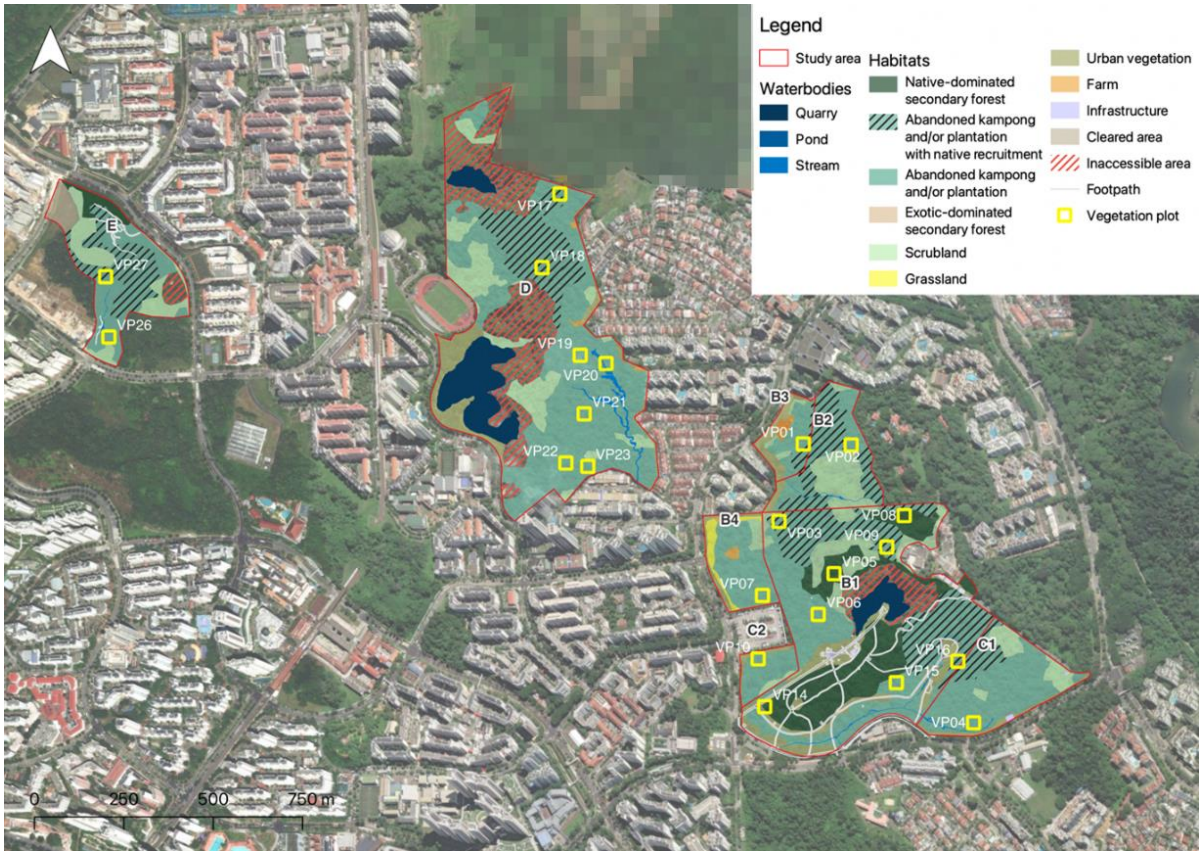


Figure 6-16: Locations of Vegetation Plots

Table 6-7: Geographic Coordinates of the Vegetation Plots

Vegetation Plot ID	Latitude	Longitude
VP01	1.35470297	103.762577
VP02	1.35467699	103.76378
VP03	1.352761	103.761967
VP04	1.347712	103.76686
VP05	1.35145096	103.76335
VP06	1.35042996	103.762952
VP07	1.35090496	103.761549
VP08	1.352907	103.765114
VP09	1.352117	103.764676
VP10	1.349315	103.761442
VP12	1.35007901	103.768281
VP13	1.35088703	103.768959
VP14	1.348117	103.761606
VP15	1.34871804	103.764917
VP16	1.34925499	103.766465
VP17	1.36097004	103.756456
VP18	1.35912401	103.756009
VP19	1.35692602	103.756966

Vegetation Plot ID	Latitude	Longitude
VP20	1.35671999	103.757615
VP21	1.35545701	103.757066
VP22	1.35422604	103.756606
VP23	1.35414097	103.757157
VP25	1.354216	103.749604
VP26	1.35738501	103.745115
VP27	1.35889602	103.745031

6.5.1.1 Flora Key Findings

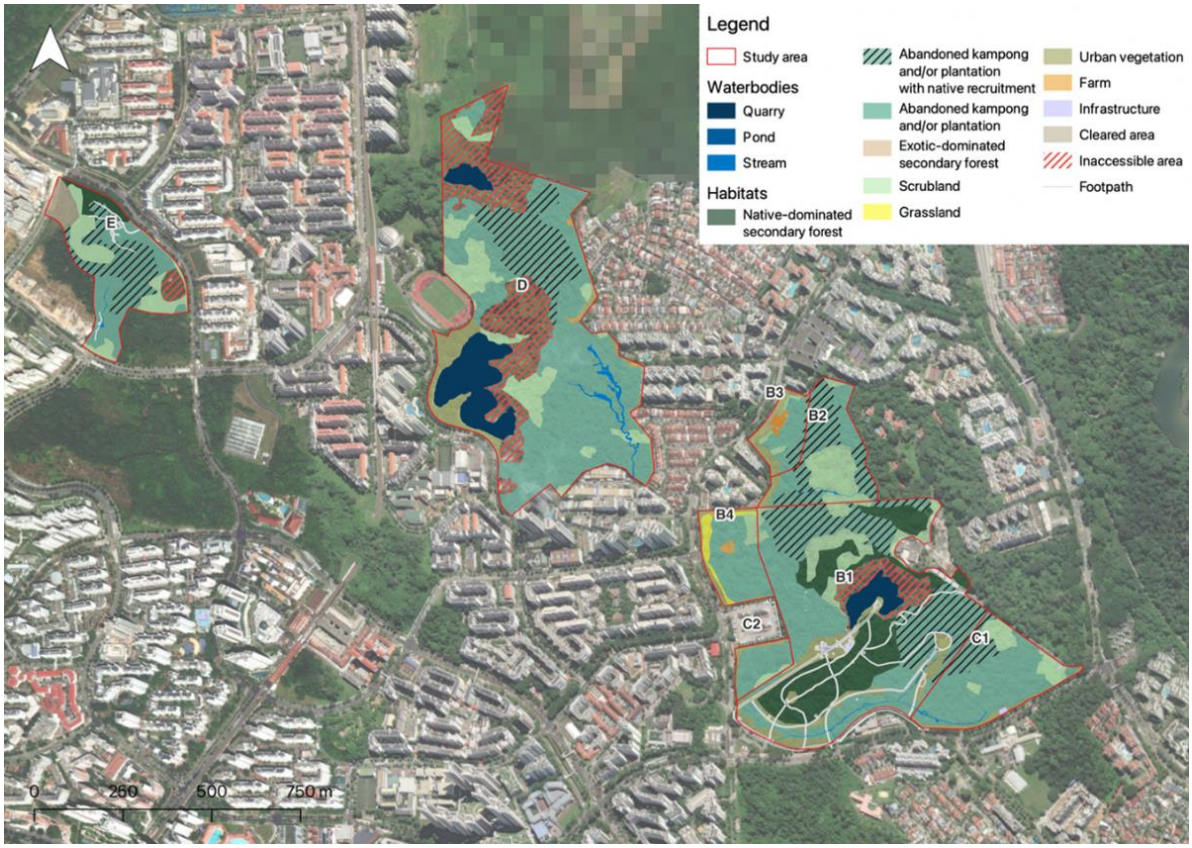


Figure 6-17: Map of the Habitat Types Recorded at BBNP, BBTP and BBHNP

Abandoned kampong and/or plantation is the dominant vegetation type in the areas studied. Other vegetation types found include scrubland, abandoned kampong and/or plantation with native recruitment, urban vegetation, native-dominated secondary forest, grassland, farm, and exotic-dominated secondary forest (Figure 6-17). The remaining areas are occupied by quarry lakes, infrastructure, cleared areas, or were inaccessible during the field assessment.

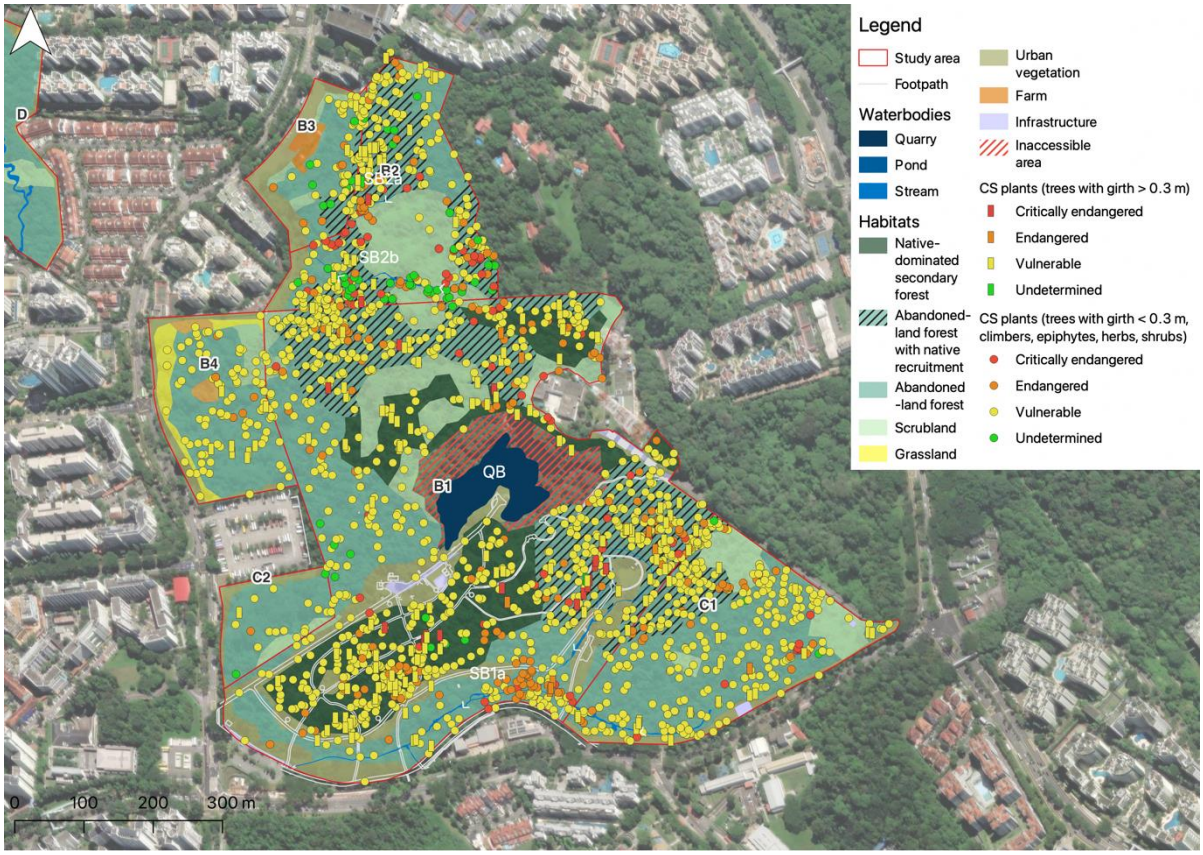


Figure 6-18: Locations of the Plants of Conservation Significance Recorded at BBNP / Study Area B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

In Study Area B1 (west of Lorong Sesuai) (BBNP), B2, B3, B4, C1, and C2, a total of 516 species and 44 species groups, and four (4) unknown species belonging to 144 families were recorded. Of the 552 species (excluding the eight (8) species groups with undetermined origin and four (4) unknown species) that were recorded, more than half of the species recorded (337 species; 61.05%) are native, while 203 species (36.78%) comprise exotic species, and 12 species (2.17%) are cryptogenic. One hundred and thirty-two (132) species are regarded as species of conservation significance (Figure 6-18; Table 6-20). Species of conservation significance are those that are listed in Lindsay et al. (2022) as nationally threatened (i.e., Vulnerable, Endangered, or Critically Endangered). However, since some populations may be relics that have persisted from past cultivation that do not belong to the native genetic stock, the assessment of whether a threatened species is of conservation significance takes into consideration multiple factors such as land use history, presence of large parent tree(s) in the Study Area, commercial availability, and reforestation efforts, amongst others. A total of 2,329 specimens of conservation significance were recorded in Study Area B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2 (Table 6-9). Three (3) nationally Vulnerable species that greatly contribute to the number of specimens within this area are elephant fern *Angiopteris evecta* (300 specimens), *Strombosia javanica* (277 specimens), and *Gynochthodes rigida* (221 specimens). A total of 151 large plant specimens (girth or spread greater than 3 m) were also recorded (Table 6-10). Notably, a high number of large native common trees were found in the native-dominated secondary forest of Study Area B1 (West of Lorong Sesuai), including *Artocarpus elasticus*, *Ixonanthes reticulata*, and *Syzygium grande*. As for other plant specimens of value, a total of 301 fig specimens were recorded in all Study Areas (Table 6-11). *Ficus variegata* is the most abundant fig species in all the study areas, making up the majority (282; 94.63%) of the fig specimens. A total of 49 bamboo specimens deemed as confirmed/potential bamboo bat (*Tylonycteris* spp.) roosting sites were recorded (Table 6-11).

Additionally, two (2) *Falcataria moluccana* trees in Study Area B1 (west of Lorong Sesuai) were observed with raptor nests and are hence considered as other specimens of value, although no raptors were observed using the nests (Table 6-11).

Table 6-8: Breakdown of Plant Species of Conservation Significance in Study Area B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

	VU	EN	CR	Undetermined	Total
Non-Cultivated Threatened Species	56	45	24	7	**132**
Cultivated Threatened Species	13	13	30	0	**56**

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

Table 6-9: Number of Individuals/Clusters and Species of Plant of Conservation Significance in Study Area B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Habitat	Number of Individuals and Clusters					Number of Species				
	VU	EN	CR	UD	Total	VU	EN	CR	UD	Total
Abandoned-Land Forest	551	61	21	7	**650**	42	20	10	3	**75**
Abandoned-Land Forest with Native Recruitments	751	101	59	45	**956**	55	32	18	6	**111**
Native-Dominated Secondary Forest	381	47	12	4	**444**	37	15	7	1	**60**
Scrubland	109	25	10	16	**160**	22	8	4	2	**35**
Grassland	4	0	0	0	**4**	1	0	0	0	**1**
Farm	6	1	0	0	**7**	3	1	0	0	**4**
Urban Vegetation	59	5	2	0	**66**	16	5	2	0	**23**

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; UD – Undetermined.

Table 6-10: Number of Large Plant Specimens in Study Area B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Study Area	Habit	Species	No. of Specimens
B1 (West of Lorong Sesuai)	Tree	*Alstonia angustifolia*	2
		Alstonia angustiloba	1
		Alstonia scholaris	3
		Artocarpus elasticus	19
		Campnosperma auriculatum	3
		Durio zibethinus	2
		Falcataria moluccana	3
		Ficus variegata	6
		Ixonanthes reticulata	4
		Pterocarpus indicus	1
		Samanea saman	2
		Spathodea campanulata	2
		Syzygium grande	15
	Strangler	*Ficus* cf. *caulocarpa*	1
		Ficus cf. *rumphii*	1
		Ficus microcarpa	1

Study Area	Habit	Species	No. of Specimens
		Ficus sp.	1
	Palm	*Elaeis guineensis*	2
	Shrub (Bamboo)	*Bambusa heterostachya*	2
		Bambusa cf. *heterostachya*	2
		Bambusa vulgaris	3
		Bambusa cf. *vulgaris*	2
		Bambusa sp.	6
B2	Tree	*Hevea brasiliensis*	1
		Spathodea campanulata	1
		Syzygium grande	5
	Shrub (Bamboo)	*Bambusa heterostachya*	2
		Bambusa vulgaris	1
		Bambusa cf. *heterostachya*	2
B3	Tree	*Falcataria moluccana*	1
		Ficus variegata	1
		Spathodea campanulata	1
		Vitex pinnata	1
	Shrub (Bamboo)	*Bambusa bambos*	1
		Bambusa vulgaris	1
B4	Tree	*Falcataria moluccana*	16
		Ficus variegata	2
		Spathodea campanulata	8
	Shrub	*Bambusa vulgaris*	4
C1	Tree	*Artocarpus elasticus*	1
		Falcataria moluccana	2
		Ficus variegata	2
		Ixonanthes reticulata	1
		Samanea saman	6
		Spathodea campanulata	1
		Syzygium grande	5
	Strangler	*Ficus* cf. *benjamina*	1
	Shrub (Bamboo)	*Bambusa* sp.	1
	Palm	*Elaeis guineensis*	1
Total			**151**

Table 6-11: Number of Other Plant Specimens of Value in Study Areas B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Habit	Species	No. of Specimens					
		B1 (West of Lorong Sesuai)	B2	B3	B4	C1	C2
Tree	*Falcataria moluccana*	2	0	0	0	0	0
	Ficus variegata	152	21	26	16	49	17
	Ficus cf. *variegata*	1	0	0	0	0	0
Strangler	*Ficus benghalensis*	2	0	0	0	0	0
	Ficus benjamina	10	0	2	0	0	0
	Ficus cf. *benjamina*	1	0	0	0	0	0

Habit	Species	No. of Specimens					
		B1 (West of Lorong Sesuai)	B2	B3	B4	C1	C2
	Ficus microcarpa	1	0	0	1	0	0
Shrub (Bamboo)	*Bambusa bambos*	0	0	1	0	0	0
	Bambusa heterostachya	2	3	0	0	0	0
	Bambusa cf. *heterostachya*	6	2	0	0	0	0
	Bambusa cf. *vulgaris*	1	0	0	0	0	0
	Bambusa vulgaris	13	1	4	4	0	0
	Bambusa sp.	9	0	0	0	3	0
Total		**200**	**27**	**33**	**21**	**52**	**17**

In Study Area D (BBTP), a total of 352 species and 13 species group belonging to 107 families were recorded. More than half (222 species; 60.99%) are native, of which, 88 species are regarded as species of conservation significance (Figure 6-19,Table 6-21). More than one-third (130 species; 35.71%) are exotic species, while the remaining are cryptogenic (12 species; 3.30%). In total, 2,033 specimens of conservation significance were recorded in the Study Area D (Table 6-13), of which, about more than a half (1,074 specimens) were recorded in the abandoned-land forest patches, although more than a fifth of these specimens (i.e., 479 specimens) were contributed by the nationally Vulnerable climber species, *Gynochthodes rigida*. *Schismatoglottis* sp. also contributed about one-fifth of these specimens (147 specimens; Table 6-13). Some species of conservation significance that were previously recorded in BBNP, such as the nationally Vulnerable *Tetracera fagifolia* var*. borneensis* were also recorded in during this study (Neo et al., 2013). The high abundance of *Gynochthodes rigida* (previously known as *Morinda rigida*) suggests that the forest here is at a late-successional stage as this species has only been recorded in mature secondary forests of BTNR and Nee Soon Swamp Forest (Chong et al., 2018; Ho et al., 2019). In addition, rare fern species, such as the nationally Critically Endangered *Diplazium tomentosum* and *Teratophyllum ludens*, nationally Endangered *Cephalomanes javanicum* var. *javanicum,* as well as the nationally Vulnerable *Abrodictyum obscurum* were also discovered along the banks of the stream of Study Area D. Approximately 43 large plant specimens were recorded (Table 6-14). These specimens comprise of 38 trees of 3.0–5.0-m girth sizes and five (3) bamboo clusters with spreads of 3.0–7.0 m. A total of 219 other plant specimens of value were recorded (Table 6-15). This includes three fig species, mainly *Ficus variegata* and *F. benjamina*, as well as 13 bamboo clusters that are deemed as confirmed/potential roosting sites for bamboo bats (*Tylonycteris* spp.). Additionally, one *Falcataria moluccana* tree in Study Area D had a grey-headed fish eagle (*Icthyophaga ichthyaetus*) nest and is hence considered as a specimen of value.

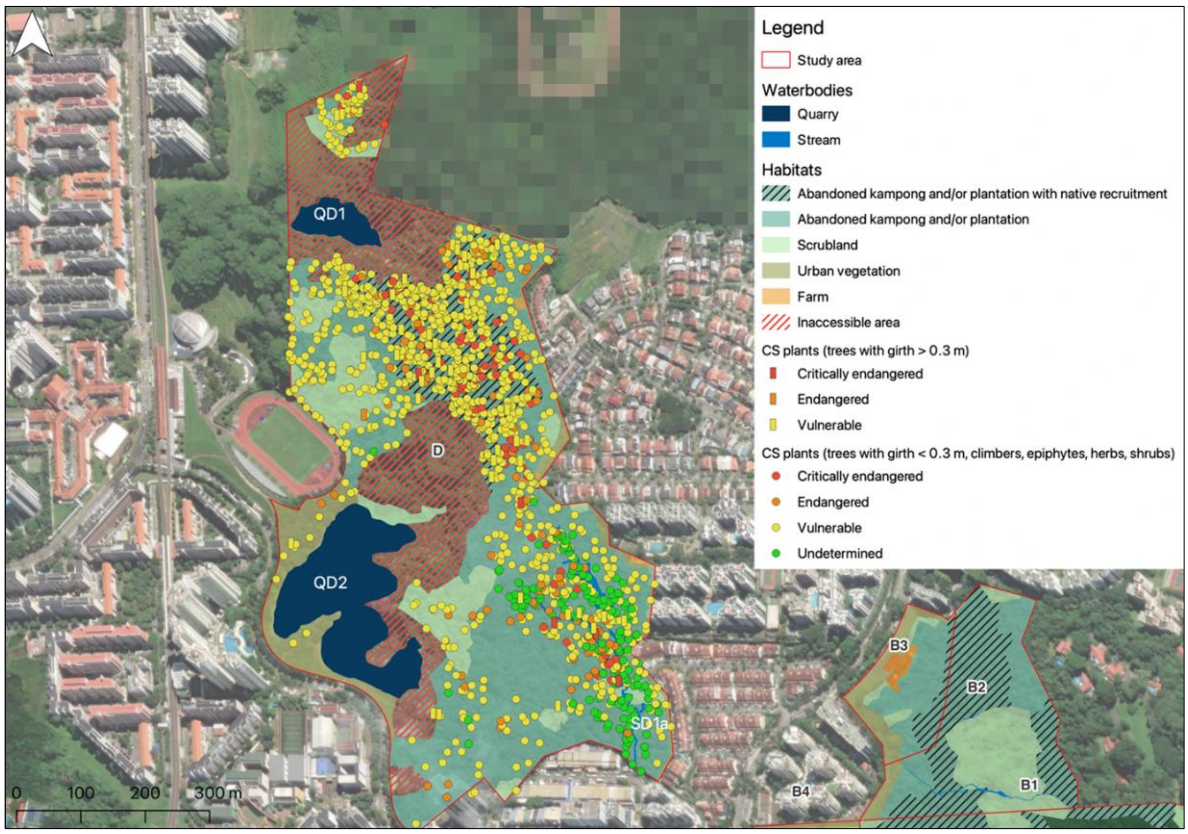


Figure 6-19: Locations of the Plants of Conservation Significance Recorded at Study Area D

Table 6-12: Breakdown of Plant Species of Conservation Significance in Study Area D

	VU	EN	CR	Undetermined	Total
Non-Cultivated Threatened Species	38	25	22	3	**88**
Cultivated Threatened Species	5	3	7	0	**15**

Note: VU – Vulnerable; EN – Endangered; CR– Critically Endangered. Undetermined species only includes *Schismatoglottis* sp.

Table 6-13: Number of Individuals/Clusters and Species of Plants of Conservation Significance in Study Area D

Habitat	Number of Individuals and Clusters					Number of Species				
	VU	EN	CR	UD	Total	VU	EN	CR	UD	Total
Abandoned-Land Forest	743	99	79	153	**1074**	37	13	17	1	**68**
Abandoned-Land Forest with Native Recruitment	658	53	78	1	**790**	21	13	10	1	**45**
Scrubland	118	4	1	11	**134**	15	4	1	1	**21**
Urban Vegetation	32	2	0	2	**36**	7	1	0	1	**9**

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; UD – Undetermined.

Table 6-14: Number of Large Plant Specimens in Study Area D

Habit	Species	No. of Specimens
Shrub (Bamboo)	*Bambusa heterostachya*	1
	Bambusa sp.	1
	Bambusa vulgaris	3
Tree	*Artocarpus elasticus*	1
	Artocarpus heterophyllus	1
	Durio zibethinus	6
	Falcataria moluccana	11
	Ficus variegata	5
	Hevea brasiliensis	2
	Peltophorum pterocarpum	1
	Pterocarpus indicus	1
	Spathodea campanulata	8
	Syzygium grande	1
	Terminalia catappa	1
Total		**43**

Table 6-15 : Number of Other Plant Specimens of Value in Study Area D

Habit	Species	No. of Specimens
Tree	*Ficus variegata*	205
	Falcataria moluccana	1
Strangler	*Ficus benjamina*	2
	Ficus microcarpa	1
Shrub (Bamboo)	*Bambusa heterostachya*	6
	Bambusa vulgaris	3
	Bambusa sp.	1
Total		**219**

In Study Area E (BBHNP), a total of 192 species and two (2) species group belonging to 79 families, were recorded. Almost two-thirds (126 species; 65.28%) of all recorded plant species from this Study Area are native, one-third (64 species, 33.16%) are exotic species, and the remaining three (3) species (1.55%) are of cryptogenic origin. The status for one (1) exotic species, *Calophyllum soulattri*, is undetermined. Of the 126 native species, 29 species and two (2) species groups, *Combretum* sp. and *Sticherus* cf. *truncatus* are of conservation significance (Figure 6-20; Table 6-16). Altogether, 338 specimens of conservation significance were recorded in Study Area E (Table 6-17). Five (5) species are considered as nationally Critically Endangered. Most of the specimens are contributed by *Melicope lunu-ankenda* and *Macaranga hulletii,* which were mostly recorded in the abandoned-land forest. Five (5) species are considered as nationally Endangered, of which, majority of the specimens are contributed by *Ficus apiocarpa*. Most of its specimens were recorded in the abandoned-land forest with native recruitment. Twenty (20) species are regarded as nationally Vulnerable, of which, majority of the specimens (144 specimens) were recorded in the abandoned-land forest with native recruitment. At least one-third of the specimens (33 specimens) are contributed by *Macaranga griffithiana*. In addition, fourteen (14) large plant specimens were recorded, including three (3) trees with girth sizes ranging from 3.0–3.2 m, one (1) *Ficus microcarpa* strangler with 3.0-m spread, 10 bamboo clusters with 3.0–8.0-m spread (Table 6-18). Notably, an

especially large specimen of the slow-growing native common tembusu (*Cyrtophyllum fragrans*) tree of 3.0-m girth was encountered in the abandoned-land forest with native recruitment in Study Area E. A total of 219 other plant specimens of value, were recorded in this Study Area. The 219 plant specimens of value includes 13 bamboo clusters, while the remaining specimens mainly comprise of three (3) fig species (*Ficus benjamina, F. microcarpa* and *F. variegata*) (Table 6-19).

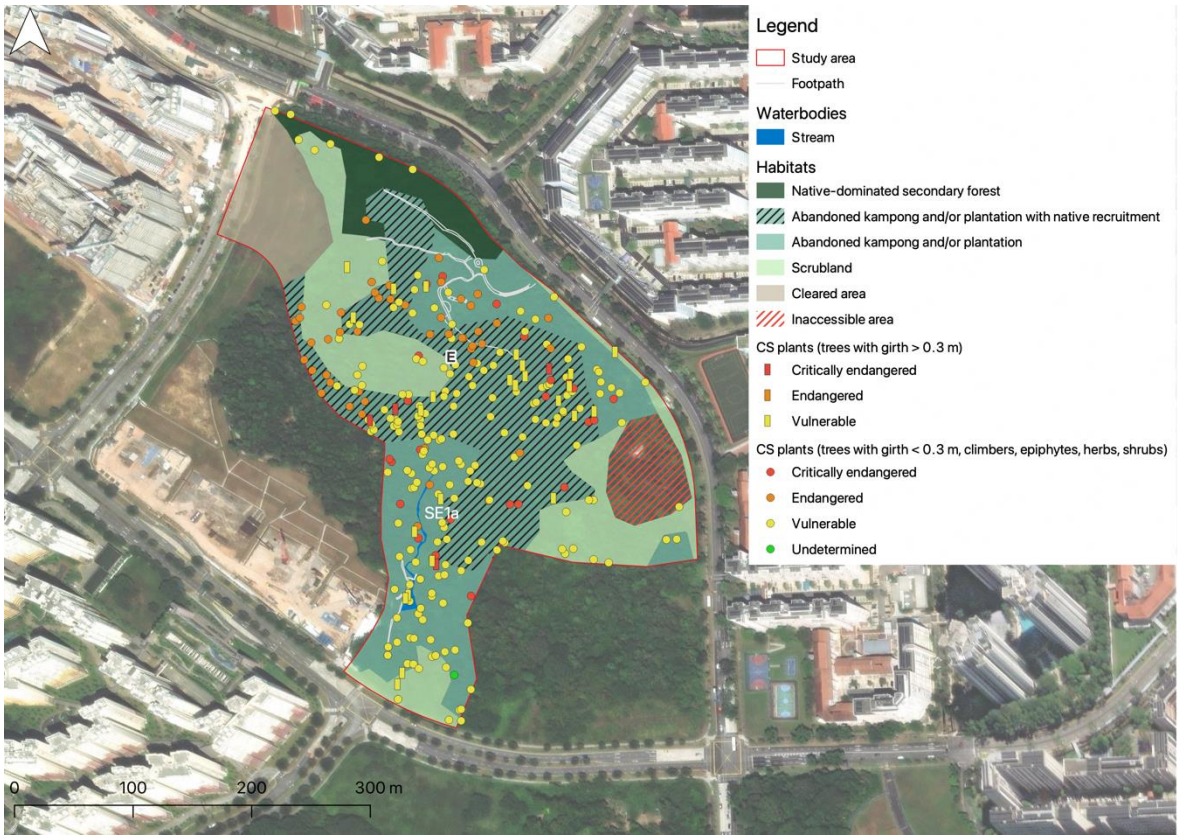


Figure 6-20: Locations of the Plants of Conservation Significance Recorded at BBHNP / Study Area E.

Table 6-16: Breakdown of Plant Species of Conservation Significance in Study Area E

	VU	EN	CR	Undetermined	Total
Non-Cultivated Threatened Species	20	5	5	**1**	**31**
Cultivated Threatened Species	1	0	4	**0**	**5**

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

Table 6-17: Number of Individuals/Clusters and Species of Plants of Conservation Significance in Study Area E

Habitat	Number of Individuals and Clusters					Number of Species				
	VU	EN	CR	UD	Total	VU	EN	CR	UD	Total
Abandoned-Land Forest with Native Recruitments	113	34	18	0	**165**	14	3	7	0	**24**
Abandoned-Land Forest	93	12	14	1	**120**	15	3	3	1	**21**
Native-dominated Secondary Forest	5	1	0	0	**6**	3	1	0	0	**4**
Scrubland	42	6	2	0	**50**	12	1	2	0	**15**

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; UD – Undetermined.

Table 6-18: Number of Large Plant Specimens in Study Area E

Habit	Species	No. of Specimens
Tree	*Acacia auriculiformis*	1
	Cyrtophyllum fragrans	1
	Hevea brasiliensis	1
Strangler	*Ficus microcarpa*	1
Shrub (Bamboo)	*Bambusa vulgaris*	10
Total		**14**

Table 6-19: Number of Other Plant Specimens of Value in Study Area E

Habit	Species	No. of Specimens
Tree	*Ficus variegata*	19
Shrub (Bamboo)	*Bambusa vulgaris*	15
Total		**34**

6.5.2 Fauna

Faunistic field surveys were carried out between 11 April 2022 and 6 December 2022 for the following taxa: (1) butterflies, (2) odonates (damselflies and dragonflies), (3) aculeate hymenopterans, (4) herpetofauna (amphibians and reptiles), (5) birds, (6) mammals (including bats), (7) freshwater fauna (fish, decapod crustaceans, and molluscs), and (8) spiders. Roadkill surveys were carried out along roads that have forest on both sides, including Bukit Batok West Avenue 2, Bukit Batok West Avenue 5, Lorong Sesuai, Upper Bukit Timah Road, Bukit Batok East Avenue 6, and Old Jurong Road. Each survey was conducted thrice with an interval of at least one (1) month between the survey cycles, unless otherwise stated. All observations of species of conservation significance from the aforementioned taxa were recorded if seen outside the stated survey times as incidental records. A checklist of all species of fauna observed from the surveys was compiled.

Table 6-20 summarises all the surveys that were carried out for fauna. Each survey was performed by at least two (2) surveyors. All fauna encountered was identified to species, or to the next lowest taxonomic level possible, and the location of each sighting was recorded using a handheld GPS (Garmin GPSMAP 64s). The number of individuals observed was also documented.

Table 6-20: Summary of Fauna Surveys

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

Survey Type	Taxon	Timing (h)	Duration	Sampling Unit*	Technique	Data Collected
	(bees and stinging wasps)		per transect; three cycles	transects along a sampling route	left, right, and front of surveyor	quantity, date, time
Aquatic point counts	Odonates (damselflies and dragonflies)	0900–1600	20 minutes per point with three surveyors; three cycles	Sampling points at waterbodies (at 50-m intervals for streams; one point along the edge of each quarry lake; one point along the edge of each pond)	Visual only; up to 25 m from sampling point or the extent of waterbodies, whichever is smaller	Location, species, quantity, date, time
	Herpetofauna (amphibians and reptiles)	0900–1600; 2000–2300	20 minutes per point with three surveyors; three cycles	Sampling points at waterbodies (at 50-m intervals for streams; one point along the edge of each quarry lake; one point along the edge of each pond)	Visual and auditory; up to 25 m from sampling point or the extent of waterbodies, whichever is smaller	Location, species, quantity, date, time
	Aquatic fauna (fish, decapod crustaceans, and molluscs)	0900–1600; 2000–2300	20 minutes per point with three surveyors; three cycles	Sampling points at waterbodies (at 50-m intervals for streams; one point along the edge of each quarry lake; one point along the edge of each pond)	Visual only; up to 25 m from sampling point or the extent of waterbodies, whichever is smaller	Location, species, quantity, date, time
Diurnal and nocturnal transect surveys	Herpetofauna (amphibians and reptiles)	0700–1000; 2000–2300	20–30 minutes per transect; three cycles	200-m continuous transects along a sampling route	Visual and auditory; up to 50 m left, right, and front of surveyor	Location, species, quantity, date, time
	Birds	0700–1000; 2000–2300	20–30 minutes per transect; three cycles	200-m continuous transects along a sampling route	Visual and auditory; up to 50 m left, right, and front of surveyor	Location, species, quantity, date, time
	Mammals (non-volant)	0700–1000; 2000–2300	20–30 minutes per transect;	200-m continuous transects along a	Visual and auditory; up to 50 m left, right, and	Location, species,

Survey Type	Taxon	Timing (h)	Duration	Sampling Unit*	Technique	Data Collected
			three cycles	sampling route	front of surveyor	quantity, date, time
Camera trapping	Mammals (non-volant)	24 h a day; 12 h a day (1900–0700 h) for road camera traps (for connectivity study)	60 days per camera trap	24-h continuous period of recording on a camera trap; 12-h continuous period of recording on a road camera trap (for connectivity study)	Infrared motion sensing	Location, species, quantity, date, time
Bioacoustic surveys (handheld bat detector)	Mammals (bats)	2000–2300	20–30 minutes per transect; three cycles	200-m continuous transects along a sampling route	Auditory only	Location, species, date, time
Bioacoustic surveys (unattended stationary bat detector)	Mammals (bats)	30 min before sunset to 30 min before sunrise	Three consecutive nights	30-min continuous period of recording on a bat detector	Auditory only	Location, species, date, time
Roost emergence surveys	Mammals (bamboo bats only)	1830–2100	Once per bamboo cluster	Bamboo clusters (if any)	Visual and auditory	Presence/ absence of bamboo bats, number of active roosts, number of bats, location, date, time
Push and scoop netting	Aquatic fauna (fish, decapod crustaceans, and molluscs)	0900–1600	20 minutes per netting event with two surveyors; three cycles	Sampling points at waterbodies (at 50-m intervals along the lengths or perimeters for streams and ponds, respectively)	–	Location, species, quantity, date, time
Minnow trapping	Aquatic fauna (fish and decapod crustaceans)	Overnight	One day one night; once per location	Traps inside waterbodies (at 50-m intervals along the lengths or perimeters for streams and ponds, respectively and where feasible; at	Baited	Location, species, quantity, date, time

Survey Type	Taxon	Timing (h)	Duration	Sampling Unit*	Technique	Data Collected
				100-m intervals within quarry lakes)		
Visual point count	Spider	2000–2300	10 minutes per point; once per location	Terrestrial sampling points at suitable forested locations	Visual only; up to 25 m from the sampling point	Location, species, quantity, date, time
Leaf litter sifting	Spider	0900–1200	20–30 minutes per quadrat; once per quadrat	50 x 50 cm quadrat at suitable forested locations	–	Location, species, quantity, date, time
Umbrella beating	Spider	0900–1200	20–30 minutes per location; once per location	20 "shakes" at each location	–	Location, species, quantity, date, time
***A sampling unit is the building block of the dataset that was used for statistical analyses. For transect surveys, one sampling unit is defined as a 200-m long transect. Hence, a sampling route may consist of several 200 m transects.**						

Aculeate Hymenopterans

Diurnal transect surveys were carried out for aculeate hymenopterans along 200-m continuous transects on a sampling route between 0900h and 1600h. Aculeate hymenopterans were identified visually (with binoculars where necessary), photographed, or caught using insect nets, if required. Captured individuals were released immediately after identification. When identification in the field was not possible, live specimens were collected and examined *post-hoc* under a microscope. The specimens were identified to the lowest taxonomic level using relevant references, identification keys, or in consultation with taxonomic experts.

Odonates

Diurnal transect surveys were carried out for adult damselflies and dragonflies along 200-m continuous transects on a sampling route between 0900h and 1600h. Twenty-minute point counts with two surveyors were also conducted at aquatic sampling points during the same survey window. Each point count was carried out along a 10-m transect, where possible, considering limitations imposed by steep terrain and/or dense vegetation. Owing to difficulties in sampling and identification, aquatic larvae and exuviae were not surveyed. Adult odonates were identified visually (with binoculars where necessary), photographed, or caught using insect nets, if required. Captured individuals were released immediately after identification.

Butterflies

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

Freshwater Fauna (Fishes, Decapod Crustaceans, and Molluscs)

Diurnal and nocturnal twenty-minute point counts with three surveyors were be conducted at aquatic sampling points in the streams, ponds, and quarry lakes between 0900h and 1600h, and 2000h and 2300h. Each point count was carried out along a 10-m transect, where possible, considering limitations imposed by steep terrain and/or dense vegetation. Torches and/or headlamps were used to elicit eyeshine during nocturnal surveys.

Push and/or scoop netting was carried out for freshwater fish, decapod crustaceans, and molluscs at sampling points inside waterbodies during the day. Push netting was carried out, usually in deeper waters, using a rigid-frame tray net (61 × 49 cm; 5-mm mesh) to catch specimens on the banks or the streambed. Scoop netting was carried out, usually in shallower waters, using hand nets (net size 25 × 18 cm; 2-mm mesh) to catch specimens within the stream column. Captured individuals were released immediately after identification.

Minnow traps baited with halal meat (e.g., sausage or liver) was deployed at 50-m intervals within the streams, ponds, and quarry lakes, where feasible (e.g., sufficient water depth). The traps were left overnight, then checked and removed the following morning. All caught individuals were released immediately upon identification.

Minnow traps within the quarry lakes were deployed via boat approximately 100 m apart along the quarry edges. The total numbers of traps deployed for the respective quarries are summarized below:

- Poh Kim Quarry (Study Area B1) – 6;
- Little Guilin Quarry (Study Area D) – 11; and
- Seng Chew Quarry (Study Area D) – 4

The traps within the quarry lakes were deployed at depths between 3 m and 10 m and anchored to the quarry bed. They were not visible on the water surface to avoid interfering with the foraging activities of piscivorous birds (e.g., grey-headed fish eagle [*Icthyophaga ichthyaetus*]). The traps were tethered individually by ropes to vegetation along the quarry edges. Polyethylene ropes that are at least 5 mm in diameter were used to reduce the risk of entanglement with foraging birds.

The traps within the quarry lakes were deployed between 1000 h and 1600 h, within operating hours allowed by NParks and were collected the following day between 1000 h and 1200 h. These hours were also outside of the active feeding hours of the grey-headed fish eagles, which tend to be more active in the early morning (0700 h – 1000 h) and late afternoon (1600 h – 1900 h).

The traps were deployed once at each location. All fauna caught were released immediately upon identification. Fauna sighted near the surface of the water during boat commutes were recorded as incidental sightings.

Camphora utilised the Kairos Whaly 270 fitted with a silent electric propellor or manual propellor for the deployment of fish traps within the quarry lakes.

The boat was transported to the launching points (or as close as possible) by a vehicle. The boat was carried down to the water manually for launching. The boat was removed from the site after each session.

The activity of the grey-headed fish eagles was noted during terrestrial and aquatic surveys at/around Little Guilin Quarry throughout the field study period to observe if there were any changes to their behaviour that may be attributed to the above fish trapping method.

Herpetofauna (Amphibians and Reptiles)

Diurnal (0700h–1000h) and nocturnal (2000h–2300h) surveys were carried out for amphibians and reptiles along 200-m continuous transects on a sampling route. Twenty-minute point counts were also conducted at aquatic sampling points during the same survey window. Each point count was carried out along a 10-m transect, where possible, considering limitations imposed by steep terrain and/or dense vegetation. As herpetofauna occupy a wide range of habitat types, both the diurnal and nocturnal surveys also involved active searches for individuals on the ground, below rocks, logs, leaf litter and debris, in the water, and/or on vegetation. Rocks, logs, and other structures were returned to their original positions if moved during the searches. Torches and/or headlamps were used to elicit eyeshine during nocturnal surveys. Vocalising fauna were also located or identified by call recognition, whenever possible. For species that are capable of quick retreats and escapes, the individuals were captured by hand, or using hooks, tongs, or dip nets for identification. Captured individuals were released immediately after identification.

Birds

Diurnal (0700h–1000h) and nocturnal (2000h–2300h) surveys were carried out for birds along 200-m continuous transects on a sampling route. Birds were identified visually (with binoculars where necessary) and photographed. Torches and/or headlamps were used to elicit eyeshine during nocturnal surveys. Vocalising birds were also located or identified by call recognition, whenever possible. At least three cycles of the diurnal surveys were conducted between September and December 2023, which was during the peak migratory bird season in Singapore (September to February).

Mammals (Non-Volant)

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

Mammals were also surveyed via camera trapping. 160 terrestrial camera traps were deployed within the main Study Areas. The data collection for 152 of these camera traps were completed as of 31 October 2022. Data collection for eight (8) of the camera traps was still ongoing and the findings were not included in this report. Camera traps were approximately evenly distributed across the Study Areas, with the exception of areas with unfavourable terrain and excessively dense undergrowth. The minimum distance between camera traps was approximately 50 m. The number of camera traps deployed in each Study Area is shown in Table 6-21.

Each terrestrial camera trap was set up approximately 20–100 cm above ground. They were in operation 24 h a day and were programmed to record one 10-s footage per motion trigger with a 10-s quiet period following each trigger. Each camera trap was deployed for a minimum of 60 days.

Table 6-21: Number of Camera Traps deployed in Each Study Area

Study Area	Number of Camera Traps
A1	5
A2	12
B1	44
B2	9

Study Area	Number of Camera Traps
B3	4
B4	5
C1	6
C2	2
D	37
E	17
F	19
Total	**160**

To study the connectivity between the forest patches within the Study Area and surrounding landscape (i.e., towards Tengah and Bukit Timah Nature Reserve [BTNR]), additional camera traps were deployed to identify (1) existing connectivity structures (e.g., culverts, canopy linkages), and (2) gaps and potential crossings. 28 terrestrial or arboreal units of camera traps were deployed for this connectivity study (Table 6-22).

To determine if existing culverts are currently used by non-volant mammals, camera traps were deployed targeting suitable culverts. Each camera trap was secured onto trees or drain guardrails. They operated 24 h a day and were programmed to record one 10-second footage per motion trigger with a 10-s quiet period following each trigger. Each camera trap was deployed for at least 60 days.

To determine if existing canopy linkages are currently used by non-volant mammals, arboreal camera traps were deployed targeting suitable canopy linkages across roads with forest on both sides. Arboreal camera traps were mounted via a lorry crane or a certified climber. They operated 24 h a day and were programmed to record one 10-s footage per motion trigger with a 10-s quiet period following each trigger. Each camera trap was deployed for at least 60 days.

To determine if non-volant mammals are currently crossing roads to move between forest patches, camera traps were deployed along roads at strategic locations. Each camera trap was set up approximately 20–100 cm above ground on trees where possible. They operated 12 h a day (1900–0700 h) to minimise false triggers due to traffic, and were programmed to record one 10-s footage per motion trigger with a 2-min quiet period following each trigger. Each camera trap was deployed for at least 60 days.

Table 6-22: Number of Camera Traps Deployed for Connectivity Study

Type	Number of Camera Traps
Culvert	5
Arboreal	7
Road	16
Total	**28**

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 (1) or a group of individuals of the same faunal species occurring within 60 minutes at each camera trap.

Mammals (Bats)

Bioacoustic surveys were carried out for bats along 200-m continuous transects on a sampling route between 2000h and 2300h. The Song Meter Mini Bat (Wildlife Acoustics, Inc.) was used to record ultrasonic calls between 18 and 192 kHz at a sampling frequency of 384 kHz.

One (1) unattended stationary bat detector (Song Meter Mini Bat; Wildlife Acoustics, Inc.) was deployed at the edge of each quarry lake to obtain a more accurate representation of the bat community using the Study Area, particularly the quarry lakes. They were deployed as close to the water edge as possible and away from flat surfaces as well as cluttered vegetation to reduce acoustic echoes (Britzke et al., 2013). They were set to record from 30 min before sunset to 30 min before sunrise. Each recorder was deployed for three (3) consecutive nights.

Roost emergence surveys were also carried out between 1830h and 2100h for bamboo bats (*Tylonycteris* spp.), specifically, at bamboo clusters. Bamboo bats were identified visually and photographed, and calls were recorded using the Song Meter Mini Bat (Wildlife Acoustics, Inc.). Bamboo slits that are actively used for entry and exit, as well as the number of bats residing within each internode were recorded.

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 kHz, duration of 2–500 ms, maximum inter-syllable gap of 500 ms and a minimum of two (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 Pottie et al. (2005), which provides echolocation signatures for bats in Singapore, and other relevant references (Collen, 2012; Hughes et al., 2011).

Spiders

The following survey methods were carried out: (1) Visual point count survey, (2) leaf litter sifting, and (3) umbrella beating.

Nocturnal (2000–2300h) 10-min visual point count surveys were carried out at suitable forested locations. Torches and/or headlamps were used to elicit eyeshine during nocturnal surveys.

Diurnal (0900–1200h) leaf litter sifting was carried out for spiders at forested locations deemed suitable for this method. At each location, one heap of leaf litter within a 50 x 50-cm quadrat was sifted on-site. The leaf litter was returned to the quadrat after sifting.

Diurnal (0900–1200h) umbrella beating was carried out at locations deemed suitable for this method. An inverted umbrella was held beneath vegetation within reach at each location and 20 "shakes" of the vegetation was executed. Spiders that fell onto the umbrella were identified or collected.

Spiders were identified visually or photographed. When identification in the field was not possible, live specimens were collected and examined *post-hoc* under a microscope before being deposited at the Lee Kong Chian Natural History Museum. The specimens were identified to the lowest taxonomic level using relevant references, identification keys, or in consultation with taxonomic experts.

Roadkills

Roadkill surveys were carried out along roads that have forest on both sides, including Bukit Batok West Avenue 2, Bukit Batok West Avenue 5, Lorong Sesuai, Upper Bukit Timah Road, Bukit Batok

East Avenue 6, and Old Jurong Road. The surveys were conducted in the day between 0700h and 1000h. Carcasses seen outside of the stated survey window were recorded as incidental sightings. Carcasses were identified visually and photographed.

6.5.2.1 Fauna Key Findings

The field assessment documented 592 species, dominated by spiders (180 species), birds (115 species), and butterflies (90 species). Of all the species recorded, 29 were of conservation significance. (Figure 6-21). While not captured in this study, 70 other species of conservation significance were considered probable (Appendices 4–6), based on recent locality records within and around the Study Area, existing habitat types and dispersal abilities of the various species.

At Study Areas B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2, the highest number of species across BBNC was recorded with of a total of 466 species. Of the recorded species, 23 were species of conservation significance. Most notably, the highest number of aculeate hymenopterans (57 species) and butterflies (67 species) were found here, including the nationally Vulnerable bee, *Amegilla insularis*, nationally Vulnerable chocolate sailor (*Neptis harita harita*), and moderately rare butterflies: orange awlet (*Bibasis harissa consobrina*), *Semanga superba deliciosa*, bamboo tree brown (*Lethe europa malaya*), and blue nawab (*Polyura Schreiber tisamenus*). Most of the Sunda colugos (*Galeopterus variegatus*) recorded were also from this area. The globally and nationally Vulnerable Asian softshell turtle (*Amyda cartilaginea*) was at the upstream section of Stream B1a. Other species that were only recorded in this area during the field assessment include the nationally Near Threatened red-necked bronzeback (*Dendrelaphis kopsteini*), and the nationally Endangered Asian red-eyed bulbul (*Pycnonotus brunneus*) and white-rumped shama (*Copsychus malabaricus*). Poh Kim Quarry QB in Study Area B1 mainly contained non-native freshwater aquatic fauna, although uncommon odonates such as the scarlet adjudant (*Aethriamanta brevipennis*), bronze flutterer (*Rhyothemis obsolescens*), and sapphire flutterer (*Rhyothemis triangularis*) were also recorded there. Two (2) unidentified flying squirrels were recorded in Study Area B1.

At Study Area D, a total of 372 species were recorded, with 18 species of conservation significance. Most notably, Little Guilin and its surrounding forest is home to a family of nationally Vulnerable Grey-headed fish eagles (*Icthyophaga ichthyaetus*). Like Poh Kim Quarry QB, Little Guilin Quarry QD2 and Seng Chew Quarry QD1 mainly contained non-native freshwater aquatic fauna. The nationally vulnerable cream-vented bulbul (*Pycnonotus simplex*), moderately rare paintbrush swift (*Baoris oceia*) and detached dart (*Potanthus trachala tytleri*), and the rare maritime gecko (*Lepidodactylus lugubris*) were only recorded in Study Area D during the field assessment. Furthermore, the camera trap study captured the elusive and rare visitor, the Malayan night heron (G*orsachius melanolophus*). While not captured in this study, the nationally Critically Endangered leopard cat (*Prionailurus bengalensis*) was also previously recorded here (O'Dempsey, pers. comm., 2022).

At Study Area E, a total of 211 species were recorded. Of these, only six (6) species were of conservation significance: the globally Critically Endangered and nationally Endangered straw-headed bulbul (*Pycnonotus zeylanicus*), globally Vulnerable long-tailed parakeet (P*sittacula longicauda*), nationally Vulnerable Swinhoe's white-eye (*Zosterops simplex*), globally Endangered long-tailed macaque (*Macaca fascicularis*), and nationally Vulnerable bamboo bat (*Tylonycteris* sp.). The lower species richness here might be attributed to the disturbance from the adjacent ongoing construction works. Nonetheless, along its natural Stream E1a, the nationally Near Threatened Malesian frog (*Limnonectes malesianus*) and common forest dragonfly species, treehugger (*Tyriobapta torrida*), were recorded only in Study Area E during the field assessment although suitable habitats for these species are available in the other Study Areas as well.

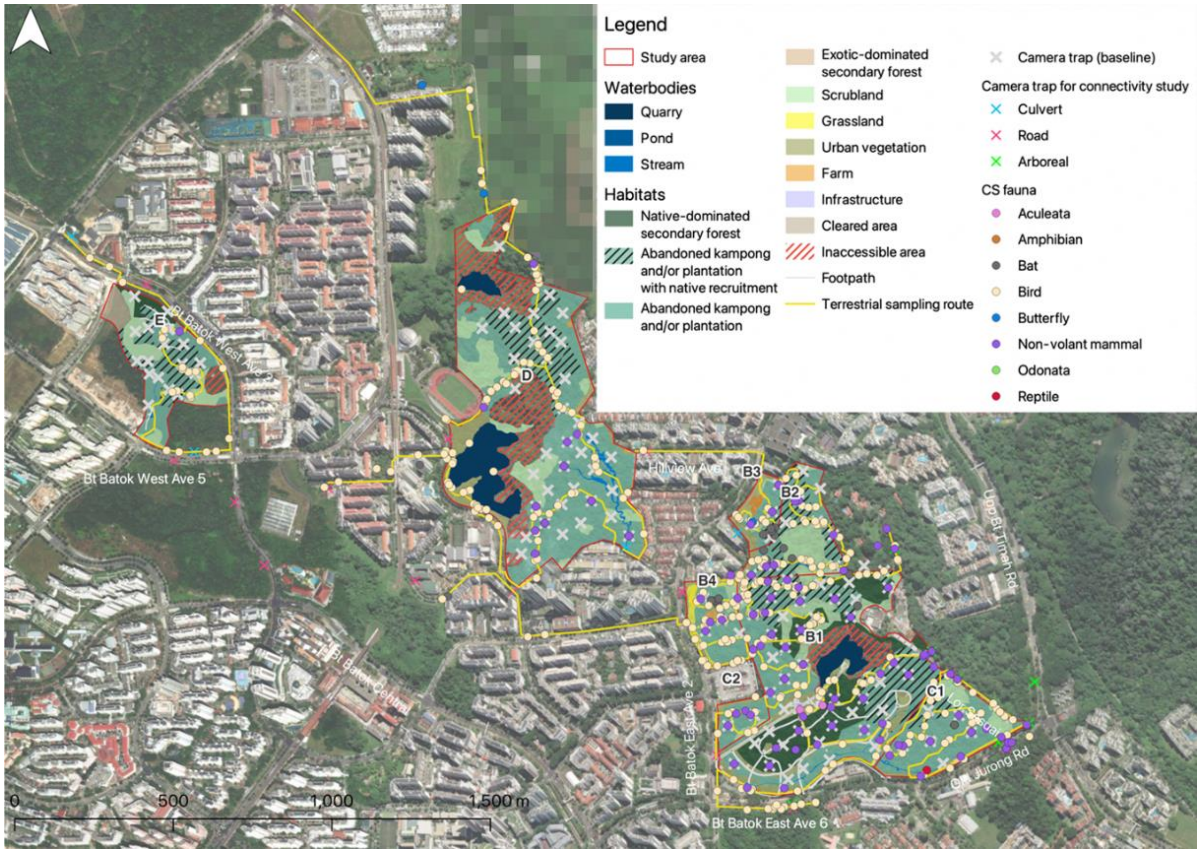


Figure 6-21: Locations of the Fauna Species of Conservation Significance Recorded at BBNP, BBTP and BBHNP

Table 6-23: Summary of Number of Recorded Faunal Species at Each Study Area

Faunal group	No. of recorded species (all species)		
	B1 (West of Lorong Sesuai), B2, B3, B4, C1 and C2	D	E
Aculeate hymenopterans	57	40	31
Bees	24	16	20
Wasps	33	24	11
Odonates	28	26	13
Dragonflies	24	22	12
Damselflies	4	4	1
Butterflies	68	56	27
Freshwater decapod crustaceans	5	7	0
Freshwater fish	14	15	4
Freshwater molluscs	4	4	0
Herpetofauna	32	23	16
Amphibians	10	9	8
Reptiles	22	14	8
Birds	90	95	52

Faunal group	No. of recorded species (all species)		
	B1 (West of Lorong Sesuai), B2, B3, B4, C1 and C2	D	E
Mammals	24	23	14
Non-volant	15	13	10
Bats	9	10	4
Spiders	144	83	54
Total	**466**	**372**	**211**
Area (ha)	**54.1**	**41.6**	**9.5**
No. of species/ha	**8.6**	**8.9**	**22.2**

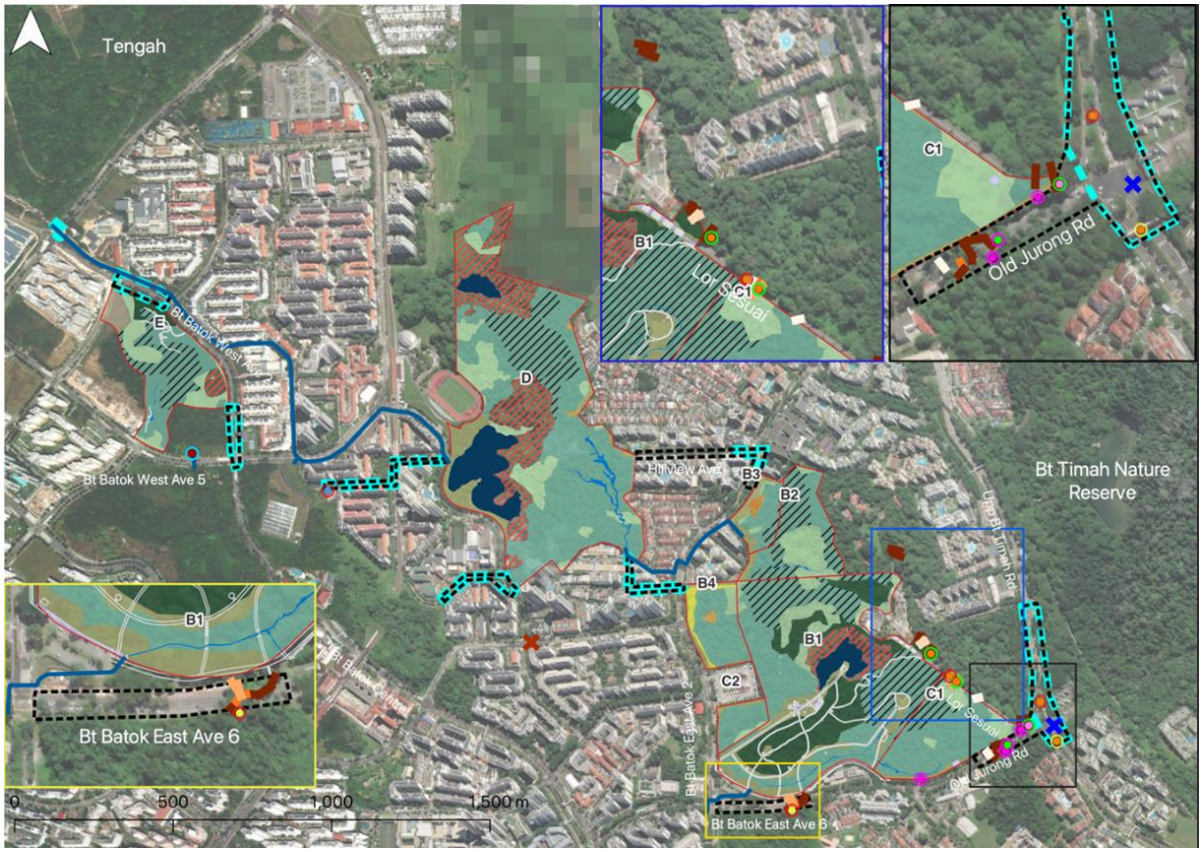
Table 6-24: Summary of Number of Recorded Faunal Species of Conservation Significance at Each Study Area

Faunal group	No. of recorded CS species		
	B1 (West of Lorong Sesuai), B2, B3, B4, C1 and C2	D	E
Aculeate hymenopterans	1	0	0
Bees	1	0	0
Wasps	0	0	0
Odonates	0	0	0
Dragonflies	0	0	0
Damselflies	0	0	0
Butterflies	1	2	0
Freshwater decapod crustaceans	NA	NA	NA
Freshwater fish	0	0	0
Freshwater molluscs	0	0	0
Herpetofauna	1	0	0
Amphibians	0	0	0
Reptiles	1	0	0
Birds	13	9	4
Mammals	6	6	2
Non-volant	4	4	1
Bats	2	2	1
Spiders	0	0	0
Total	**22**	**17**	**6**

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

The connectivity study found that the only road where ground-dwelling and arboreal mammals can cross relatively safely is Lorong Sesuai as it is a narrow road that has several canopy linkages and low traffic. Along Old Jurong Road and Bukit Batok East Avenue 6, canopy linkages exist, although

they may be subject to regular pruning along these major roads. Gliding mammals such as the Sunda colugo can utilise the tall and straight trunks of the *Khaya senegalensis* specimens lining these roads to move between BBNP and Toh Tuck Forest/forest across Study Area C1, although the connectivity across Bukit Batok East Avenue 6 has been hindered by forest clearance for road widening works. The mature trees lining Upper Bukit Timah Road may also be utilised by gliding mammals to move between Study Areas A1 and A2. Across BBNC, there are currently gaps in connectivity for arboreal mammals along Upper Bukit Timah Road, Hillview Avenue, Hillview Terrace, Bukit Batok Street 51, Bukit Batok Street 52, Bukit Batok West Avenue 2, and Bukit Batok West Avenue 5 (Figure 6-22). For ground-dwelling mammals, the aforementioned roads as well as Old Jurong Road and Bukit Batok East Avenue 6 are gaps in terrestrial connectivity (Figure 6-22). For gliding mammals, Hillview Avenue currently lacks mature trees that can serve as launching and landing points (Figure 6-22). The connectivity for gliding mammals across Bukit Batok East Avenue 6 is also recommended to be restored. Additional linkages in the form of grade-separated crossings (i.e., wildlife bridges, underpasses, canopy crossings) are recommended to be established to enhance the arboreal and terrestrial connectivity across BBNC (Figure 6-23) subject to detailed planning.



Legend

- Study area

Waterbodies
- Quarry
- Pond
- Stream

Habitats
- Native-dominated secondary forest
- Abandoned kampong and/or plantation with native recruitment
- Abandoned kampong and/or plantation
- Exotic-dominated secondary forest
- Scrubland
- Grassland
- Urban vegetation
- Farm
- Infrastructure
- Cleared area
- Inaccessible area

Mammal crossing
- Callosciurus notatus
- Canis lupus familiaris
- Galeopterus variegatus
- Macaca fascicularis
- Manis javanica
- Paradoxurus musangus
- Rattus tiomanicus
- Sus scrofa

Mammal crossing type
- Arboreal
- Culvert
- Glide
- Road
- Pedestrian overhead bridge

Roadkill
- Callosciurus notatus
- Unidentified Muridae

Existing linkages

Canopy linkage
- gap 0 m
- gap 0.1-0.9 m
- gap 1.0-1.4 m
- gap 1.5-1.9 m
- gap 2 m
- Culvert linkage

Gaps in connectivity
- Arboreal
- Terrestrial

Figure 6-22: Existing Ecological Linkages and Gaps across BBNC

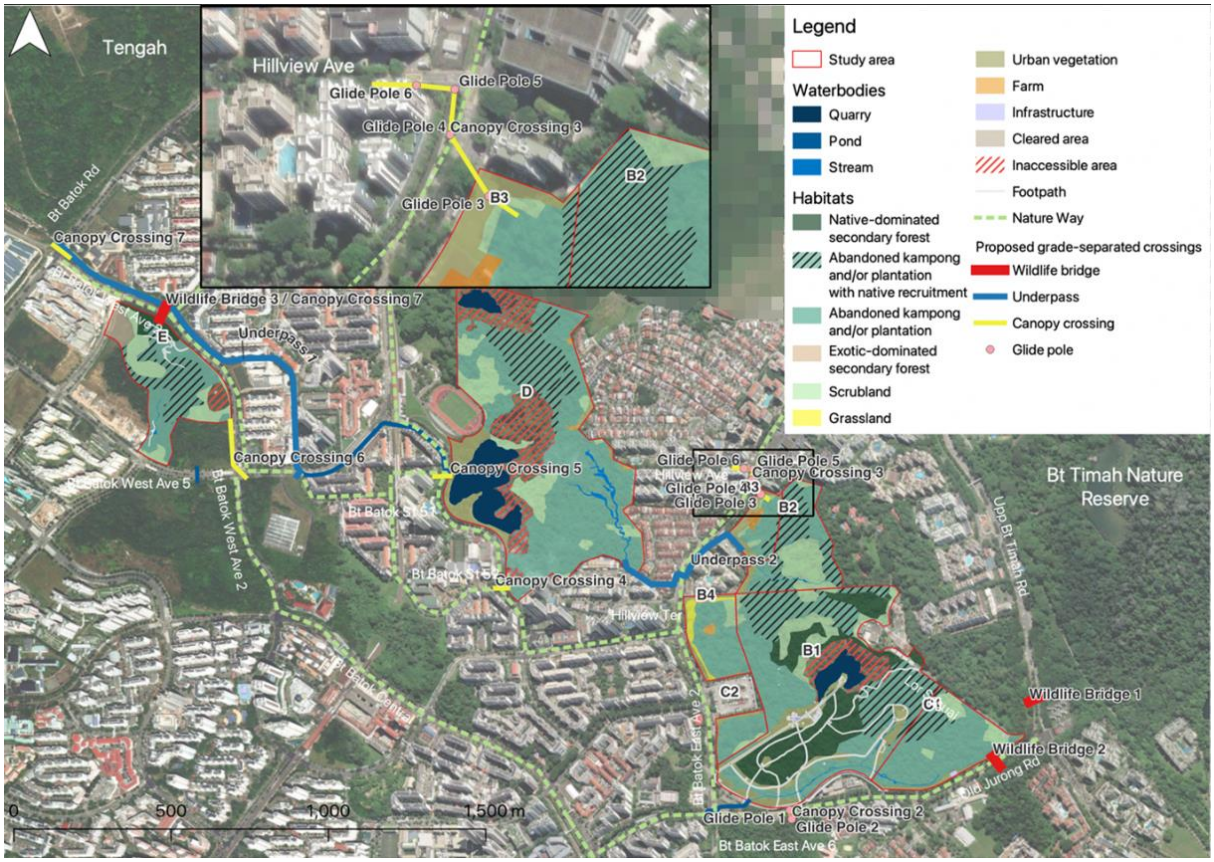


Figure 6-23: Proposed Ecological Linkages in Various Forms of Proposed Grade-separated Crossings (subject to detailed planning) across BBNC

6.5.3 Areas of High Conservation Value

Based on the findings of the biodiversity baseline study, areas of high conservation value were identified (Figure 6-24).

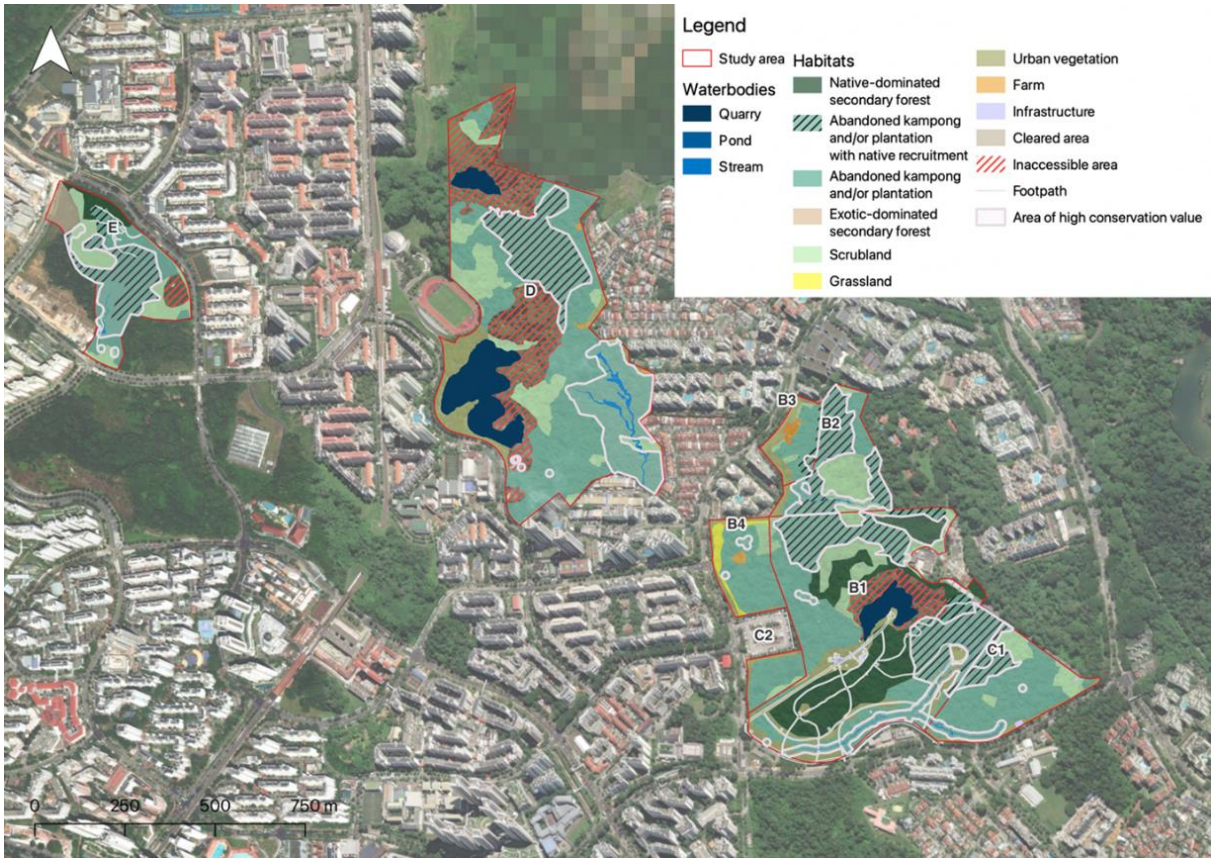


Figure 6-24: Areas of High Conservation Value at BBNP, BBTP and BBHNP

7. IDENTIFICATION OF IMPACTS

7.1 Overview of Scoping Study

The Project is to be developed as a 'Design and Build Scheme', which includes upgrading of the existing BBNP and BBTP, development of the currently disused BBHNP, car parks, trails, elevated boardwalks, viewing decks, walkways, stream enhancement works at BBNP, BBTP and BBHNP, etc. The development of the Project is based on the actual design and corresponding construction method will be developed by the Main Contractor to whom the Contract will be awarded.

A summary of the anticipated key developments at the respective study areas, namely BBNP, BBTP and BBHNP are summarized under table below:

Table 7-1: Summary of Key Developments at Respective Study Areas

S/N	Key Developments	BBNP	BBTP	BBHNP
1	Demolition of Existing Structures (Minor & Moderate Scale)	√	√	√
2	BBNP Plaza & Play Area / BBTP Courtyard Arrival Node/ BBHNP Arrival Node Construction	√	√	√
3	Boardwalks and Viewing Decks Construction	√	√	√
4	Trail Refurbishment or Construction	√	√	√
5	Stream / Water Body Enhancement	√		√
6	Driveways and Car Park Construction	√		

7.2 Scoping Methodology

7.2.1 Sources of Information

The design architects, LAUD and landscape architects, HL provided information on the construction process through various documents and dialogue, as summarised below:

- Kick off Meeting Presentation;
- Bi-Weekly Progress Meeting Presentation; and
- Various stakeholder meetings and discussions.

NParks provided information on BBNP, BBTP and BBHNP through various documents and dialogue, as summarised below:

- History, biodiversity and operational information of BBNP, BBTP and BBHNP; and
- Various stakeholder meetings and discussions.

7.2.2 Assessment of Potential Construction Methodologies

The typical construction methodologies employed in the Singapore context are assessed in this section, as well as other feasible alternative methodologies. The construction methodologies are assessed taking into consideration the following factors:

- Site Constraints
  - Undulating and steep topography for construction access;

  - Minimising impacts of existing trees and streams during construction and restoration works; and
  - Existing soil conditions and capacity of method.
- Environmental Impacts
  - Noise;
  - Air (dust) pollution;
  - Water management;
  - Soil and sediment;
  - Chemical usage and management; and
  - Biodiversity.
- Cost
- Speed and scheduling of works

7.3 Identification of Impacts Associated with Construction Activities

7.3.1 Overview of Construction Activities

The proposed timeline of the project development is provided in Figure 2-3. Construction activities anticipated during the development for the respective study area, which is subject to change by the appointed Contractor is as follows:

Table 7-2: Summary of Proposed Construction Activities at Respective Study Areas

S/N	Proposed Construction Activities	BBNP	BBTP	BBHNP
1	**Stage 1 – Preliminary Works**			
1.1	Site Clearance / Tree Removal • Tree removal / vegetation clearance	√	√	√
1.2	Site Preparation • Mobilization of construction machineries, equipment and vehicle; • Construction of work access; • Erection of hoarding and site entrance; • Erection of construction site signage; • Erection of temporary site office, toilets, material and equipment storage areas, workshops, waste management facilities, etc.; • Installation of sanitary facilities, utilities, wash-bays; and • Earth control measures ("ECM")	√	√	√
2	**Stage 2 – Construction Works of Proposed Development**			
2.1	Demolition of existing structures			
2.1.1	• Demolition of existing structures (minor scale) using handheld equipment (jack hammers and welding or cutting equipment)	√	√	√
2.1.2	• Demolition of existing structures (moderate scale) (e.g., GFRC) using excavator mounted with hydraulic breaker			√
2.2	BBNP Plaza & Play Area/ BBTP Courtyard / BBHNP Arrival Node Construction			
2.2.1	*Excavation* • Shallow excavation by machinery such as excavator or manual excavation	√	√	√
2.2.2	• Deep excavation for sewer line connections	√	√	√
2.2.3	Slope Forming / Stabilisation • Cut and fill for slope forming (land cutting, back-filling and compactions) • Slope stabilization via micro piling and soil nailing		√	√
2.2.4	Substructure • Installation of foundation slabs	√	√	√

S/N	Proposed Construction Activities	BBNP	BBTP	BBHNP
2.2.5	Superstructures • Construction of superstructure (columns, beams, slabs & roofing)	√	√	√
2.3	Boardwalks and Viewing Decks Construction			
2.3.1	Excavation • Shallow excavation by machinery such as excavator or manual excavation	√	√	√
2.3.2	Substructure • Installation of reinforced concrete (RC) footings for boardwalk and viewing decks	√	√	√
2.3.3	*Superstructures* • Construction of boardwalk decks	√	√	√
2.4	Trail Refurbishment and Construction			
2.4.1	Excavation • Shallow excavation by machinery such as excavator or manual excavation	√	√	√
2.4.2	Slope Forming / Stabilisation • Cut and fill for slope forming (land cutting, back-filling and compactions) • Slope stabilization via micro piling and soil nailing	√		
2.4.3	Tread construction, trail curing/hardening/surfacing/mulching	√	√	√
2.5	Stream / Water Body Enhancement			
2.5.1	Minor excavation with edge treatment	√		√
2.6	Driveways and Car Park Construction			
2.6.1	Shallow excavation by machinery such as excavator or manual excavation, asphalt laying, compaction and finishing	√		
3	**Stage 3 - Finishing Works**			
3.1	• Surface Water Drainage; • Landscaping Works; • Architectural works, including wet and dry works; and • M&E works, including underground and aboveground servicing works, wiring works, etc.	√	√	√
4	**All Stages (Stage 1, 2 and 3)**			
4.1	• Movement and operation of machinery and equipment on the site; • Movement of construction vehicles on public roads to and from site; • Generation of spoil, construction waste (including toxic waste) and debris, and removal off-site; • Generation of office and food waste; • Storage and of construction chemicals, fuels, oils, etc.; and • Treatment and discharge of wastewater / runoff	√	√	√

The set of equipment listed below are typical of the machinery/equipment to be used during the construction phase [the actual list is dependent on the construction methodology adopted by the Contractor]:

- Crawler, mobile or lorry cranes for lifting works;
- Lorry cranes for tree pruning or cutting works;
- Vibratory piling rig for sheet piling;
- Excavators mounted with hydraulic breaker;
- Drilling machines;
- Piling machines (jack-in pile, bore pile or micro pile);
- Excavators, graders, rollers and trucks for construction of foundation and land preparation;
- Road Paving and Compactor;

- Soil nail launchers;
- Concrete Pump for the in-situ portions; and
- Generator Sets for temporary power.

7.3.2 Scoping of Potential Impacts Associated with Construction Activities

A scoping process was conducted to identify the potential environmental impacts associated with the construction activities, to be assessed in the EIA. The Scoping Matrices provided in Table 7-3 (Construction Phase) and Table 7-4 (Operational Phase) identify the possible interactions between sensitive receptors and project activities to be assessed in further detail in the Study.

For ecological receptors, the identified impact types are further listed in Table 7-5. The impact assessment considers only the increase in the risk of these impacts occurring during the construction stage compared to the existing conditions.

Table 7-3: Scoping Impact Matrix Table (Construction Phase)

S/N	Proposed Construction Activities	Environmental Surroundings/ Receptors														
		Ambient Air-borne Noise	Ambient Ground-borne Noise and Vibration	Ambient Air Quality	Hydrology	Hydrogeology	Surface Water Quality	Geology	Topography	Soil & Sediment	Ambient Illumination	Ambient Temperature	Ecological and Biodiversity	Landscape and Visual	Recreational and Enjoyment	Road Traffic and Transportation
1	**Stage 1 – Preliminary Works**															
1.1	Site Clearance / Tree Removal • Tree removal / vegetation clearance	I		I	I		I					I	I	I	I	
1.2	Site Preparation • Mobilization of construction machineries, equipment and vehicle	I	I	I			I			I					I	
	• Construction of work access	I	I	I			I			I					I	
	• Erection of hoarding and site entrance	I	I												I	
	• Erection of construction site signage	I														
	• Erection of temporary site office, toilets, material and equipment storage areas, workshops, waste management facilities, etc.	I	I	I			I			I				I	I	
	• Installation of sanitary facilities, utilities, wash-bays	I	I				I									
	• Earth control measures (ECM)	I					I (+)									
2	**Stage 2 – Construction Works of Proposed Development**															
2.1	Demolition of existing structures • Demolition of existing structures using excavator mounted with hydraulic breakers or small structures using hack hammers	I	I	I			I			I			I	I		
2.2	Excavation • Shallow excavation by machinery such as bulldozers and trackers or manual excavation	I	I	I	I		I	I		I			I	I		

S/N	Proposed Construction Activities	Environmental Surroundings/ Receptors														
		Ambient Air-borne Noise	Ambient Ground-borne Noise and Vibration	Ambient Air Quality	Hydrology	Hydrogeology	Surface Water Quality	Geology	Topography	Soil & Sediment	Ambient Illumination	Ambient Temperature	Ecological and Biodiversity	Landscape and Visual	Recreational and Enjoyment	Road Traffic and Transportation
	• Deep excavation	I	I	I	I	I	I	I	I	I			I	I		
2.3	<u>Slope Forming / Stabilisation</u> • Cut and fill for slope forming (land cutting, back-filling and compactions)	I	I	I	I		I	I	I	I			I	I		
	• Slope stabilization via micro piling and soil nailing	I	I	I	I		I	I	I	I			I	I		
2.4	<u>Substructure</u> • Piling: Installation of concrete / steel bored piles into ground to support the pile caps and foundation slabs, using a rotary boring rig / hydraulic drilling machine	I	I					I		I			I			
	• Micro piling: installation of concrete / steel micropiles into the ground, using a small diameter bored-case-insitu piles	I	I					I		I			I			
	• Pile Caps Installation: Distribute the load of the building into the piles and will be typically constructed in-situ, above the piles.	I						I		I			I			
2.5	<u>Superstructures</u> • Construction of superstructure (columns, beams, slabs & roofing)	I											I			
	• Installation of RC footings for boardwalk and trails	I											I			
2.6	<u>Superstructures</u> • Construction of superstructure (columns, beams, slabs & roofing)	I											I	I	-	
	• Installation of RC footings for boardwalk and trails	I											I		-	
3	**Stage 3 - Finishing Works**															

S/N	Proposed Construction Activities	Environmental Surroundings/ Receptors													
		Ambient Air-borne Noise	Ambient Ground-borne Noise and Vibration	Ambient Air Quality	Hydrology	Hydrogeology	Surface Water Quality	Geology	Topography	Soil & Sediment	Ambient Illumination	Ambient Temperature	Ecological and Biodiversity	Landscape and Visual	Recreational and Enjoyment	Road Traffic and Transportation
3.1	• Surface Water Drainage	I		I	I (+)		I		I	I			I	I		
	• Landscaping Works	I		I	I		I		I	I			I (+)	I (+)	I (+)	
	• Architectural works, including wet and dry works	I					I			I			I			
	• M&E works, including underground and aboveground servicing works, wiring works, etc.	I		I			I			I			I			
	• Road access and car park	I		I			I			I			I	I		I (+)
4	**All Stages (Stage 1, 2 and 3)**															
4.1	• Movement and operation of machinery and equipment on the site	I	I	I									I			
	• Movement of construction vehicles on public roads to and from site	I	I	I									I			I
	• Generation of spoil, construction waste (including toxic waste) and debris, and removal off-site			I			I			I			I			I
	• Generation of office and food waste						I			I			I			
	• Storage and of construction chemicals, fuels, oils, etc.						I			I			I			
	• Treatment and discharge of wastewater / runoff						I			I			I			

Notes:

	No interaction
I	Interaction likely
I (+)	Interaction likely, and potentially leading to positive effect(s)

Table 7-4: Scoping Impact Matrix Table (Operational Phase)

S/N	Project Activity	Environmental Surroundings/ Receptors														
		Ambient Air-borne Noise	Ambient Ground-borne Noise and	Ambient Air Quality	Hydrology	Hydrogeology	Geology	Surface Water Quality	Topography	Soil and Sediment	Ambient Illumination	Ambient Temperature	Ecological and Biodiversity	Landscape and Visual	Recreational and Enjoyment	Road Traffic and Transportation
1	**Operational Phase**															
1.1	Presence of people on Project Site (visitors and workers)	I	I					I			I		I			
1.2	Movement of vehicles to / on Project Site (NParks / visitors vehicles, Coaches, Buses, etc.)	I	I	I									I			I
1.3	Daily operation of the Project's on-site buildings	I		I							I		I			
1.4	Landscaping and maintenance works (e.g., landscape pruning and renovation works to building and elevated boardwalks)	I		I				I		I			I (+)	I (+)	I (+)	

Notes:

	No interaction
I	Interaction likely
I (+)	Interaction likely, and potentially leading to positive effect(s)

Table 7-5: Potential Impacts on Ecology (Habitats, Flora Species, Fauna Species) during Construction

Receptor	Impact Type	Description	Impact Category
Habitat	Loss of habitats	Terrestrial habitat Direct removal of vegetation (with extensive underground root systems that protect against soil erosion) to create space for construction activities Aquatic habitat Changes in waterbody due to canalisation and diversion activities, and/or changes in hydrology	Direct
	Habitat degradation	Terrestrial habitat Improper disposal of construction waste, accidental release of hazardous materials (such as construction slurry, concrete, paint, and/or solvents) Aquatic habitat Changes in surface water quality	Indirect
	Formation of edge effects	Changes in microclimatic conditions (such as direct sunlight, temperature, humidity and wind exposure) of the habitat due to vegetation removal	Indirect
Flora species	Mortality	Direct removal of vegetation to create space for construction activities	Direct
	Decline in plant health and survival	Changes in microclimatic conditions (i.e., dust noise, temperature, humidity, hydrology, or surface water quality)	Indirect
Fauna species	Loss of or reduction in habitats and food sources	Terrestrial habitat Direct removal of vegetation, nests, or roost sites to create space for construction activities Aquatic habitat Changes in waterbody due to canalisation and diversion activities, and/or changes in hydrology	Direct
	Accidental injury or mortality	Collisions with machinery, entrapment in construction materials (such as non-biodegradable erosion control blankets) and structures (such as exposed pits or drains), and accidental kills by construction personnel, including roadkills	Direct
	Human-wildlife conflict	Negative consequences of human-wildlife interactions, such as deliberate killing and depopulation of faunal species perceived as nuisances or threats by construction personnel	Indirect
	Loss of or reduction in ecological connectivity for faunal movement	Terrestrial habitat Habitat fragmentation from the removal of vegetation and installation of structures that hinder faunal movement (e.g., hoarding) Aquatic habitat Changes that impede connectivity of waterbody	Indirect
	Light disturbances	Increase in light levels from construction activities	Indirect
	Human disturbances	Increase in human traffic flow, such as workers and site personnel	Indirect

7.4 Identification of Impacts Associated with Operational Activities

7.4.1 Overview of Operational Activities

The activities anticipated during the operational phase of the respective study areas mainly include recreational and educational activities by park visitors, as well as regular maintenance activities (e.g., landscape maintenance, cleaning, minor upgrades) by the park operations team. The opening hours of the various parks are expected to differ, and the impact assessment was conducted based

on the tentative opening hours provided by NParks (Table 7-6). The impact assessment considers only the increase in the risk of these impacts occurring during the construction stage compared to the existing conditions.

Table 7-6: Lighting Provision for the Various Parks

Study Area / Park	Tentative Opening Hours	Lighting Provision
BBNP	24 h	Only proposed trails towards quarry and existing PCN in southern part of the park
BBTP	24 h	Only Main Entrance
BBHNP	24 h	Only Arrival Node

Table 7-7: Potential Impacts on Ecology (Habitats, Flora Species, Fauna Species) during Operation

Receptor	Impact Type	Description	Impact Category
Habitat	Introduction of exotic species (aquatic habitats only)	Accidental and/or intentional release of exotic animals by humans into waterbodies	Indirect
	Habitat degradation	Terrestrial habitat Trampling on vegetation or pollution (e.g., litter) from increased human activities Aquatic habitat Changes in surface water quality	Indirect
	Changes in microclimatic conditions	Changes in microclimatic conditions (such as direct sunlight, temperature, humidity and wind exposure) of the habitat due to operational activities and/or micro urban heat island effect from the adjacent development	Indirect
Flora species	Poaching	Deliberate taking of plants by humans due to their ethnobotanical value (e.g., ornamental, medicinal, food, craft)	Direct
Fauna species	Accidental injury or mortality	Navigation failures into the wrong areas and entrapment in facility structures, including bird collision into buildings (distorted perception of reflective surfaces on buildings as flyways, greenery, and or/water) and roadkills	Direct
	Human-wildlife conflict	Negative consequences of human-wildlife interactions, such as deliberate killing and depopulation of faunal species perceived as nuisances or threats by members of the public and antagonistic interactions between pets (e.g., dogs) and wildlife	Indirect
	Poaching	Deliberate taking of fauna by humans (e.g., pets, food, wildlife trade)	Direct
	Loss of or reduction in ecological connectivity for faunal movement	Terrestrial habitat Impediment to faunal movement by presence of buildings, infrastructure, and human activity Aquatic habitat Changes that impede connectivity of waterbody	Indirect
	Light disturbances	Increase in light levels from operational activities	Indirect
	Human disturbances	Increase in noise due to human traffic, such as visitors, including accompanying pets (e.g., dogs)	Indirect

8. NOISE QUALITY IMPACT EVALUATION AND MITIGATION

8.1 Minimum Control Measures

Table 8-1 sets out the minimum controls that are assumed to be implement for the project during construction and operational phases to reduce noise pollution.

Table 8-1: Description of Minimum Controls Assumed to be Implemented at Construction and Operational Phases

Phase	Work Activities	Minimum Controls
Construction	Site clearance Demolition and removal of existing building or structure Earthworks, including excavations, slope forming and slope stabilization General construction activities, including site preparation works, superstructure, finishing works	• Restricted Working Hours (RWH): The Contractor shall ensure that general construction activities are confined to daytime (0800-1800 hours) only, Monday to Saturday for all parks, while noisy activities are only limited to 1000 – 1700 hours for BBNP and BBTP, on weekdays only. • The noise levels should not exceed the maximum permissible noise levels for construction set out in the Schedule to the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, and the project-specific maximum permissible noise levels of 75 dB (Leq 1 hour) and 90 dB (Leq 5 min) at the boundary. • The Contractor shall ensure that hoarding is installed around the work zones to reduce noise propagation to surrounding area. • The Contractor shall ensure that workers are trained in noise-reduction behaviours such as reducing the drop height of materials, and turning off equipment and vehicle engines when not in use. • Daily toolbox briefings should include reminders on the need to implement noise-reduction behaviours, in particular during demolition activities.
	Movement and operation of machinery, equipment and heavy vehicles	• The Contractor shall select quieter construction equipment and construction methods in accordance with Singapore Standard SS 602:2014 Code of Practice for Noise Control on Construction and Demolition Site, Annex G where necessary to achieve the permissible noise limits. • The Contractor shall deploy quiet models of construction equipment i.e. generators, compressors, excavators. Where there are no quieter models, the Contractor shall demonstrate so under the submission of Quiet Machine/ Equipment List. Quieter models are defined as those having sound pressure levels at least 5 dB quieter than other models readily available locally, when measured 1 m from the equipment body while the equipment is operating at its rated load. • Provide acoustic shed / enclosure for construction equipment, where viable. • Site noisy machinery or equipment Plant away from the nearby noise sensitive receptors, where possible.

Phase	Work Activities	Minimum Controls
		• All machines and equipment shall be labelled with weatherproof stickers showing clearly its noise specification i.e. noise levels at 1m from source. The Contractor shall verify the performance using a Class 1 (Type 1) sound meter on all machines monthly at 1 m distance from source. • The Contractor shall ensure that vehicles and equipment are not left idling when not in use. • The Contractor shall ensure that all equipment and machinery is maintained and operated in a manner such that it does not give rise to excessive noise emissions. A list of equipment shall be submitted demonstrating consideration of alternatives.
	Piling / Substructure Works	• The Contractor shall use quieter (non-percussive) piling methods, for example bored, jack-in or micropiling methods. • The Contractor shall install noise barriers around the work areas before any work commences assessment show that the stipulated noise criteria will be breached by the works. Noise barriers shall be in accordance with Singapore Standard SS 602:2014 Code of Practice for Noise Control on Construction and Demolition Site, Annex F Noise Control Techniques, Section F3.3 and the any specific noise mitigation measures to be stipulated by the Board. The noise barriers shall be designed to achieve a minimum reduction of 5 dB(A). • Daily toolbox briefings should include reminders on the need to implement noise-reduction behaviours, in particular during piling activities.
Operational	Noise from increased traffic Noise from the park visitors and/or park maintenance workers Noise from landscaping and maintenance works at the parks (e.g., use of lorry cranes, grass cutter, chainsaws, leaf blowers, etc.)	• The Contractor shall select quieter landscaping and maintenance related equipment. • The Contractor shall ensure that all landscaping and maintenance-related equipment and machinery is maintained and operated in a manner such that it does not give rise to excessive noise.
	Operations of the park Air-conditioning and mechanical ventilation ("ACMV") and M&E equipment	• Use low noise air-conditioning compressors. • While expected to only operate over a short period / only during emergencies, the fire hosereel pumps and emergency diesel generator shall be sited as far away as practical from the noise-sensitive and residential buildings. • Noise abatement measures, if required, shall be provided to comply with the allowable boundary noise levels.

8.2 Identification of Noise Sensitive Receptors

8.2.1 Human Receptors

The noise sensitive human receptors identified for the Project during construction phase include residents staying adjacent / near to the proposed Project and students from the nearby schools (off-site receptors). As BBNP and BBTP are expected to continue to be partially opened to public throughout the construction phase, noise sensitive human receptors for the park also include park visitors / members of public (for BBNP and BBTP only) (on-site receptors).

The noise sensitive human receptors identified for the Project during operational phase include park visitors / members of public.

A list of the identified noise sensitive receptors located near / adjacent to the Project (off-site), which might be impacted by the proposed development, is presented under table below.

Table 8-2: List of Noise Sensitive Receptors (Human Receptors)

Study Area	Sensitive Receptor ID	Description	Land Use	Direction and Approximate Distance (m)	Noise Source/ Noisy Activity
Bukit Batok Nature Park (BBNP)					
B1	SR5	Park Natura	High-rise residential	390-m east 330-m southeast 400-m south	BBNP Car park & Main Entrance construction BBNP Plaza & Play Area construction BBNP Proposed trails towards quarry Works
	SR6	Shamah Terrace	Landed residential	250-m east 300-m southeast 400-m south	BBNP Car park & Main Entrance construction BBNP Plaza & Play Area construction BBNP Proposed trails towards quarry Works
	SR7	St Mary of the Angels Church	Place of worship	115-m west 435-m southwest	BBNP Car park & Main Entrance construction BBNP Plaza & Play Area construction
B2	SR8	Park Palais	High-rise residential	700-m north 600-m north	BBNP Plaza & Play Area construction Slope Stabilisation
	SR9	Lorong Sesuai	Landed residential	495-m northeast 330-m north 270-m north	BBNP Plaza & Play Area construction BBNP Proposed trails towards quarry Works BBNP Slope Stabilisation
B3	SR10	Meralodge	High-rise residential	485-m north 480-m northwest	BBNP Plaza & Play Area construction BBNP Proposed trails towards quarry

Study Area	Sensitive Receptor ID	Description	Land Use	Direction and Approximate Distance (m)	Noise Source/ Noisy Activity
				540-m northwest	Works BBNP Slope Stabilisation
	SR11	Hillview Apartment	High-rise residential	700-m north 620-m north 625-m northwest	BBNP Plaza & Play Area construction BBNP Proposed trails towards quarry Works BBNP Slope Stabilisation
B4	SR12	BLK 259 HDB Bukit Batok East	High-rise residential	430-m northwest 415-m northwest	BBNP Car park & Main Entrance construction BBNP Plaza & Play Area construction
	SR13	The Petals	High-rise residential	430-m north 435-m northwest	BBNP Plaza & Play Area construction BBNP Proposed trails towards quarry Works
	SR14	Hillview Cres	Landed residential	525-m northwest	BBNP Plaza & Play Area construction
C2	SR15	BLKS 266-267 HDB Bukit Batok East	High-rise residential	150-m north 300-m west	BBNP Car park & Main Entrance construction BBNP Plaza & Play Area construction
Bukit Batok Town Park (BBTP)					
D	SR16	Regent Heights	High-rise residential	500-m southeast	BBTP Courtyard construction
	SR17	BLKS 510-511 HDB Bukit Batok	High-rise residential	440-m south	BBTP Courtyard construction
	SR18	Hillgrove Secondary School	School	350-m south	BBTP Courtyard construction
	SR19	Lianhua Primary School	School	350-m south	BBTP Courtyard construction
	SR20	Guilin View	High-rise residential	140-m southwest	BBTP Courtyard construction
	SR21	BLK 524 HDB Bukit Batok	High-rise residential	70-m west	BBTP Courtyard construction
	SR22	BLK 383 HDB Bukit Batok West	High-rise residential	580-m northwest	BBTP Courtyard construction
	SR23	Hillview Court	Landed residential	470-m northeast	BBTP Courtyard construction
	SR24	The Hilloft	Landed residential	450-m northeast	BBTP Courtyard construction
	SR25	Chu Yen St/Chu Lin Rd	Landed residential	380-m east	BBTP Courtyard construction
	SR26	Hilltop Grove	High-rise residential	465-m east	BBTP Courtyard construction
	SR27	Merawoods	High-rise residential	545-m east	BBTP Courtyard construction

Study Area	Sensitive Receptor ID	Description	Land Use	Direction and Approximate Distance (m)	Noise Source/ Noisy Activity
Bukit Batok Hillside Nature Park (BBHNP)					
E	SR28	West Plains@Bukit Batok	High-rise residential	300-m northwest 430-m southwest	BBHNP Arrival Node construction Removal of GFRC rocks
	SR29	Bukit Batok Home for the Aged	Homes for the aged	260-m northwest	Removal of GFRC rocks
	SR30	BLK 425 HDB Bukit Batok West	High-rise residential	220-m northwest	Removal of GFRC rocks
	SR31	BLK 315 HDB Bukit Batok	High-rise residential	390-m north 40-m northeast	BBHNP Arrival Node construction Removal of GFRC rocks
	SR32	Dazhong Primary School	School	400-m northeast 150-m southeast	BBHNP Arrival Node construction Removal of GFRC rocks
	SR33	BLK 306 HDB Bukit Batok	High-rise residential	275-m northeast 225-m southeast	BBHNP Arrival Node construction Removal of GFRC rocks
	SR34	BLK 302 HDB Bukit Batok	High-rise residential	380-m east 400-m southeast	BBHNP Arrival Node construction Removal of GFRC rocks
	SR35	The Madeira	High-rise residential	520-m east 430-m southeast	BBHNP Arrival Node construction Removal of GFRC rocks
	SR39	BLK 467 Bukit Batok West Ave 9	High-rise residential	130-m west	BBHNP Arrival Node construction
	SR40	Future West Hill @ Bukit Batok	High-rise residential	235-m northwest 250-m southwest	BBHNP Arrival Node construction Removal of GFRC rocks
	SR41	Future West Glades @ Bukit Batok	High-rise residential	200-m east 320-m south	BBHNP Arrival Node construction Removal of GFRC rocks

While park visitors / members of the public could also be potentially exposed to excessive noising arising from the construction activities as listed under Table 8-1 at BBNP and BBTP, which will be partially opened throughout the construction phase, the visitors are not expected to be exposed over an extended period (exposed for eight hours or more in a day). The **Receptor Sensitivity** for the BBNP and BBTP park visitors / members of public is classified as **Priority 3**.

Residents residing near to the BBNP, BBTP and BBHNP and students identified BBHNP (off-site receptors located less than 150 m from the construction site) could potentially be exposed to excessive noise arising from the construction activities. The **Receptor Sensitivity** for school is

classified as **Priority 1** while the **Receptor Sensitivity** for Residential Buildings is classified as **Priority 2**.

Table 8-3: Human Receptor Sensitivity for the Respective Study Areas During Construction Phase

Proposed Development (Study Area)	Receptor Sensitivity		
	Human Receptors		
	Park Visitors / the Public	Nearby Residents	Nearby Students
BBNP (Study Areas B1 [West of Lor Sesuai])	Priority 3*	Priority 2	-
BBTP (Study Area D)			
BBHNP (Study Area E)	-		Priority 1
Note: * BBNP and BBTP will be partially opened to the public throughout the construction phase			

No major noises sources or emissions are expected during operational phase, other than:

- Noise from vehicles from the potential of traffic increase at some of the parks, especially for parks with car parks e.g., BBNP;
- Noise from the park visitors and/or park maintenance workers;
- Noise from the park landscaping, maintenance and renovation works (e.g., use of lorry cranes, grass cutter, chainsaws, leaf blowers, etc.); and
- Noise from the operations of the park M&E equipment e.g., backup diesel generator and fire water pump for hose reel; which are only operational during emergency.

During operational phase, the park visitors and members of public could potentially be exposed to the excessive noise from these potential noise sources when visiting at these parks, although the exposure is not expected to be over an extended period.

The **Receptor Sensitivity** of the human receptor is classified **Priority 3**.

Table 8-4: Human Receptor Sensitivity for the Respective Study Areas During Operational Phase

Proposed Development (Study Area)	Receptor Sensitivity
	Human Receptors
	Park Visitors / the Public
BBNP (Study Areas B1 [West of Lor Sesuai])	Priority 3
BBTP (Study Area D)	
BBHNP (Study Area E)	

8.2.2 Ecological Receptor

Ecological sensitive receptors are fauna species recorded during the Baseline Study or identified as probable species within each Study Area. The classification of their sensitivity during both the construction and operational phases is based on the criteria in Table 8-5.

Table 8-5: Ecological Receptor Sensitivity for the Respective Study Areas During Construction and Operational Phases

Proposed Development (Study Area)	Receptor Sensitivity		
	Ecological Receptors		
	Species that use sounds for communication, foraging, and breeding, or are known to have their behaviours disrupted by sound, and are of conservation significance	Species that are less affected by airborne noise but are of conservation significance	Species that are not of conservation significance
BBNP (Study Areas B1 [West of Lor Sesuai) BBTP (Study Area D) BBHNP (Study Area E)	Priority 1 • Birds of conservation significance • Non-volant mammals of conservation significance • Bats of conservation significance	Priority 2 • Aculeate hymenopterans of conservation significance • Odonates of conservation significance • Butterflies of conservation significance • Decapods of conservation significance • Reptiles of conservation significance	Priority 3 • All other species

A compilation of noise sensitive fauna recorded or identified as probably species at BBNP, BBTP and BBHNP, and their corresponding sensitivity ratings is presented in Appendix 3.

The **Receptor Sensitivity** of the ecological receptors are classified **Priority 1 to 3**.

8.3 Potential Impacts on Noise Quality

8.3.1 Construction Phase

Sensitive receptors can be potentially exposed to excessive noise arising from activities taking place during the project's construction phase. The sources that could potentially impact the noise quality throughout BBNP, BBTP and BBHNP include, but are not limited to, those listed in Table 8-6.

Table 8-6: Potential Noise Quality Impacts during the Construction Phase

Relevant Development / Study Area	Activity	Potential Source of Impacts	Potential Associated Impacts
BBNP (Study Areas B1 [West of Lor Sesuai]) BBTP (Study Area D) BBHNP (Study Area E)	Demolition and removal of existing building or structure (minor scale)	Noise arising from the minor demolition of existing structures including: • Existing shed near to the BBNP toilet; • Stonewall and walkway along Little Guilin at BBTP; and • Existing wooden shelter, pergola and boardwalk at BBHNP; using handheld equipment (jack hammers and welding or cutting equipment)	Human Impact • Potential human health impact due to exposure to excessive noise to park visitors / member of public (BBNP and BBTP only) • Potential human annoyance to receptors residing in the vicinity of the construction footprint.

Relevant Development / Study Area	Activity	Potential Source of Impacts	Potential Associated Impacts
BBHNP (Study Area E)	Demolition and removal of existing building or structure (moderate scale)	• Noise arising from the demolition of GFRC using excavator mounted with hydraulic breaker at BBHNP	Ecological Impact • Potential fauna disturbance, affecting ecological foraging behaviour, intra- and inter-species communication.
BBNP (Study Areas B1 [West of Lor Sesuai]) BBTP (Study Area D)	Slope forming and slope stabilization	• Noise arising from cutting of slope at the proposed BBTP Arrival Node using excavators mounted with hydraulic breaker • Noise arising from the slope stabilization works at the proposed trail leading to the eco-pedestrian bridge, at BBNP, using excavators, micropile machines and soil nail launchers	
BBNP (Study Areas B1 [West of Lor Sesuai]) BBTP (Study Area D) BBHNP (Study Area E)	Site clearance Earthworks, including excavations General construction activities, including site preparation works, superstructure, finishing works Movement and operation of machinery, equipment and heavy vehicles	• Noise arising from the clearance and removal of trees or vegetation using excavators	
		• Noise arising from general construction activities, including the use of cranes for lifting works, heavy vehicles movement for mobilization of construction machineries, equipment, vehicle, excavators, graders, rollers, trucks, road paving and compactor for creating work access, erection and operation of construction office and its amenities	
		• Noise arising from the movement and operation of machinery, equipment and heavy vehicles (e.g., lorries, water and concrete pumps, diesel generators, compressors, etc.)	
BBNP (Study Areas B1 [West of Lor Sesuai]) BBTP (Study Area D)	Piling / Substructure Works	• Noise arising from piling and substructure activities, using cranes and piling machines at the BBNP Proposed trails towards quarry • Noise arising from installation of sheet piles at the proposed BBTP Arrival Node using vibratory hammer	

The expected sound pressure level of the typical construction machinery, equipment and heavy vehicles, anticipated to be used during the construction phase is listed in Table 8-7.

Table 8-7: Sound Pressure Levels of Typically Used Construction Machinery, Equipment and Heavy Vehicle during Construction Stage

Typical Construction Machinery, Equipment and Heavy Vehicles	Sound Pressure Level at 10 m, dB(A) [1]
Handheld Hydraulic Breaker / Jack Hammer	93
Welding/Cutting Equipment	73
Excavator Mounted With Hydraulic Breaker	90
Vibratory Piling Rig	88
Excavator	78
Mini Excavator	68
Soil Nail Launcher	75
Drilling Rig	74
Crawler Crane	86
Mobile Crane	67
Lorry Cranes	70
Bored Piling Machine	89
Jack-In Piling Machine	70
Micro Piling Machine	76
Lorry	70
Grader	86
Roller	73
40 Ft Trailer	79
Ready Mix Concrete Truck	80
Dump Trucks	79
Air Compressor	75
Water Pump	68
Concrete Pump	78
Concrete Vibrator	89
Generator	65

Note:
[1] Sound Pressure Level (SPL) of the equipment are made reference to "BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise

The construction noise impacts generated from the on-site construction activities will depend on the inventory adopted during each construction activity during the construction phase. The noisiest activity anticipated during the construction phase is associated to the demolition of the GFRC at BBHNP, piling works at the BBNP Proposed trails towards quarry, sheet piling at BBTP, slope cutting and stabilization activities at BBTP and BBNP and general construction activities at the proposed BBNP Plaza & Play Area, BBTP Courtyard and BBHNP Arrival Node.

8.3.2 Operational Phase

Excessive noises are not expected during operational phase of the Project, other than the noise from vehicles from the potential of traffic increase at some of the parks, especially for parks with car parks e.g., BBNP, noise from the park visitors and/or park maintenance workers, noise from the landscaping and maintenance works (e.g., landscape pruning and renovation works) and noise from the operations of the park M&E equipment e.g., backup diesel generator and fire water pump for hose reel, which are not expected to be significant.

8.4 Relevant Environmental Legislation and Guidelines

The control of environmental noise pollution by industrial premises is regulated by the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations ("EPM Noise Regulations"). These Regulations stipulate the maximum permitted noise level at the different types of affected buildings. The maximum permitted noise levels at each type of affected buildings are established in the Second Schedule in Part I, Part II, and Part III of the EPM Noise Regulation, as presented below in Table 8-8, Table 8-9, and Table 8-10.

Table 8-8: EPM Noise Regulation Maximum Permissible Noise Levels Part I

Type of Affected Buildings	Maximum permissible noise level for construction sites (reckoned as an equivalent continuous noise level over a period of 12 hours) in decibels (A)	
	Day (7am – 7pm)	Evening (7pm – 7am)
(a) Hospitals, schools, institutions of higher learning, homes for aged sick, etc.	60	50
(b) Residential buildings located less than 150m from the construction site where the noise is being emitted	75	-
Buildings (other than those in paragraphs (a) and (b))	75	65

Table 8-9: EPM Noise Regulation Maximum Permissible Noise Level Part II

Type of Affected Buildings	Maximum permissible noise level for construction sites (reckoned as an equivalent continuous noise level over a period of one hour) in decibels (A)		
	Day (7am – 7pm)	Evening (7pm – 10pm)	Evening (10pm – 7am)
(a) Hospitals, schools, institutions of higher learning, homes for aged sick, etc.	-	-	-
(b) Residential buildings located less than 150m from the construction site where the noise is being emitted	-	65	55
Buildings (other than those in paragraphs (a) and (b))	-	-	-

Table 8-10: EPM Noise Regulation Maximum Permissible Noise Level Part III

Type of Affected Buildings		Maximum permissible noise level for construction sites (reckoned as an equivalent continuous noise level over a period of 5 minutes) in decibels (A)		
		Day (7am – 7pm)	Evening (7pm – 10pm)	Evening (10pm – 7am)
(a) Hospitals, schools, institutions of higher learning, homes for aged sick, etc.		75	55	55
(b) Residential buildings located less than 150m from the construction site where the noise is being emitted	(i) on Mondays to Saturdays	90	70	55
	(ii) on Sundays and public holidays	75	55	55
Buildings (other than those in paragraphs (a) and (b))		90	70	70

8.5 Study Methodology

The computer modelling programme CadnaA (Computer Aided Noise Abatement) by DataKustik GmbH has been used to predict the noise propagation from the Project to the surrounding environment. This computer software uses the International Standard ISO 9613-2 industrial standard for sound propagation (*Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*). CadnaA accounts for lateral diffraction around building edges and multiple reflections off parallel buildings and solid ground areas. Within the CadnaA model, the industrial noise prediction standard programme was selected, which requires the following inputs:

- Meteorological Information;
- Topographical Data;
- Ground Absorption and Attenuation;
- Building Transmission Loss; and,
- Source Sound Power Levels.

Table 8-11 lists the noisiest activities anticipated during the construction phase together with the typical construction equipment used for these activities. The equipment is usually used in different stage of construction activities and is unlikely to be operated concurrently at a single site. In this noise modelling study, the equipment was modelled as point sources in separate simulations. Multiple simulations were conducted for the activity with several equipment employed, e.g., trail refurbishment and construction at BBNP. The maximum noise levels predicted in the simulations will be used as the indices for the noise impact of corresponding construction activities.

Table 8-11: Noisiest Construction Activities and Typical Construction Equipment

S/N	Proposed Construction Activities	Description	Modelled Equipment
1	Slope stabilization works at proposed trail leading to the eco-pedestrian bridge @BBNP	This construction activity is usually conducted in multiple steps including excavation, slope forming and slope stabilisation. As construction equipment or machines are different in category and power capacity for each step, the intensity of operation-generating noises will not be consistent throughout the construction activity. The noise impact assessment will focus on slope forming and slope stabilisation at the proposed trail leading to the eco-pedestrian bridge, at BBNP, which are identified as the noisiest steps as multiple heavy and noisy construction equipment will be used.	- Tracked excavator for land cutting - Dozer for back-filling - Roller/compactor for compaction - Micro piling machine and soil nail launcher for stabilisation - Jack-in piling machine

S/N	Proposed Construction Activities	Description	Modelled Equipment
2	General Construction of Plaza & Play Area and Proposed trails towards quarry @BBNP	The construction of the BBNP Plaza & Play Area will require shallow and deep excavation, installation of foundation slabs, and construction of columns, beams and roofing while the construction of the Proposed trails towards quarry will involve piling and substructure activities, using cranes and piling machines. The noisiest construction activity has been identified to be the deep excavation for sewer line connections.	- Tracked excavator
3	General Construction of Courtyard @ BBTP	The construction of the BBTP courtyard will require slope cutting, installation of sheet piles, shallow and deep excavation, installation of foundation slabs, construction of columns, beams and roofing and minor demolition of the existing stonewall and walkway. The noise impact assessment will focus on the slope forming activities, which have been identified as the noisiest construction activity. Slope forming will consist of the cutting of slope and installation of sheet piles using excavators mounted with hydraulic breaker and vibratory hammer.	- Tracked excavator for land cutting - Dozer for back-filling - Roller/compactor for compaction
4	Demolition of existing structures @BBHNP	Demolition activities will be conducted at selected locations within BBHNP. Powerful demolition equipment such as excavator mounted with hydraulic breaker will be used to demolish the GFRC. Compared with the equipment used to demolish minor scale structures e.g., the existing wooden shelter, pergola and boardwalk at BBHNP, the powerful equipment usually generates louder noise. The noise impact assessment will focus on the demolition of GFRC at BBHNP.	- Excavator mounted with hydraulic breaker
5	General Construction of Arrival Node @ BBHNP	The construction of the arrival node at BBHNP will consist of shallow and deep excavation, installation of foundation slabs and construction of superstructures, such as columns, beams and roofing. The noisiest construction activity has been identified as the deep excavation for sewer line connections, which will be carried out using a tracked excavator.	- Tracked excavator

8.6 Model Input Parameters

8.6.1 Meteorological Information

The meteorological information incorporated into the model was based on Singapore conditions and is conservative in terms of noise propagation. Specifically, the meteorological data used included an average temperature of 24 °C, an average humidity of 85%, and all wind directions. Per Section 10 of ISO 9613-2, the model assumed the following downwind propagation conditions:

- Wind direction within an angle of ± 45° of the direction connecting the centre of the dominant sound source and centre of the specified receiver region, with wind blowing from source to receiver; and,
- Wind speed between approximately 1 m/s and 5 m/s, measured at a height of 3 m to 11 m above the ground.

These conditions also apply for average propagation under a well-developed, moderate ground-based temperature inversion, such as those which commonly occur on clear, calm nights. Since ISO

assumes general light downwind conditions (i.e., wind from source to receiver), the calculations result in conservative noise levels.

8.6.2 Technical characteristics of Equipment

Sound power level (Lw) is an important parameter for the modelling study. The details of the estimated sound power level are presented in Table 8-12. The sound power levels were estimated based on the typical sound pressure levels archived in BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise. The sound power levels summarised in Table 8-12 are for one unit per each kind of equipment.

Table 8-12: Estimated Sound Power Levels for the Modelled Noise Sources

Equipment	Octave band sound power levels, dB(A)								Total Sound Power Level, dB(A)
	63	125	250	500	1k	2k	4k	8k	
Tracked excavator	94	105	103	101	105	102	100	94	111
Hydraulic jacking power pack	82	93	95	94	94	89	82	72	101
Vibratory piling rig	88	97	101	110	115	114	109	97	119
Excavator mounted with hydraulic breaker	84	90	95	102	108	109	107	100	114
Dozer	80	94	99	105	105	103	97	87	110
Roller	77	90	103	106	105	102	95	85	111
Hydraulic vibratory compactor	86	91	94	101	103	104	100	93	109
Mini piling rig	92	92	94	101	102	101	97	87	107
Compressor for mini piling	80	86	87	98	102	101	94	87	106

8.6.3 Ground Absorption, Reflection and Attenuation

Ground absorption varies from a value of 0 to 1, with 0 being for an acoustically reflective ground (e.g., water or bitumen) and 1 for acoustically absorbent ground (e.g. grass or porous ground). In this instance, a value of 1 has been used assuming the site to be covered mostly by vegetated or forested areas.

8.7 Key Assumptions in the Noise Assessment

The noise assessment was conducted at a preliminary stage of the Project development, prior to the construction stage and final selection of all construction equipment to be deployed at the Project. Reasonable and conservative assumptions were made where necessary in the assessment which described as follows:

8.7.1 Noise Sources

The major noise sources in association with the Project development are the typical construction equipment listed in Table 8-12. As it is rarely that the equipment is operated concurrently at a same construction site, a group of simulations were conducted to investigate the possible impacts of each equipment individually.

8.7.2 Model Spatial Data

Accurate spatial data comprising ground profile contour lines was included for all study areas. Given the nature of the Project, most of study areas are covered by forest. The only on-site structures that were included in the model were the noise emitting equipment.

8.7.3 Surrounding Area Noise Levels

The noise assessment is conducted solely based on the noise-generating sources at construction sites within study areas. Cumulative noise impacts from surrounding premises have not been accounted for due to the absence of relevant noise data during the stage of assessment.

8.8 Noise Model Results

The predicted site-specific noise levels for the modelled scenario were compared against the daytime maximum permissible noise levels for construction sites (reckoned as an equivalent continuous noise level over a period of 5 minutes), as stipulated in EPM Noise Regulations (Table 8-10) as the construction activities are anticipated to be scheduled only between 8 am to 6 pm.

Figure 8-1 to Figure 8-8 presents the predicted incremental noise levels at identified human and ecological sensitive receptors.

The overall noise model results are summarised in the table below (Table 8-13), and elaborated upon in the subsequent sections.

Table 8-13: Summary of Noise Model Results

S/N	Proposed Construction Activities	Modelled Equipment	Radius of Area with Leq ≥ 75 dB(A) [1]	Assessment
1	Slope stabilization works at proposed trail leading to the eco-pedestrian bridge @BBNP	- Tracked excavator for land cutting - Dozer for back-filling - Roller/ compactor for compaction - Micro piling machine and soil nail launcher for stabilisation - Jack-in piling machine	N.A.	The nearest noise sensitive human receptor is the residential area at Lorong Sesuai (SR9) which is located around 270 m north of the construction site.
2	General Construction of Plaza & Play Area and Proposed trails towards quarry @BBNP	- Tracked excavator	14 m	The nearest noise sensitive human receptor is the residential area of Blocks 266 and 267 HDB Bukit Batok East (SR15) which is located around 300 m west of the construction site.
3	General Construction of Courtyard @ BBTP	- Tracked excavator for land cutting - Dozer for back-filling - Roller/ compactor for compaction	33 m	The nearest noise sensitive human receptor is the residential area of Block 524 HDB Bukit Batok (SR21) which is located at 60 – 70 m west of the construction site.
4	Demolition of existing structures @BBHNP	- Excavator mounted with hydraulic breaker	N.A.	The nearest noise sensitive human receptor is the residential area of Block 315 HDB Bukit Batok (SR31) which is located 40 m northeast of the construction site.
5	General Construction of Arrival Node @ BBHNP	- Tracked excavator	16 m	The nearest noise sensitive human receptor is the residential area of Block 467 Bukit Batok West Avenue 9 (SR39) which is located about 130m west of the construction site.
Note: 1. N.A. indicates that the predicted noise levels are well below 75 dB(A) throughout the modelled domain.				

8.8.1 BBNP

As shown in Figure 8-1, the predicted 5-min Leq at BBNP caused by the excavation works near the proposed Proposed trails towards quarry (also in the vicinity of the Plaza and Play Area) construction is predicted to reach a maximum of 70 dB(A) around the construction area, before decreasing to 5 dB(A) – 10 dB(A) when it reaches the closest human receptors i.e., the residents at Blocks 266 and 267 HDB Bukit Batok East. This is well below the 90 dB(A) maximum permissible noise level for daytime for residential buildings located less than 150m from the construction site where the noise is being emitted, for Monday through Saturdays, as stipulated in the EPM Noise Regulations.

Figure 8-2 details the predicted 5-min Leq at the proposed slope stabilization site within BBNP i.e., for the proposed trail leading to the proposed eco-pedestrian bridge, which will reach a maximum of 75 dB(A) around the construction area, also well below the 90 dB(A) maximum permissible noise level for daytime. The noise is predicted to fall to 30 dB(A) – 45 dB(A) when it reaches the closest human receptors i.e., the residents at the Hillside Residential and Park Natura.

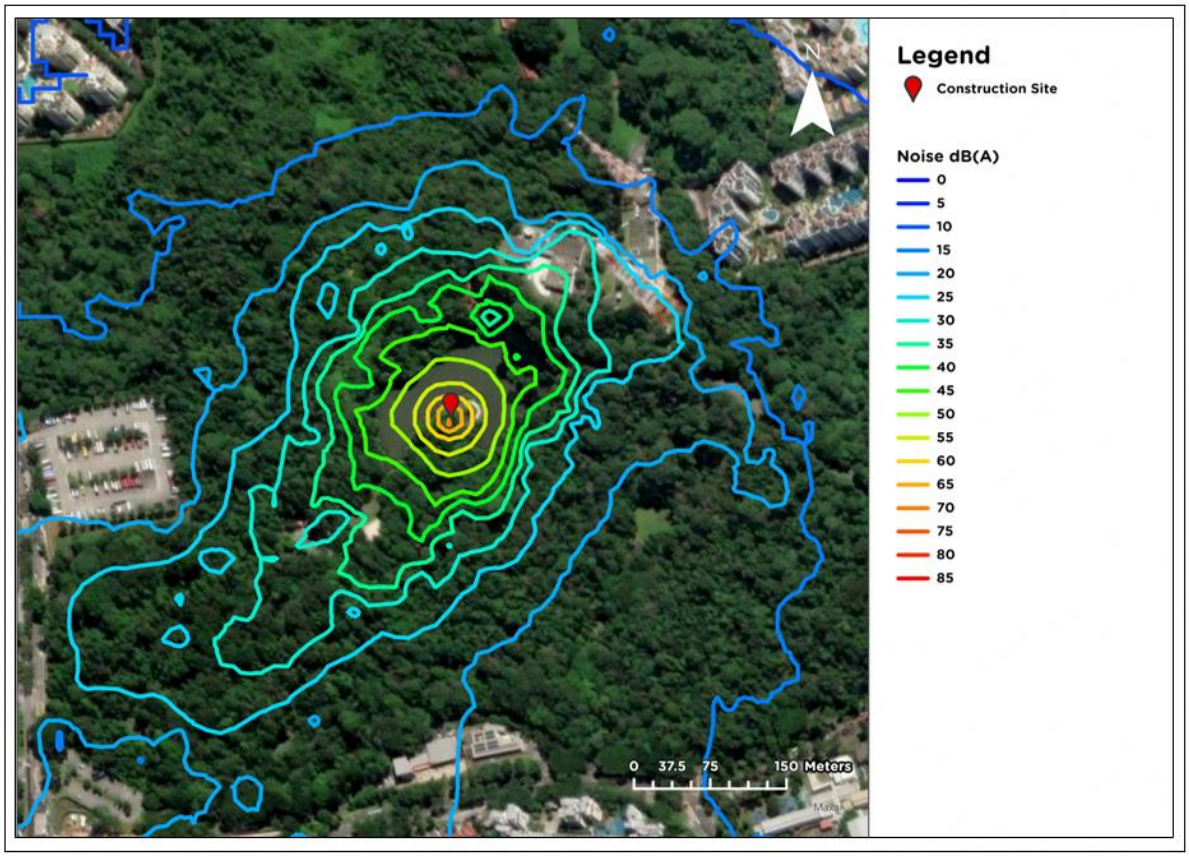


Figure 8-1: Predicted 5-min Leq impact from excavation works at BBNP

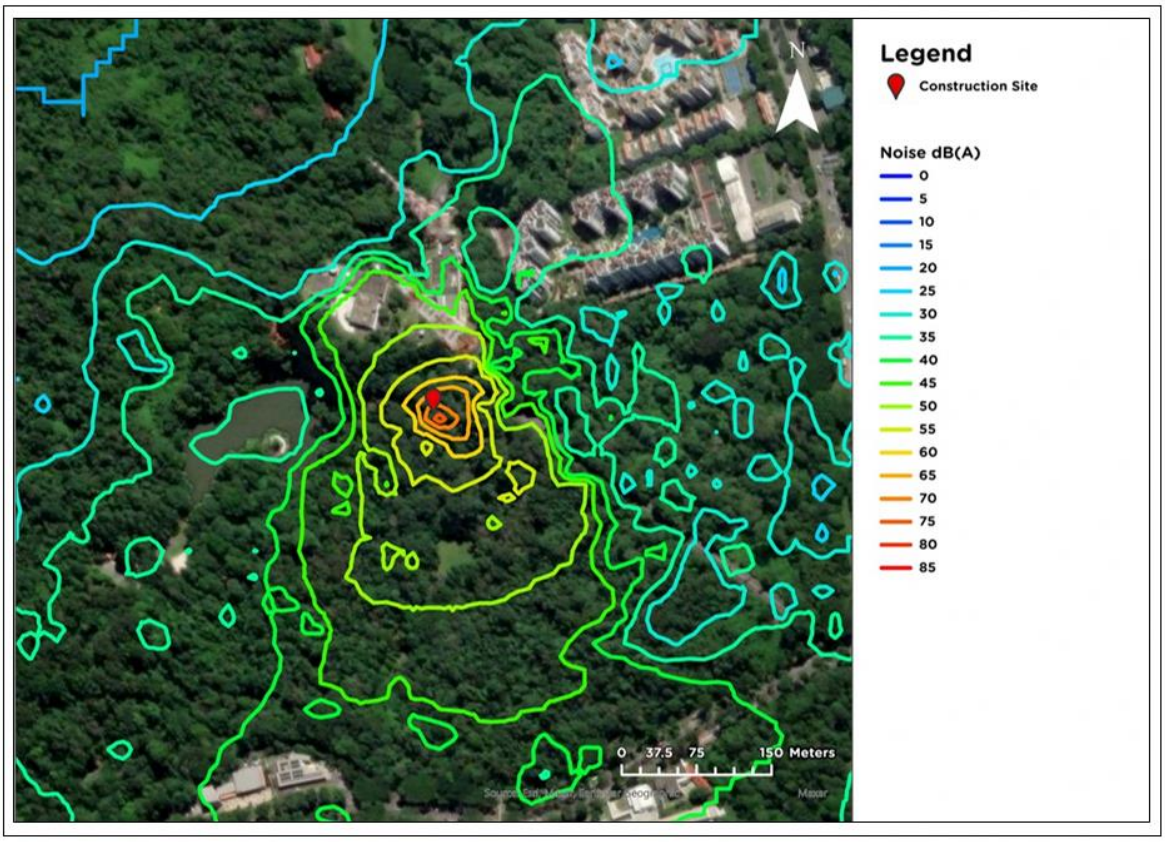


Figure 8-2: Predicted 5-min Leq impact from slope stabilization at BBNP

The noise levels were also modelled at various different heights (5 m, 10 m and 15 m) at the proposed slope stabilization site, as presented in Figure 8-3 to Figure 8-5, to account for the various fauna present at BBNP, which may nest or reside at varying heights. The noise was modelled for various height levels for the ecological receptors at BBNP as a representative for the other study areas, as BBNP has the highest number of faunal species recorded overall (466 species), as well as the highest number of faunal species of conservation significance recorded (23 species) (Appendix 4).

The maximum predicted noise levels at the proposed slope stabilization site at 5 m, 10 m and 15 m height were 80 dB(A), 80 dB(A) and 75 dB(A), respectively, which are also well below the 90 dB(A) maximum permissible noise level for daytime. Although the noise level gets lower at greater heights, the noise contours are also more diffuse and spread out than at a lower height. A similar pattern is likely to be observed for the predicted noise levels at various heights for other construction sites at the other study areas. The results simulated model in Figure 8-3 to Figure 8-5 is thus likely representative of the ecological receptors in the other study areas as well.

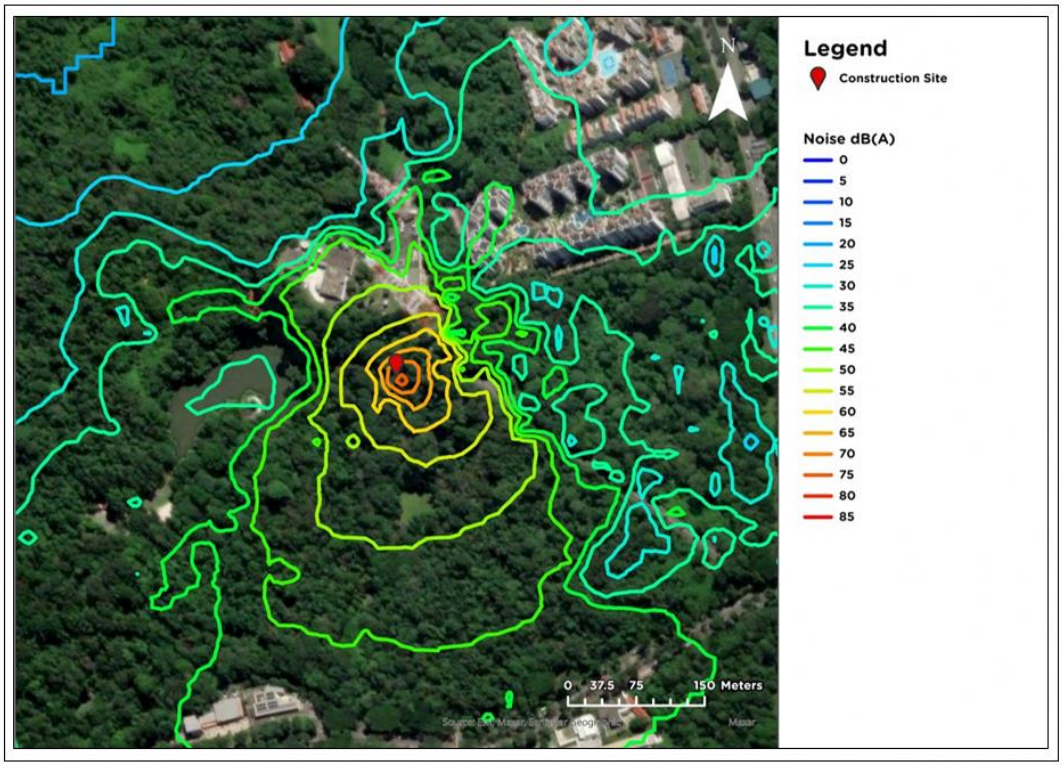


Figure 8-3: Predicted 5-min Leq impact from slope stabilization works at a height of 5 m

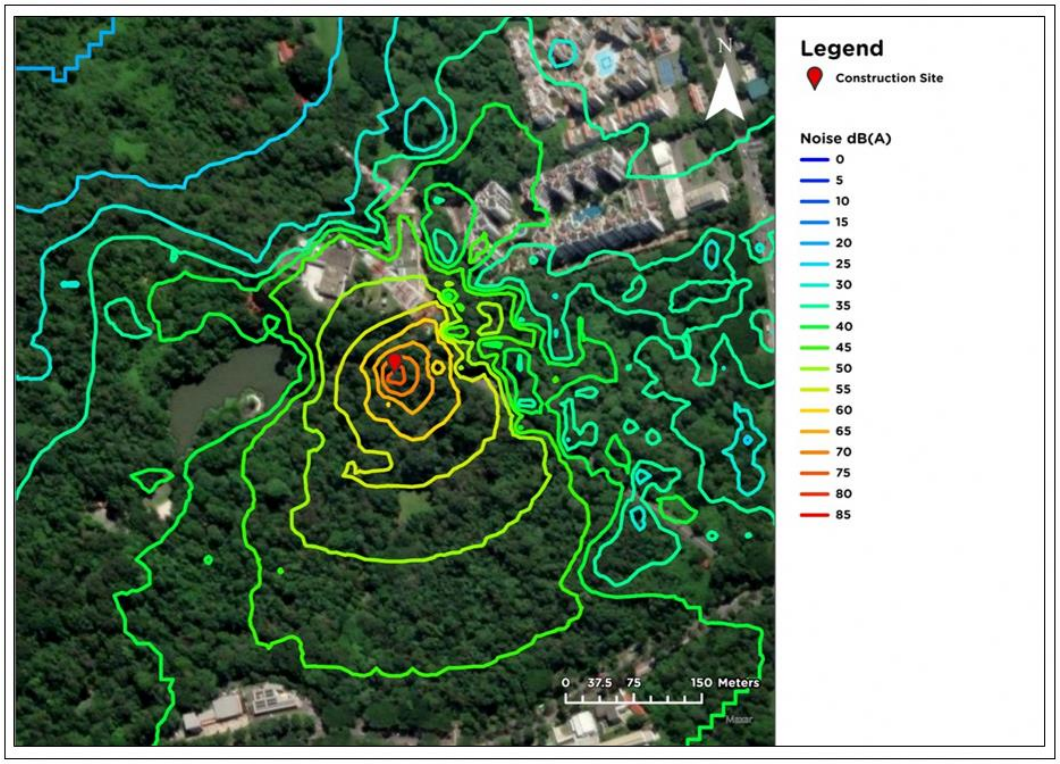


Figure 8-4: Predicted 5-min Leq impact from slope stabilization works at a height of 10 m

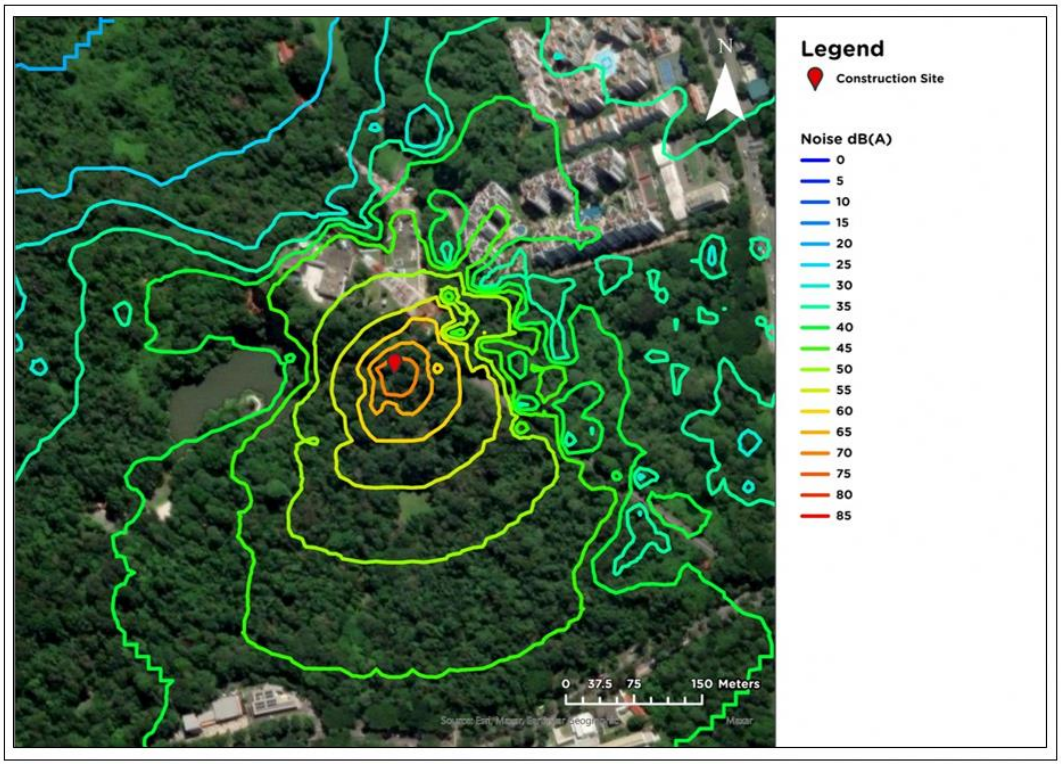


Figure 8-5: Predicted 5-min Leq impact from slope stabilization works at a height of 15 m

8.8.2 BBTP

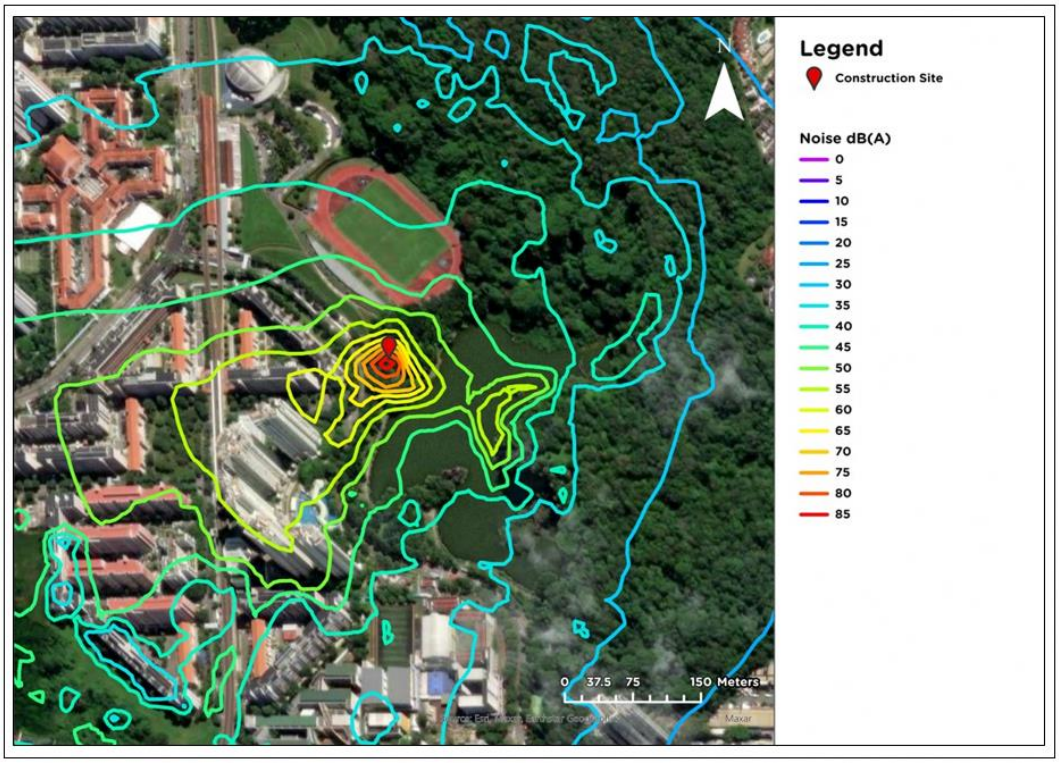


Figure 8-6: Predicted 5-min Leq impact from slope forming and stabilization works at BBTP

As shown in Figure 8-6, the predicted 5-min Leq at the proposed BBTP Courtyard construction site, caused by slope forming works will be 85 dB(A) maximum around the construction area. The closest human receptors to the proposed Courtyard construction site are BLK 524 HDB Bukit Batok and Guilin View, both residential buildings located less than 150 m away from site. The predicted noise level at the residential buildings range from 50 dB(A) – 65 dB(A), well below 90 dB(A), the maximum permissible noise level for residential buildings less than 150 m away for Monday through Saturdays.

8.8.3 BBHNP

The predicted 5-min Leq at BBHNP caused by excavation works at the proposed Arrival Node will be 85 dB(A) maximum at the construction site (Figure 8-7). The predicted noise levels decrease to 50 dB(A) – 60 dB(A) at the closest human receptor i.e., Block 467 Bukit Batok West Avenue 9, which is well below 90 dB(A), the maximum permissible noise level for residential buildings less than 150 m away for Monday through Saturdays.

For the demolition of the GFRC at BBHNP, the maximum 5-min Leq is predicted to be 55 dB(A) around the GFRC demolition site, as shown in Figure 8-8. The noise levels dissipate to 40 dB(A) – 50 dB(A) at the closest residential receptor i.e., Block 315 HDB Bukit Batok, which is well below 90dB(A), the maximum permissible noise level for residential buildings less than 150 m away for Monday through Sundays.

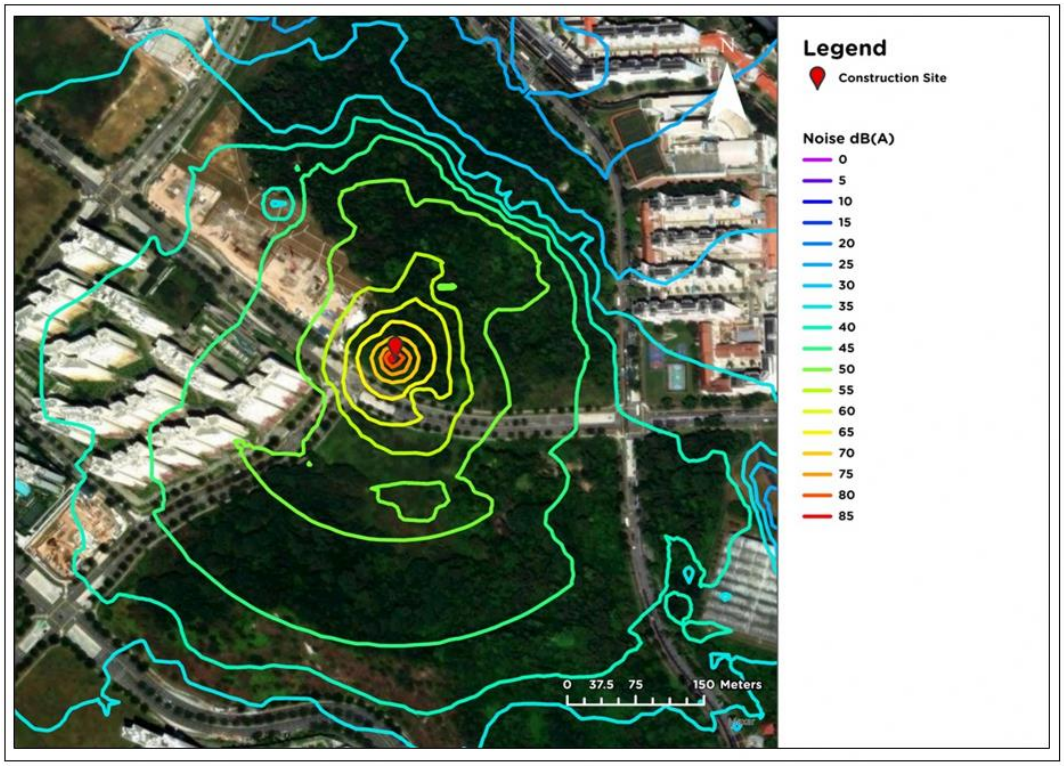


Figure 8-7: Predicted 5-min Leq impact from excavation works at BBHNP arrival node

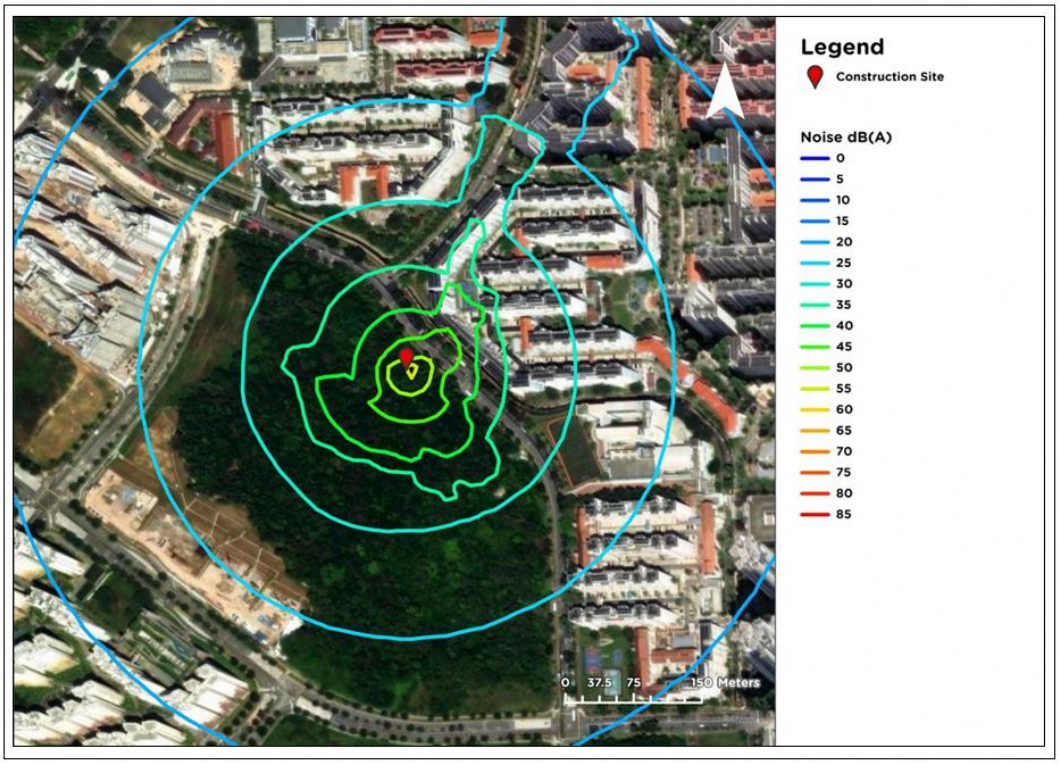


Figure 8-8: Predicted 5-min Leq impact from the demolition of GFRC at BBHNP

8.9 Evaluation of Noise Quality Impacts

8.9.1 Construction Phase

During construction phase, the **Impact Intensity** arising from the on-site construction activities are expected to be **Negligible** for Human Receptors as the predicted noise levels are less than 3 dB(A) above the regulatory limits. The Impact Intensity arising from the on-site construction activities are expected to be **High** for Ecological Receptors as the predicted maximum noise levels are more than 10 dB(A) above the baseline background noise. The predicted noise levels for the respective study areas and the scoring of the impact intensity for noise quality listed in Table 8-14.

Table 8-14: Summary of Impact Intensity of the Respective Development/Study Area during Construction Phase

Relevant Development / Study Area	Predicted Maximum Noise Level (5-min Leq) at Noise Source (dB(A))	NEA Maximum Permissible Levels for Day Time, Mondays to Saturdays (dB(A))	Maximum Baseline Background Noise Levels (dB(A))	Impact Intensity	
				Human Receptor	Ecological Receptor
BBNP (Study Areas B1 [West of Lor Sesuai])	70 – 80	90	67.9	Negligible	High
BBTP (Study Area D)	85	90	70.0	Negligible	High
BBHNP (Study Area E)	55 85	75 90	68.3	Negligible	High

The **Impact Consequences** (Receptor Sensitivity x Impact Intensity) is considered **Negligible** to **Very Low** for Human Receptors**,** and **Low** to **High** for Ecological Receptor.

It should be noted that the noise model results are a conservative estimate of the noise levels generated from construction work, as they do not take into consideration potential mitigation measures that may be taken to reduce the noise levels at site, such as using noise barriers and using mufflers on equipment. Based upon implementation of the minimum controls, where applicable, it is unlikely that excessive noise, that may adversely impact the human and ecological receptors, will regularly occur during the construction phase. On this basis, the **Likelihood** of occurrence during construction phase is expected to be **Possible / Occasional**.

Therefore, the **Impact Significance** (Impact Consequences x Likelihood) for the construction phase is assessed to be **Negligible** to **Minor** for Human Receptors**,** and **Minor** to **Moderate** for Ecological Receptor.

Table 8-15: Summary of Impact Evaluation during Construction Phase

Relevant Development / Study Area	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
BBNP (Study Areas B1 [West of Lor Sesuai])	Human Receptor - Priority 2 to 3	Negligible	Negligible	Possible / Occasional	Negligible
	Ecological Receptor – Priority 1 to 3	High	Low to High		Minor to Moderate
BBTP (Study Area D)	Human Receptor - Priority 2 to 3	Negligible	Negligible	Possible / Occasional	Negligible
	Ecological Receptor – Priority 1 to 3	High	Low to High		Minor to Moderate
BBHNP (Study Area E)	Human Receptor - Priority 1 to 2	Negligible	Negligible to Very Low	Possible / Occasional	Negligible to Minor
	Ecological Receptor – Priority 1 to 3	High	Low to High		Minor to Moderate

8.9.2 Operational Phase

During operational phase, the **Impact Intensity** for noise quality arising from the operations of BBNP, BBTP and BBHNP i.e., noise from vehicular movement, noise from the park visitors and/or park maintenance workers, noise from the park landscaping and maintenance works and noise from the operations of the park M&E equipment is expected to be **Negligible** to **Low.** For reference, 30 dB(A) is the typical volume of a whisper, 60 to 70 dB(A) is that of a normal conversation, and 110 to 129 dB(A) is that of ambulance sirens.

The **Impact Consequences** (Receptor Sensitivity x Impact Intensity) is therefore considered **Negligible** to **Low**.

With the implementation of minimum control, the **Likelihood** of occurrence of exposure to excessive noise during the operational phase is assessed to be **Less Likely / Rare**.

Therefore, the **Impact Significance** (Impact Consequences x Likelihood) to both human and ecological receptors for the operational phase is assessed to be **Negligible,** and **Negligible** to **Minor**, respectively.

Table 8-16: Summary of Impact Evaluation during Operational Phase

Relevant Development / Study Area	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
BBNP (Study Areas B1 [West of Lor Sesuai],) BBTP (Study Area D)	Human Receptor - Priority 3	Negligible	Negligible	Less Likely/Rare	Negligible
BBHNP (Study Area E)	Ecological Receptor – Priority 1 to 3	Low	Low to Very Low	Less Likely/Rare	Negligible to Minor

8.10 Recommended Mitigation Measures

8.10.1 Construction Phase

Based on the assessment in Section 8.9.1, the **Impact Significance** during the construction phase at BBNP, BBTP and BBHNP was determined to be **Minor** to **Moderate** for Ecological Receptors.

As a mitigation measure, noise pollution mitigation measures shall be implemented in line with the *Singapore Standards Code of Practice for Noise Control at Construction Sites, 2014 (SS602:2014)*, where practicable, at the construction sites are outlined below to further reduce the Likelihood of occurrence of the anticipated impact.

As the impact significance on the human receptors identified for BBNP, BBTP and BBHNP for noise is **Negligible** to **Minor** during the construction phases, no additional management or mitigation measures are required, other than to implement the minimum controls.

8.10.2 Operational Phase

As the impact significance on the sensitive human receptors for noise quality is **Negligible** to **Minor** during the operational phases, no additional management or mitigation measures are required, other than to implement the minimum controls.

8.11 Residual Impacts

8.11.1 Construction Phase

Residual Impact Assessment assumes that the mitigation measures within Section 8.10.1 are implemented in the development / construction footprint of BBNP, BBTP and BBHNP. The Likelihood of occurrence of a significant adverse impact would be classified as Less Likely / Rare, subject to relevant mitigation measures identified being implemented. This Likelihood is combined with Impact Consequence to provide the residual Impact Significance results for the proposed development. The residual Impact Significance is listed in Table 8-17 below.

Table 8-17: Summary of Residual Impact Evaluation during Construction Phase (Post Implementation of Mitigation Measures)

Relevant Development / Study Area	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
BBNP (Study Areas B1 [West of Lor Sesuai)	Ecological Receptor – Priority 1 to 3	High	Low to High	Less Likely / Rare	Minor
BBTP (Study Area D)	Ecological Receptor – Priority 1 to 3	High	Low to High	Less Likely / Rare	Minor
BBHNP (Study Area E)	Ecological Receptor – Priority 1 to 3	High	Low to High	Less Likely / Rare	Minor

Based on the assessment, by implementing the proposed mitigation measures, the Impact Significance for the Ecological Receptors at BBNP, BBTP and BBHNP is expected to reduce from **Minor to Moderate**, to **Minor**.

9. AIR QUALITY IMPACT EVALUATION AND MITIGATION

9.1 Minimum Control Measures

Table 9-1 sets out the minimum controls that are assumed to be implement for the project during construction and operational phases to reduce air pollution.

Table 9-1: Description of Minimum Controls Assumed to be Implemented at Construction and Operational Phases

Phase	Work Activities	Minimum Controls
Construction	General construction activities, including site preparation works, finishing works	• Ensure that hoarding is installed around the Project site or work areas to control the dispersion of dust. • Perform earthworks in phases to reduce the extent of exposed footprint at one time.
	Demolition and removal of existing building or structure	• Ensure effective water suppression is used during demolition operations. • Minimize drop height. • Avoid crushing or screening of demolished construction material on-site.
	Site clearance / tree removal Earthworks, including excavations, slope forming and slope stabilization	• Prepare an Earth Control Measures Plan.
	Operation of construction machinery, heavy vehicles and equipment	• Ensure that vehicles and equipment are not left idling when not in use. • Maintain and operate all equipment and machinery in a manner such that it does not give rise to smoke emissions, and ensure emissions comply with the Environmental Protection and Management (Vehicular Emissions) Regulations or Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations 2012, if applicable. • A list of equipment shall be submitted demonstrating consideration of alternatives.
	Movement of construction machinery, heavy vehicles and equipment	• Ensure that truck loads carrying dry materials (such as cement, sand, aggregate, soil etc.) into the construction area will be covered. • Periodically wet the unpaved temporary access roads to prevent dust propagation. • Ensure that workers clean up any spoil/earth spillage onto the haulage routes immediately and undertake proper housekeeping of the construction site, as well as roadways linked to the entrances of the worksites, to ensure that roadways, vehicle

Phase	Work Activities	Minimum Controls
		wheels and equipment tracks are clear of dust or mud, and that appropriate barriers, tarpaulin covers/erosion blankets (fully biodegradable, wildlife-friendly) have been repaired and/or reinstated. • Impose a maximum-speed-limit of 10 kilometres per hour (km/hr) as per Vehicular Entry Permit in publicly accessible areas of the parks, 25km/hr on non-publicly accessible areas on paved or surfaced haul roads and 15 km/hr on unpaved haul roads and work areas.
	Stockpiling on the construction site	• Ensure all stockpiles of demolished items, debris or good earth / aggregates are covered under canvas sheets or erosion control blankets (fully biodegradable, wildlife-friendly). • Minimise the volume of spoil stockpiled and potential for dust generation and erosion/runoff, schedule removal of spoil from the contract area at least once every five (5) days.
Operational	Emissions from increased traffic	• None required.
	Emissions from park M&E equipment (backup diesel generator), and landscaping and maintenance equipment (e.g., lorry cranes, grass cutter, chainsaws, leaf blowers, etc.)	• The Board shall ensure that the park backup diesel generator and all landscaping and maintenance-related equipment, machineries and vehicles are maintained and operated in a manner such that it does not give rise to excessive smoke emissions, and ensure emissions comply with the Environmental Protection and Management (Vehicular Emissions) Regulations or Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations 2012, if applicable.

9.2 Identification of Air Sensitive Receptors

The ASRs identified for the Project include human receptors i.e., residents staying adjacent / near to the proposed Project, students from the nearby schools during the construction phase, park visitors / members of public (off-site receptors) during the operational phase, and natures areas during both construction and operational phases. As BBNP and BBTP are expected to continue to be partially opened to public, air sensitive human receptors for the park also include park visitors / members of public (for BBNP and BBTP only) (on-site receptors).

A list of the identified ASRs located near / adjacent to the Project (off-site), which might be impacted by the proposed development, is presented under Table 9-2.

Table 9-2: List of ASRs (Human Receptors)

Study Area	Sensitive Receptor ID	Description	Land Use	Direction and Approximate Distance (m)	Air Emission Source/ Construction Activity
Bukit Batok Nature Park (BBNP)					
B1	SR5	Park Natura	High-rise residential	390-m east 330-m southeast 400-m south	BBNP Car park & Main Entrance construction BBNP Plaza & Play Area construction BBNP Proposed trails towards quarry Works
	SR6	Shamah Terrace	Landed residential	250-m east 300-m southeast 400-m south	BBNP Car park & Main Entrance construction BBNP Plaza & Play Area construction BBNP Proposed trails towards quarry Works
	SR7	St Mary of the Angels Church	Place of worship	115-m west 435-m southwest	BBNP Car park & Main Entrance construction BBNP Plaza & Play Area construction
B2	SR8	Park Palais	High-rise residential	700-m north 600-m north	BBNP Plaza & Play Area construction Slope Stabilisation
	SR9	Lorong Sesuai	Landed residential	495-m northeast 330-m north 270-m north	BBNP Plaza & Play Area construction BBNP Proposed trails towards quarry Works BBNP Slope Stabilisation
B3	SR10	Meralodge	High-rise residential	485-m north 480-m northwest 540-m northwest	BBNP Plaza & Play Area construction BBNP Proposed trails towards quarry Works BBNP Slope Stabilisation
	SR11	Hillview Apartment	High-rise residential	700-m north 620-m north 625-m northwest	BBNP Plaza & Play Area construction

Study Area	Sensitive Receptor ID	Description	Land Use	Direction and Approximate Distance (m)	Air Emission Source/ Construction Activity
					BBNP Proposed trails towards quarry Works BBNP Slope Stabilisation
B4	SR12	BLK 259 HDB Bukit Batok East	High-rise residential	430-m northwest 415-m northwest	BBNP Car park & Main Entrance construction BBNP Plaza & Play Area construction
	SR13	The Petals	High-rise residential	430-m north 435-m northwest	BBNP Plaza & Play Area construction BBNP Proposed trails towards quarry Works
	SR14	Hillview Cres	Landed residential	525-m northwest	BBNP Plaza & Play Area construction
C2	SR15	BLKS 266-267 HDB Bukit Batok East	High-rise residential	150-m north 300-m west	BBNP Car park & Main Entrance construction BBNP Plaza & Play Area construction
Bukit Batok Town Park (BBTP)					
D	SR16	Regent Heights	High-rise residential	500-m southeast	BBTP Courtyard construction
	SR17	BLKS 510-511 HDB Bukit Batok	High-rise residential	440-m south	BBTP Courtyard construction
	SR18	Hillgrove Secondary School	School	350-m south	BBTP Courtyard construction
	SR19	Lianhua Primary School	School	350-m south	BBTP Courtyard construction
	SR20	Guilin View	High-rise residential	140-m southwest	BBTP Courtyard construction
	SR21	BLK 524 HDB Bukit Batok	High-rise residential	70-m west	BBTP Courtyard construction
	SR22	BLK 383 HDB Bukit Batok West	High-rise residential	580-m northwest	BBTP Courtyard construction
	SR23	Hillview Court	Landed residential	470-m northeast	BBTP Courtyard construction
	SR24	The Hilloft	Landed residential	450-m northeast	BBTP Courtyard construction
	SR25	Chu Yen St/Chu Lin Rd	Landed residential	380-m east	BBTP Courtyard construction
	SR26	Hilltop Grove	High-rise residential	465-m east	BBTP Courtyard construction

Study Area	Sensitive Receptor ID	Description	Land Use	Direction and Approximate Distance (m)	Air Emission Source/ Construction Activity
	SR27	Merawoods	High-rise residential	545-m east	BBTP Courtyard construction
Bukit Batok Hillside Nature Park (BBHNP)					
E	SR28	West Plains@Bukit Batok	High-rise residential	300-m northwest 430-m southwest	BBHNP Arrival Node construction Removal of GFRC rocks
	SR29	Bukit Batok Home for the Aged	Homes for the aged	260-m northwest	Removal of GFRC rocks construction
	SR30	BLK 425 HDB Bukit Batok West	High-rise residential	220-m northwest	Removal of GFRC rocks construction
	SR31	BLK 315 HDB Bukit Batok	High-rise residential	390-m north 40-m northeast	BBHNP Arrival Node construction Removal of GFRC rocks
	SR32	Dazhong Primary School	School	400-m northeast 150-m southeast	BBHNP Arrival Node construction Removal of GFRC rocks
	SR33	BLK 306 HDB Bukit Batok	High-rise residential	275-m northeast 225-m southeast	BBHNP Arrival Node construction Removal of GFRC rocks
	SR34	BLK 302 HDB Bukit Batok	High-rise residential	380-m east 400-m southeast	BBHNP Arrival Node construction Removal of GFRC rocks
	SR35	The Madeira	High-rise residential	520-m east 430-m southeast	BBHNP Arrival Node construction Removal of GFRC rocks
	SR39	BLK 467 Bukit Batok West Ave 9	High-rise residential	130-m west	BBHNP Arrival Node construction
	SR40	Future West Hill @ Bukit Batok	High-rise residential	235-m northwest 250-m southwest	BBHNP Arrival Node construction Removal of GFRC rocks
	SR41	Future West Glades @ Bukit Batok	High-rise residential	200-m east 320-m south	BBHNP Arrival Node construction Removal of GFRC rocks

While park visitors / members of the public could also be potentially exposed to air pollutants arising (mainly PM_{10} and $PM_{2.5}$) from the construction activities as listed under Table 9-1 at BBNP and BBTP, which will be partially opened throughout the construction phase, the visitors are not expected to

be exposed over an extended period (exposed for eight hours or more in a day). The **Receptor Sensitivity** for the BBNP park visitors / members of public is classified as **Priority 3**.

Residents and students residing / located near to BBNP, BBTP and BBHNP (off-site receptors) could potentially be exposed to air pollutants arising from the construction activities, if carried by the prevailing wind. While these group of human receptors are not expected to be exposed for eight (8) hours or more in a day, as a conservative approach, the **Receptor Sensitivity** for this group is classified as **Priority 1**. Considering the future Project is nature area of nationally designated sites, the **Receptor Sensitivity** is classified as **Priority 2**.

Table 9-3: Receptor Sensitivity for the Respective Study Areas During Construction Phase

Proposed Development (Study Area)	Receptor Sensitivity		
	Human Receptors		Nature Areas
	Park Visitors / Member of Public	Nearby Residents / Students	
BBNP (Study Areas B1 [West of Lor Sesuai])	Priority 3*	Priority 1	Priority 2
BBTP (Study Area D)			
BBHNP (Study Area E)	-		
Note: * BBNP and BBTP will be partially opened to the public throughout the construction phase			

No major air emissions are expected during operational phase, other than the emission from vehicles from the potential of traffic increase at some of the parks, especially for parks with car parks e.g., BBNP, and emissions from the park M&E equipment (backup diesel generator), and landscaping and maintenance works (e.g., use of lorry cranes, grass cutter, chainsaws, leaf blowers, etc. for landscape pruning and renovation works) at the parks.

During operational phase, the park visitors and members of public could potentially be exposed to the air pollutants from these potential sources of pollutants when visiting these parks. The **Receptor Sensitivity** of the receptors are classified **Priority 3**, while the Project, which serves as nature areas of nationally designated sites is classified as **Priority 2**.

Table 9-4: Receptor Sensitivity for the Respective Study Areas During Operational Phase

Proposed Development (Study Area)	Receptor Sensitivity	
	Human Receptors	Nature Areas
	Park Visitors / Member of Public	
BBNP (Study Areas B1 [West of Lor Sesuai])	Priority 3	Priority 2
BBTP (Study Area D)		
BBHNP (Study Area E)		

9.3 Potential Impacts on Air Quality

9.3.1 Construction Phase

Sensitive receptors can be potentially exposed to air pollutants arising from activities taking place during the project's construction phase. The sources that could potentially impact the air quality throughout Project include, but are not limited to, those listed in Table 9-5.

Table 9-5: Potential Air Quality Impacts during the Construction Phase

Relevant Development / Study Area	Activity	Potential Source of Impacts	Potential Associated Impacts
BBNP (Study Areas B1 [West of Lor Sesuai]) BBTP (Study Area D) BBHNP (Study Area E)	Demolition and removal of existing buildings or structures (minor scale)	• Air emission generated from the minor demolition of existing structures including the existing shed near to the BBNP toilet, the stonewall and walkway along Little Guilin at BBTP, and existing wooden shelter, pergola and boardwalk at BBHNP	• Potentially result in adverse impacts on air quality, and public and ecosystem health; and • Potentially generate significant nuisance at receptors (human receptors) in the vicinity of the construction footprint/ proposed development.
BBHNP (Study Area E)	Demolition and removal of existing building or structure (moderate scale)	• Air emission generated form the demolition of GFRC	
BBNP (Study Areas B1 [West of Lor Sesuai]) BBTP (Study Area D)	Slope forming and stabilization	• Air emissions generated from the exposed earth surface due to slope forming and stabilization activities	
BBNP (Study Areas B1 [West of Lor Sesuai]) BBTP (Study Area D) BBHNP (Study Area E)	Site clearance, Earthworks, including excavations Stockpiling on the construction site Use of machinery, heavy vehicles and equipment Movement of construction vehicles General construction activities	• Air emissions generated from site clearance, earthworks, including soil-stripping, ground levelling, excavations, stockpiling and landscaping.	
		• Air emissions from the use of heavy machinery, heavy vehicles and equipment	
		• Air emission generated from movement of construction vehicles, and transport of earth / material from the site onto public road network, where it may be deposited and resuspended by vehicles using the existing road networks.	

Relevant Development / Study Area	Activity	Potential Source of Impacts	Potential Associated Impacts
		• Air emissions generated from the construction of new structures, their modification or refurbishment.	

9.3.2 Operational Phase

No significant air emissions are expected during operational phase, other than the emission from vehicles from the potential of traffic increase at some of the parks, and emissions from the M&E equipment (backup diesel generator), landscaping and maintenance equipment (e.g., landscape pruning and renovation works) at the parks, which are not expected to be significant.

9.4 Prediction and Evaluation of Air Quality Impacts

9.4.1 Construction Phase

During construction phase, the **Impact Intensity** arising from the on-site construction activities are expected to be **Negligible** to **High**. Based on the land area of the proposed development footprint, soil type encountered during the baseline study and the total materials anticipated to be moved, the impact intensity for air quality for the respective development or study areas are scored and listed in Table 9-6.

Table 9-6: Summary of Impact Intensity of the Respective Development/Study Area during Construction Phase

Relevant Development / Study Area	Impact Intensity Assessment Criteria			Impact Intensity
	Earthwork Footprint (m^2)[1]	Soil Type[2]	Total Materials to be Moved (tonnes)[3]	
BBNP (Study Areas B1 [West of Lor Sesuai))	~36,000 (>10,000)	Clayey SAND, clayey/silty SAND and silty SAND *(soil type with large grain size)*	~28,500 (>20,000 – 100,000)	Low - High
BBTP (Study Area D)	~4,000 (>2,500 - 10,000)	Sandy SILT *(moderately dusty soil type)*	~3,200 (<5,000)	Negligible - Medium
BBHNP (Study Area E)	~4,000 (>2,500 - 10,000)	Silty/Gravelly SAND, gravelly SAND *(soil type with large grain size)*	~3,200 (<5,000)	Negligible - Medium

Note:

[1] Based on the proposed development footprint with a 10% allowance for access construction

[2] Based on the soil baseline study

[3] Derived based on the anticipated earthwork footprint, multiplied by 0.4 m (anticipated excavation depth for existing trail removal and new trail constructions). Materials to be moved are assumed of clay/silt material; 1 m^3 of clay/silt is approximately 2 tonnes

The **Impact Consequences** (Receptor Sensitivity x Impact Intensity) is therefore considered **Negligible** to **High**.

Based upon implementation of the minimum controls, where applicable, it is unlikely that excessive release of air pollutants, that may adversely impact the air quality, will regularly occur during the construction phase. On this basis, the **Likelihood** of occurrence during construction phase is expected to be **Possible / Occasional**.

Therefore, the **Impact Significance** (Impact Consequences x Likelihood) for the construction phase is assessed to be **Negligible** to **Moderate** for both Human Receptors and Nature Areas.

Table 9-7: Summary of Impact Evaluation during Construction Phase

Relevant Development / Study Area	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
BBNP (Study Areas B1 [West of Lor Sesuai))	Human Receptor - Priority 1 to 3	Low - High	Very Low to High	Possible / Occasional	Minor to Moderate
	Nature Areas – Priority 2		Very Low to Medium	Possible / Occasional	Minor to Moderate
BBTP (Study Area D)	Human Receptor - Priority 1 to 3	Negligible - Medium	Negligible to Medium	Possible / Occasional	Negligible to Moderate
	Nature Areas – Priority 2		Negligible to Low	Possible / Occasional	Negligible to Minor
BBHNP (Study Area E)	Human Receptor - Priority 1	Negligible - Medium	Negligible to Medium	Possible / Occasional	Negligible to Moderate
	Nature Areas – Priority 2		Negligible to Low	Possible / Occasional	Negligible to Minor

9.4.2 Operational Phase

During operational phase, the **Impact Intensity** for air quality arising from the operations of the BBNP, BBTP, and BBHNP i.e., emissions from vehicular movement and emissions from M&E equipment (backup diesel generator), landscaping and maintenance equipment (e.g., landscape pruning and renovation works) at the parks, is expected to be **Low** (i.e., small scale increase in air quality levels in the vicinity of proposed development).

The **Impact Consequence** (Receptor Sensitivity x Impact Intensity) is therefore considered **Very Low**. The **Likelihood** of occurrence of a significant release of air pollutant(s) during the operational phase is assessed to be **Less Likely / Rare**.

Therefore, the **Impact Significance** (Impact Consequences x Likelihood) to both human receptors and nature areas for the operational phase is assessed to be **Negligible**.

Table 9-8: Summary of Impact Evaluation during Operational Phase

Relevant Development / Study Area	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
BBNP (Study Areas B1 [West of Lor Sesuai]) BBTP (Study Area D) BBHNP (Study Area E)	Human Receptor - Priority 3	Low	Very Low	Less Likely / Rare	Negligible
	Nature Areas – Priority 2	Low	Very Low	Less Likely / Rare	Negligible

9.5 Recommended Mitigation Measures

9.5.1 Construction Phase

Based on the assessment in Section 9.4.1, the **Impact Significance** during the construction phase at BBNP, BBTP, and BBHNP was determined to be **Negligible to Moderate** for both human receptors and nature areas. As a mitigation measure, a site-specific Air Pollution Control Plan (APCP) should be developed to put in place measures such as establishing communications, implementation of site management measures, monitoring, etc., to further reduce the Likelihood of occurrence of the anticipated impact.

9.5.2 Operational Phase

As the impact significance on the sensitive receptors for air quality is **Negligible** during the operational phases, no additional management or mitigation measures are required, other than to implement the minimum controls.

9.6 Residual Impacts

9.6.1 Construction Phase

Residual Impact Assessment assumes that the mitigation measures within Section 9.5.1 are implemented in the development / construction footprint at BBNP, BBTP and BBHNP. The Likelihood of occurrence of a significant adverse impact would be classified as **Less Likely / Rare**, subject to relevant mitigation measures identified being implemented. This Likelihood is combined with Impact Consequence to provide the residual **Impact Significance** results for the construction footprint. The residual Impact Significance is listed in Table 9-9 below.

Table 9-9: Summary of Residual Impact Evaluation during Construction Phase (Post Implementation of Mitigation Measures)

Relevant Development / Study Area	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
BBNP (Study Areas B1 [West of Lor Sesuai])	Human Receptor - Priority 1 to 3	Low - High	Very Low to High	Less Likely / Rare	Negligible - Minor

Relevant Development / Study Area	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
	Nature Areas – Priority 2		Very Low to Medium	Less Likely / Rare	Negligible - Minor
BBTP (Study Area D)	Human Receptor - Priority 1 to 3	Negligible - Medium	Negligible to Medium	Less Likely / Rare	Negligible - Minor
	Nature Areas – Priority 2		Negligible to Low	Less Likely / Rare	Negligible - Minor
BBHNP (Study Area E)	Human Receptor - Priority 1 to 3	Negligible - Medium	Negligible to Medium	Less Likely / Rare	Negligible - Minor
	Nature Areas – Priority 2		Negligible to Low	Less Likely / Rare	Negligible - Minor

Based on the assessment, by implementing the proposed mitigation measures, the Impact Significance at BBNP, BBTP and BBHNP is expected to reduce from **Negligible to Moderate** to **Negligible to Minor** for both human receptors and nature areas.

10. SOIL AND SEDIMENT QUALITY IMPACT EVALUATION AND MITIGATION

10.1 Minimum Control Measures

Table 10-1 sets out the minimum controls that are assumed to be implement for the project during construction and operational phases to reduce impacts to soil (and potentially groundwater) and sediment.

Table 10-1: Description of Minimum Controls Assumed to be Implemented at Construction and Operational Phases

Phase	Work Activities	Minimum Controls
Construction and Operational	Storage, use and refuelling of equipment and machinery	• Practice due diligence in proper storage and handling of machinery to prevent release of chemicals, fuels or other potentially harmful materials. • Transfer of fuel shall be done over contaminant trays and mats to prevent spillage into the ground. • Ensure oil-containing equipment or machineries are inspected for leaks before being put into use. • Provide emergency spill kits on site in the event of any fuel spillages. The emergency response team shall also be competent in the use of these spill kits.
	Chemical and fuel storage	• Chemical and fuel in drums, carboys, containers, etc shall be stored in a designated storage area within a building or covered shed with concrete floors and containment facilities to contain any leak or spillage. • A full containment should be provided for bulk storage oil tanks, including skid tanks. • Ensure all hazardous substance and chemical containers are labelled as per the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) requirement. • Ensure a chemical inventory is maintained to track the movement of all hazardous substance and chemicals. • Return the chemicals back to its designated storage areas when not in use. • Transfer of chemicals shall be done over contaminant trays and mats to prevent spillage into the ground. • All leaks and spillages in the storage area or construction site shall be collected and sent to a licensed toxic waste collector for proper disposal. • Provide emergency spill kits on site in the event of any chemical spillages. The emergency response team shall also be competent in the use of these spill kits.

Phase	Work Activities	Minimum Controls
	Toxic waste storage and disposal	• Ensure TIWs are stored in a designated storage area within a building or covered shed with concrete floors and containment facilities to contain any leak or spillage. • Maintains a TIW register, which is to be updated on a weekly basis. • TIW shall be collected regularly by a licensed TIW collector for off-site disposal. • Ensure leaks and spillages in the TIW storage area or construction site are collected and sent to a licensed toxic waste collector for proper disposal.

10.2 Identification of Soil and Sediment Sensitive Receptors

The sensitive receptors identified include human receptors i.e., visitors / members of public at BBNP and BBHNP, which will be partially opened during the construction phase, visitors / members of public during the operational phase for BBNP, BBTP and BBHNP, and natures areas at all parks. As human receptors at the proposed Project, which is designated as a park, are not expected to come into contact with soil and sediment over an extended period under normal circumstances during both construction and operational phase, the **Receptor Sensitivity** is classified as **Priority 3**. Considering the future Project are nature areas of nationally designated sites, the **Receptor Sensitivity** is classified as **Priority 2**.

Table 10-2: Receptor Sensitivity for the Respective Study Areas During Both Construction and Operational Phase

Proposed Development (Study Area)	Receptor Sensitivity	
	Human Receptors	Nature Areas
BBNP (Study Area B1 [West of Lor Sesuai])	Priority 3	Priority 2
BBTP (Study Area D)		
BBHNP (Study Area E)		

10.3 Potential impacts on Soil and Sediment

10.3.1 Construction Phase

Soil and sediment can be potentially exposed to contamination due to the activities taking place during the project's construction phase. The sources that could potentially impact nearby soil and sediment quality throughout Project include, but are not limited to, those listed in Table 10-3.

Table 10-3: Potential Soil and Sediment Quality Impacts during the Construction Phase

Relevant Development / Study Area	Activity	Potential Source of Impacts	Potential Associated Impacts
BBNP (Study Area B1 [West of Lor Sesuai]) BBTP (Study Area D) BBHNP (Study Area E)	Improper storage, use and refuelling of construction equipment and machinery	• Accidental release of hydrocarbon products due to leakages or spillages from the storage, use and refuelling of equipment and machinery	• Potential for direct soil and/or groundwater, and sediment contamination within the Study Area. • Potential pollution to the adjacent areas within the immediate vicinity of the project

Relevant Development / Study Area	Activity	Potential Source of Impacts	Potential Associated Impacts
	Improper handling, transfer, refuelling and storage of chemical and fuel (e.g., diesel, bentonite, lubricants, oils, grease, paints, solvents, waste treatment chemicals, etc.)	• Accidental release of chemical and fuel due improper handling of chemical and fuel	due to migration of soil and/or groundwater contamination, off-site.
	Improper handling, transfer and storage of toxic waste (e.g., spent oil, used chemical / oil containers, etc.)	• Accidental release of chemical and fuel due improper handling of toxic waste	

10.3.2 Operational Phase

Soil and sediment can be potentially exposed to contamination due to the activities taking place during the project's operational phase. The sources that could potentially impact nearby soil and sediment quality throughout Project include, but are not limited to, those listed in Table 10-4.

Table 10-4: Potential Soil and Sediment Quality Impacts during the Operational Phase

Relevant Development / Study Area	Activity	Potential Source of Impacts	Potential Associated Impacts
BBNP (Study Areaa B1 [West of Lor Sesuai]) BBTP (Study Area D) BBHNP (Study Area E)	Improper maintenance of M&E equipment (e.g., diesel generator)	• Accidental release of hydrocarbon products due to leakages or spillages from the operations and maintenance of M&E equipment	• Potential for direct soil and/or groundwater, and sediment contamination within the Study Area. • Potential pollution to the adjacent areas within the immediate vicinity of the project due to migration of soil and/or groundwater contamination, off-site.
	Improper handling, transfer, refuelling and storage of chemical and fuel (e.g., diesel, lubricants, oils, grease, solvents, etc.)	• Accidental release of chemical and fuel due improper handling of chemical and fuel	
	Improper handling, transfer and storage of toxic waste (e.g., spent oil, used chemical / oil containers, etc.)	• Accidental release of chemical and fuel due improper handling of toxic waste	

It is anticipated that there will be limited sources of impacts to soil sediment during the operational phase as use of chemicals and generation of toxic chemical waste are expected to be of limited quantities.

10.4 Prediction and Evaluation of Soil and Sediment Impacts

10.4.1 Construction Phase

During construction phase, the Impact Intensity arising from improper storage, use and refuelling of construction equipment and machinery and improper handling and storage of chemicals, fuels and toxic waste are expected to be Low (small scale localised soil and/or sediment contamination which is not likely to extend beyond the Study Area and possible to remediate), assuming the minimum controls listed under Table 11-1 are implemented.

The **Impact Consequences** (Receptor Sensitivity x Impact Intensity) is therefore considered **Very Low**.

Based upon implementation of the minimum controls, where applicable, it is unlikely that discharge, spillage or leakage from construction equipment and machinery, chemicals, fuels and toxic waste handling and storage in a quantity that may adversely impact the soil (and/or groundwater) and sediment will regularly occur during the construction phase. On this basis, the Likelihood of occurrence during construction phase is expected to be Possible / Occasional.

Therefore, the **Impact Significance** (Impact Consequences x Likelihood) for the construction phase is assessed to be **Minor**.

Table 10-5: Summary of Impact Evaluation during Construction Phase

Relevant Development / Study Area	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
BBNP (Study Area B1 [West of Lor Sesuai]) BBTP (Study Area D) BBHNP (Study Area E)	Human Receptor - Priority 3	Low	Very Low	Possible / Occasional	Minor
	Nature Areas – Priority 2				

10.4.2 Operational Phase

During operational phase, the **Impact Intensity** arising from improper maintenance of M&E equipment, and improper handling and storage of chemicals, fuels and toxic waste are expected to be **Low** (small scale localised soil and/or sediment contamination which is not likely to extend beyond the Study Area and possible to remediate), assuming the minimum controls listed under Table 11-1 are implemented. It is also expected that there will be little use of hazardous chemicals/substances and fuel, and generation of toxic waste during the operational phase.

The **Impact Consequences** is therefore considered **Very Low**.

With the minimum controls implemented, the **Likelihood** of occurrence of a chemical, fuel or toxic waste spill leading to soil (and/or groundwater) and sediment contamination is assessed to be **Less Likely / Rare** during operational phase.

Therefore, the **Impact Significance** for the operational phase is assessed to be **Negligible**.

Table 10-6: Summary of Impact Evaluation during Operational Phase

Relevant Development / Study Area	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
BBNP (Study Area B1 [West of Lor Sesuai]) BBTP (Study Area D) BBHNP (Study Area E)	Human Receptor - Priority 3	Low	Very Low	Less Likely / Rare	Negligible
	Nature Areas – Priority 2				

10.5 Recommended Mitigation Measures

The significance of the identified impacts on the sensitive receptors to soil and sediment range from **Minor to Negligible** during both construction and operational phases. Thus, no additional management or mitigation measures are required, other than to implement the minimum controls.

11. SURFACE HYDROLOGY AND WATER QUALITY IMPACT EVALUATION AND MITIGATION

11.1 Minimum Control Measures

Table 11-1: Description of Minimum Controls Assumed to be Implemented during the Construction and Operational Phases

Phase	Key Work Activities	Minimum Controls
Site preparation and construction	(refer to Table 7-2) • Vegetation clearance/removal • Earthworks • Construction (sub- and super-structure) • Finishing works	**Main**: All work must comply to the PUB, Singapore's National Water Agency's *Code of Practice on Surface Water Drainage*, particularly Section 6 – *Requirements for Construction Activities*. The key relevant requirements are highlighted below: <u>General</u> • The execution of any work shall not change, disrupt, fill, block, divert or disturb the existing overland flow or the existing system of drains unless an alternative drainage system has been approved by PUB. • The runoff within, upstream of and adjacent to the worksite shall be effectively drained away without causing drainage problems within the worksite or in areas outside the worksite. • Bunds of stockpiled materials such as earth from trench work shall not be longer than 10 m and gaps of at least 1 m width shall be provided between the bunds to allow the free flow of surface runoff. • Material from any stockpile shall not be allowed to fall or be washed into the drain. <u>Earth Control Measures</u> • Water quality parameter compliance: The discharge from any construction / earthwork sites into storm water drainage system shall not contain Total Suspended Solids (TSS) in concentrations greater than, the prescribed limits under Regulation 4(1) of the Sewerage and Drainage (Surface Water Drainage) Regulations. • Minimal or no discharge: Wherever possible, a construction / earthwork site should practise recycling of water. The recycled water could be used for non-potable purposes to minimise discharge into the stormwater drainage systems. • Design criteria: The ECM shall be designed to cope with a minimum design rainfall intensity of a return period of 1 in 5 years storm. • ECM installation before commencement of work: The ECM shall be installed by the site operator / contractor according to the endorsed plans and the completed ECM at site shall be approved by the Qualified Erosion Control Professional (QECP) before commencement of construction and earthworks.

Phase	Key Work Activities	Minimum Controls
		• The site operator/contractor shall ensure that the ECM designed and installed shall be continuously reviewed by the QECP for every stage of the earthworks and construction. The ECM shall remain effective throughout the whole duration of works. The site operator/contractor shall add or amend the ECM at the site according to the design of the QECP. <u>Guidelines of effective ECM</u> An effective ECM requires 2 components which shall include, but is not limited to, the following minimum measures in order to meet the legal requirements cited under Regulation 4(1) of the Sewerage and Drainage (Surface Water Drainage) Regulations: • Erosion Control Measures: The erosion control measures shall minimise the extent and duration of any exposed /bare / erodible surfaces by proper work sequencing, covering up of all bare/erodible surfaces and progressive and timely revegetation and stabilisation. • Sediment Control Measures: The sediment control measures shall trap, contain and treat the silty discharges from within a construction / earthworks site (including rain, runoff, water from wash bay, underground water at basement, etc.) by providing: perimeter cut-off drain, perimeter silt fence, intermediate silt trap, sedimentation basin or storage pond/tank, treatment system, turbidity curtains, wheel wash.
Operational	General	• Strategically allocate garbage bins to minimise the likelihood of littering into water bodies. • Put up signs to remind park users to not litter into the water bodies and the environment.

11.2 Potential Impacts on Surface Hydrology and Water Quality

Section 11.2.1 and Section 11.2.2 detail the common potential impacts on surface hydrology and water quality for all study areas during the construction and operational phases. The specific impacts relevant to each study area are further described in Section 11.3 to Section 11.5 respectively.

11.2.1 Construction Phase

Nearby waterbodies can be potentially exposed to contamination and hydrological impacts due to the activities taking place during the project's construction phase. The sources that could potentially impact nearby surface hydrology and water quality include, but are not limited to, those listed in Table 11-2.

Table 11-2: Potential Surface Hydrology and Water Quality Impacts during the Construction Phase

Activity	Potential Source of Impacts	Potential Associated Impacts
Land clearing, earthworks and excavation activities	• Run-off from exposed soil surfaces, earth work areas, soil stockpiles; • Stormwater/groundwater pumped out from excavated areas;	Changes in surface hydrology and drainage: • Increased surface runoff can lead to elevated stormwater peak flow contributions to the channel, subsequently leading to increased water level and subsequent flooding of

Activity	Potential Source of Impacts	Potential Associated Impacts
	• Release of grouting and cement materials; • Run-off from dust suppression sprays; • Elevated suspended solids (e.g. silt and sediment) in site run-off due to heavy rain; • Spoil generation, handling and transport; and • Heavy rain during construction.	surrounding areas adjacent to the stream/drain due to the land use change from land clearing; and • Increased stormwater run-off from exposed and unstable slopes may cause soil erosion and erosion of stream banks. Water contamination: • Elevated levels of suspended solids leading to increased turbidity and sedimentation rates, solid waste, toxic material, etc; and • Increase in the levels of oil, grease, and other chemical substances. Liquid effluent generation: • Inappropriate discharge of wastewater to the watercourse will result in contamination in nearby water sources; and • Inappropriate discharge of domestic sewage and poor maintenance of the portable toilet (e.g. overflow or overload) can result in run-off to nearby water sources and potentially contaminate the waterbodies located adjacent to the construction sites. Solid wastes: • Solid waste generated can lead to elevated levels of suspended solids entering water-bodies via run-off or improper handling/disposal. • Improper storage, handling, disposal or leakage of toxic waste generated at temporary work areas can lead to water contamination. Improper management of chemical substances: • Contaminated stormwater due to improper storage/disposal/transport of chemical materials handled and stored on site leading to an increase in the levels of oil, grease and other chemical substances in the nearby waterbodies; and • Fuel and lubricants spillage from maintenance of construction vehicles and mechanical equipment can also lead to elevation in levels of oil in the nearby waterbodies.
Storage and disposal of solid wastes	• Improper handling, transfer, storage, and disposal of spoil and solid waste (e.g. excavated earth, construction debris).	
Storage and disposal of liquid wastes	• Improper management of sewage effluents from on-site; and • Inappropriate discharge of domestic sewage and poor maintenance of the portable chemical toilet, storage tanks and septic tanks (e.g. overflow or overload).	
Storage and disposal of toxic wastes	• Improper handling, transfer, and storage of toxic waste (e.g. contaminated excavated earth).	
Use and storage of chemical substances, and refuelling activities	• Improper handling, transfer, and storage of chemical substances; • Accidental spill and leaks; and • Fuel and lubricants spillage from maintenance of construction vehicles and mechanical equipment.	

11.2.2 Operational Phase

Waterbodies can potentially be exposed to contamination and hydrological impacts due to the activities taking place during the project's operational phase. The sources that could potentially impact on nearby surface hydrology and water quality include but are not limited to the ones listed in Table 11-3.

Table 11-3: Potential Surface Hydrology and Water Quality Impacts during Operational Phase

Activity	Potential Source of Impacts	Potential Associated Impacts
Stormwater Run-off Generation	• Heavy rain and stormwater wash-off pollutants built-up in the new development area and discharge to the streams; • Increase of runoff peak flow draining to the stream or drain during storm events due to the increase in urbanized area; and	Changes in surface hydrology and drainage: • Increased surface runoff can lead to elevated stormwater peak flow contributions to the channel, subsequently leading to increased water level and subsequent flooding of surrounding areas adjacent to the stream/drain;

Activity	Potential Source of Impacts	Potential Associated Impacts
		• Impervious ground cover reducing infiltration and the baseflow contributing to natural stream; and • Stormwater run-off from exposed and unstable slopes may cause soil erosion Surface Water Quality: • Elevated suspended solids (e.g. silt and sediment) and pollutants (e.g. heavy metals and nutrients from human activities) in site run-off
Increased number of park visitors	• Increased visitors can lead the increase of waste generation	Surface Water Quality: • Increased likelihood of littering into water bodies, particularly for those exposed to higher human traffic.

11.3 BBNP / Study Area B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2

11.3.1 Identification of Water Sensitive Receptors

There are two (2) pertinent main bodies of water for this part of BBNP / Study Area B1: the Poh Kim Quarry Lake (QB) located near the centre of Area B1 and the west-flowing stream (SB1a) at the southern boundaries of Areas B1 and C1. The waterbodies generally support aquatic habitat of medium ecological value (see section 12.4.1). These two (2) water bodies are assessed separately.

The quarry is as a manmade water body that supports a thriving ecosystem and provides recreational benefits for visitors, the Receptor Sensitivity is classified as **Priority 2**.

Considering the near-pristine nature of the stream, SB1a's Receptor Sensitivity is classified as **Priority 1**.

11.3.2 Prediction and Evaluation of Water Impacts

11.3.2.1 Construction Phase

Most of the work is expected to be carried out predominantly in the southern half of BBNP / Area B1. They include: (i) the Proposed trails towards quarry; (ii) the Heritage Trail; (iii) the Forest Discovery Trail and; (iv) the Stream Loop (Figure 11-1).

Quarry lake: Construction activities relevant to the Proposed trails towards quarry may have an impact on the quarry's water quality. Some pertinent features include the boardwalk on the banks of the quarry lake (Figure 11-2) and the plaza area near the quarry lake's outlet (Figure 11-3).

The primary concern relates to the potential erosion following land clearing and construction activities especially for the building of the boardwalk at the fringe of the water body. ECM will be implemented and therefore, the potential impacts can be mitigated. Quantity of eroded soil will be controlled and prevented from entering the water body. If sediments do wash into the water body, eventually they will settle to the quarry bed and turbidity will recover. The **Impact Intensity** is considered **Medium**, considering the proximity of construction activities to the water.

The **Impact Consequence** is therefore considered **Low** by taking into account the Receptor Sensitivity as Priority 2 and Impact Intensity as Medium.

The appointed contractors are expected to deploy sufficient erosion control measures during the construction phase to minimise potential impacts. As such, the projected impacts are expected to

be **Less Likely / Rare**. Taking this into account, the **Impact Significance** therefore falls in the **Minor** category.

With reference to surface hydrology, the quarry lake is an artificial water body with no natural surface inlet – its water level is kept regulated and relatively constant through an overflow outflow channel, hence surface currents are expected to be minimal. As such, and given the limited spatial extents of boardwalk construction works adjacent to the quarry lake edges and the short-term nature of the works, the changes to surface hydrology within the quarry lake are not expected to be measurable. Moreover, the edges of the quarry lake are largely lined with granite, hence the risks of erosion are negligible. Therefore, the **Impact Intensity** is considered **Negligible**, and the Impact Significance correspondingly **Negligible**.

Table 11-4: Summary of Impact Evaluation during Construction Phase for BBNP / Area B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2 (Quarry)

Receptor Sensitivity	Predicted Impact	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Priority 2	Surface water quality	Medium	Low	Less Likely / Rare	Minor
	Surface hydrology	Negligible	Negligible	Less Likely / Rare	Negligible

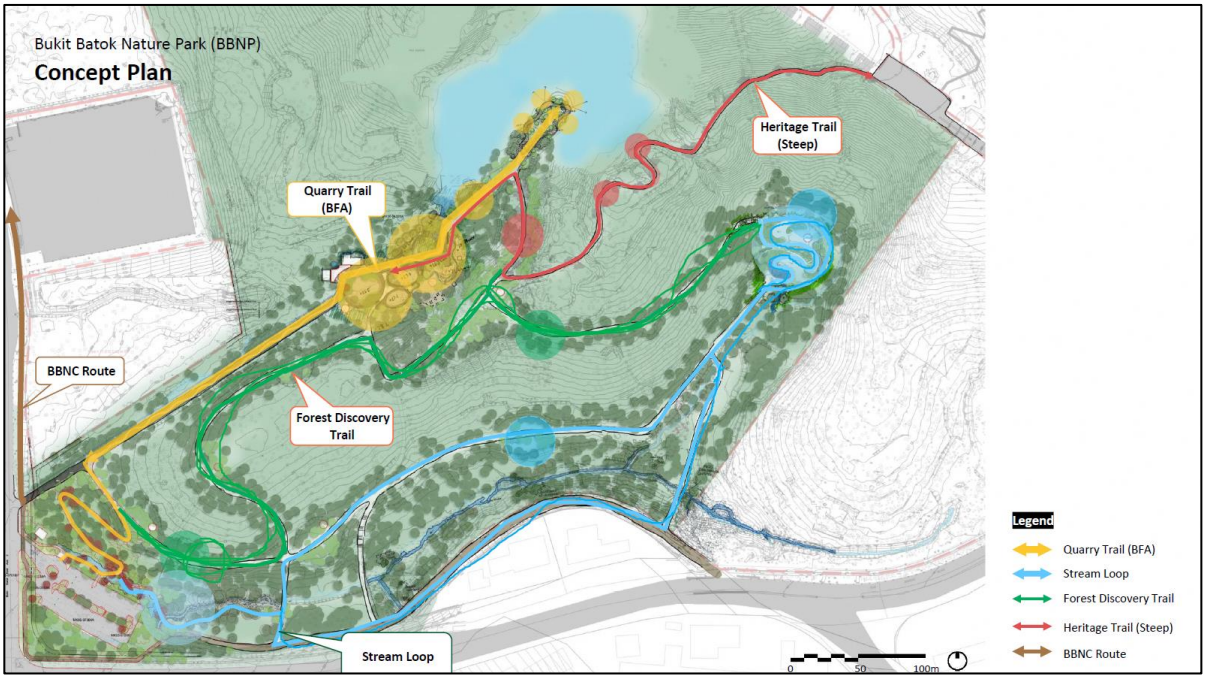


Figure 11-1: Proposed development work at BBNP / Study Area B1 and near C1

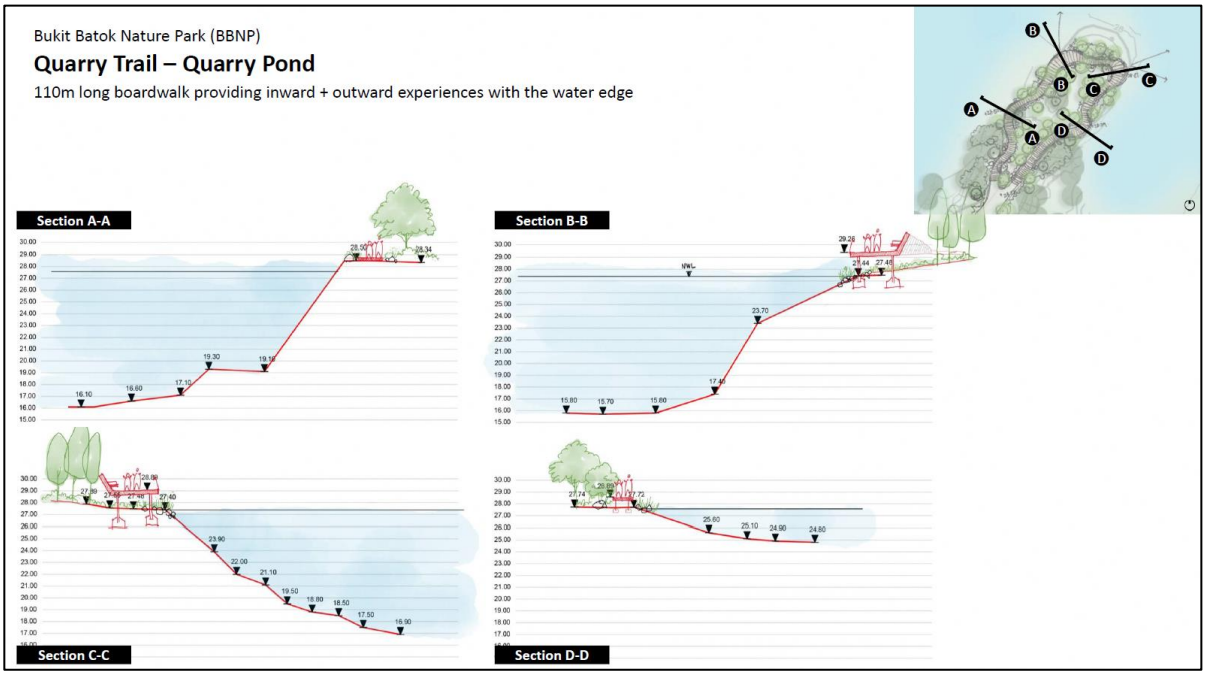


Figure 11-2: Sectional view of the proposed boardwalk at the BBNP Proposed trails towards quarry

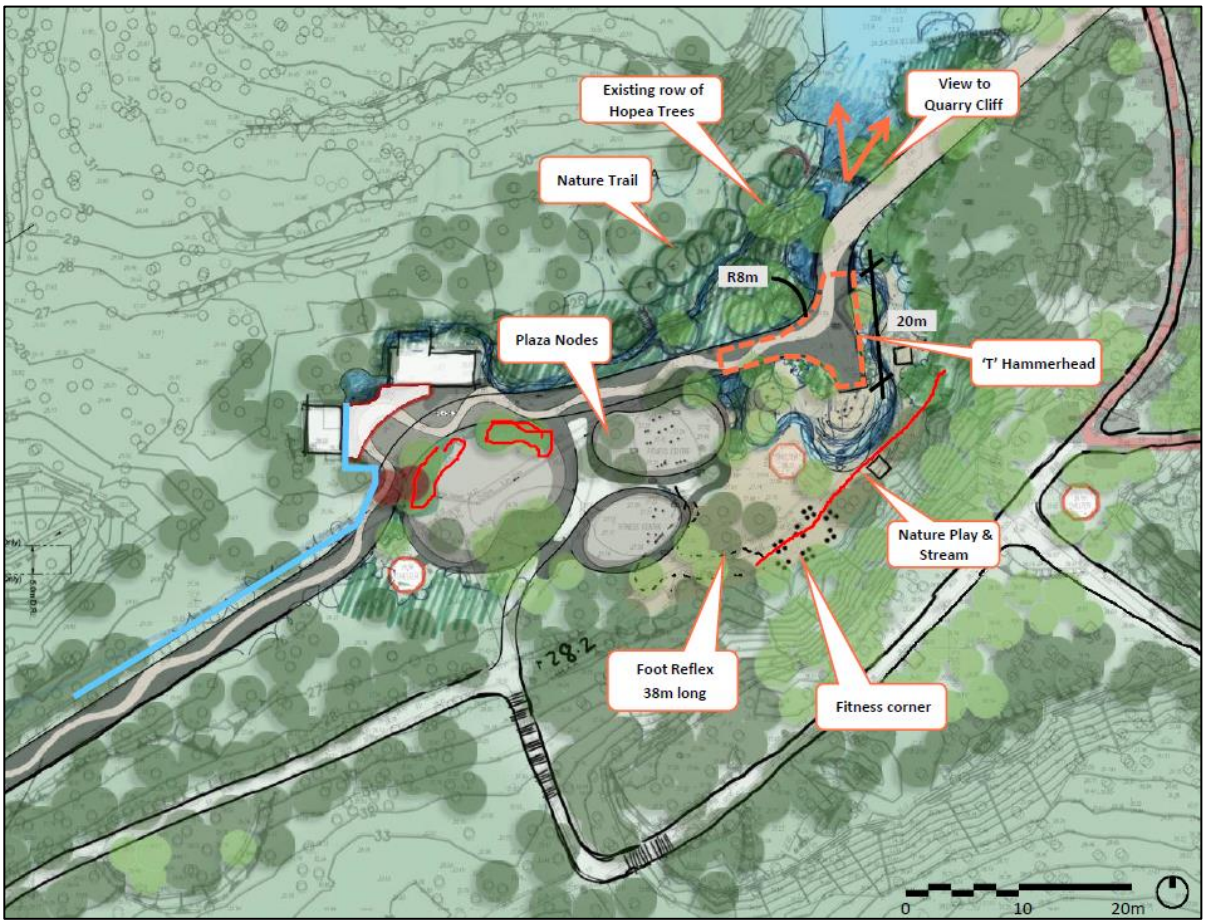


Figure 11-3: Proposed development of the at the BBNP Proposed trails towards quarry, near the quarry lake's outlet

Stream: The construction of the Stream Loop is not expected to have significant impacts to the existing stream (SB1a). The location of the proposed trail is sufficiently separated and buffered from the existing stream. Only a small segment bypasses the stream on the southeast corner of B1. As such, the **Impact Intensity** is considered as **Medium** with the implementation of the necessary minimum erosion control measures.

The **Impact Consequence** is therefore considered **Low** by taking into account the Receptor Sensitivity as Priority 1 and Impact Intensity as Medium.

The appointed contractors are expected to deploy sufficient erosion control measures during the construction phase to minimise potential impacts. As such, the projected impacts are expected to be **Less Likely / Rare**. Taking this into account, the **Impact Significance** therefore falls in the **Minor** category.

With reference to surface hydrology, given that the construction work area adjacent to stream SB1a is minimal, and given the phased approach of works, the spatial extent of exposed earth at any point in time is highly limited, relative to the broader catchment area of the stream. As such, the potential increase in surface runoff, peak flow, and water levels within the stream is not expected to be high, and will be short-term in nature. Nonetheless, the risks of hydrological changes resulting in bank erosion remains, given the high bank erosion hazard scores recorded for stream SB1a. As such, the **Impact Intensity** is considered as **Medium**, while the **Impact Significance** is predicted to be **Minor**.

Table 11-5: Summary of Impact Evaluation during Construction Phase for BBNP / Area B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2 (Stream)

Receptor Sensitivity	Predicted Impact	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Priority 1	Surface water quality	Medium	Medium	Less Likely / Rare	Minor
	Surface hydrology	Medium	Medium	Less Likely / Rare	Minor

11.3.2.2 Operational Phase

Quarry lake: There shall be an overall increase of paved surfaces at the area, especially with the construction of the trail and plaza. Corresponding to this will be the increase of surface runoff. However, Water Senstive Urban Design (WSUD)/ABC Waters features are expected to be implemented to negate this effect. In addition, bank stabilisation/erosion prevention features are also expected to be incorporated in the design. Another point of consideration is the potential littering by park visitors. Largely, the average visitor is expected to be civic minded enough to not litter. Impacts, if any, will be **Low** (**Impact Intensity**). The Impact Consequence is therefore considered Very Low by taking into account the Receptor Sensitivity as **Priority 2**. **Likelihood** of the impacts are considered **Less Likely / Rare** and therefore, the **Impact Significance** fall in the category of **Negligible**.

With reference to surface hydrology, given the increased surface runoff from the increase in impervious cover, there could potentially be an increase in the water levels of the quarry lake. Nonetheless, the presence of the outlet helps regulate the water level and keeps its variation to a minimum. Given that bank erosion of the quarry lake is not expected to be an issue due to the granite substrate, the Impact Significance fall in the category of **Negligible**.

Table 11-6: Summary of Impact Evaluation during Operational Phase for BBNP / Area B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2 (Quarry)

Receptor Sensitivity	Predicted Impact	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Priority 2	Surface water quality	Low	Very Low	Less Likely / Rare	Negligible
	Surface hydrology	Negligible	Negligible	Not expected to occur	Negligible

Stream: As discussed above, the stream is sufficiently separated from the route and therefore buffered from potential pollutants. Sediments as the result of the erosion of the earth path can be filtered by the vegetated space which acts as a buffer between the stream and the route. Park visitors will also likely be distanced from the stream and thereby, minimising the introduction of anthropogenic pollutants to the stream. Therefore, the **Impact Intensity** is considered **Low** and taking into account the **Receptor Sensitivity** as **Priority 1**, the **Impact Consequence** is classified as **Low** as well. As also mentioned above, the **Likelihood** of impacts is considered **Less Likely / Rare**. The Impact Significance is hence, **Minor**.

With reference to surface hydrology, given that following construction works, the vegetation adjacent to the stream will be reinstated and enhanced, it is not expected that the surface hydrological conditions and stream bank erosion risks deviate from baseline conditions. Consequently, the impact significance is taken to be **Negligible**.

Table 11-7: Summary of Impact Evaluation during Operational Phase for BBNP / Area B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2 (Stream)

Receptor Sensitivity	Predicted Impact	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Priority 1	Surface water quality	Low	Low	Less Likely / Rare	Minor
	Surface hydrology	Negligible	Negligible	Not expected to occur	Negligible

11.3.3 Recommended Mitigation Measures

The impact significance of both water bodies during the construction and operational phases range from **Negligible to Minor**. Therefore, no additional mitigation measures will be required.

11.4 BBTP / Study Area D

11.4.1 Identification of Water Sensitive Receptors

BBTP / Area D features three (3) main water bodies, namely, (i) the Seng Chew Quarry Lake to (QD1) the north of the site; (ii) the Little Guilin Quarry Lake (QD2) to the west and; (iii) a stream in the southeast corner of the site (SD1a). The latter flows southwards and discharges into an existing roadside drain.

All three (3) waterbodies generally support aquatic habitat of medium ecological value (see Section 12.4.1). There are no proposed developmental works at the existing stream and therefore, impacts to the water body is deemed negligible. Hence, the emphasis shall be on the Little Guilin Quarry Lake and Seng Chew Quarry Lake (Figure 11-4).

Both quarries are manmade water bodies that support thriving ecosystems. In addition, the Little Guilin Quarry Lake also provides recreational benefits for visitors. As such, the Receptor Sensitivity for both quarry lakes is classified as **Priority 2**.

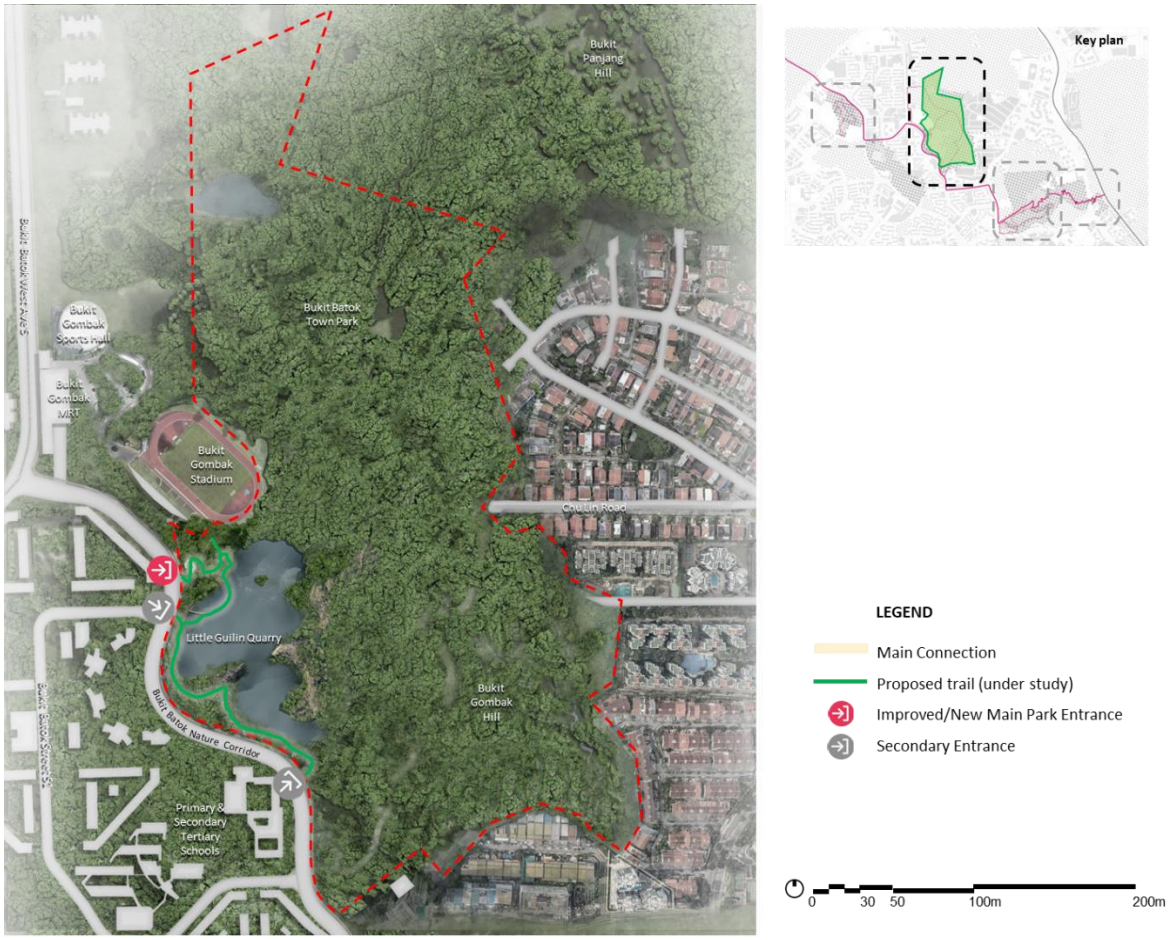


Figure 11-4: Proposed development at BBTP

11.4.2 Prediction and Evaluation of Water Impacts

11.4.2.1 Construction Phase

Little Guilin Quarry Lake: Most of the related key activities are for the construction of the boardwalk along the western banks of the water body (Figure 11-5). Construction work in close proximity to water sources increases the chances of contamination. Noteworthy is the northern stretch of the suspended boardwalk near the west entrance of the site. Here, construction work will be carried in the water body.

The relevant impacts will by and large be due to soil erosion from construction work on the banks. Eroded soil washed into the lake can increase TSS concentrations and turbidity. Where work is carried out in the lake, bed sediments can be suspended into the water column to increase TSS and turbidity as well. For the suspended boardwalk, no foundation work (e.g., piling) will be carried out. Instead, the suspended boardwalk takes the form of a series of pontoons (floating platforms) anchored to the bed of the quarry. This will ensure minimum disruption to the bedload material and therefore minimises deterioration of water quality. Hence, the **Impact Intensity** is considered to be **Medium**.

The **Impact Consequence** is therefore expected to be **Low** when considering the Receptor Sensitivity as Priority 2.

Likelihood of impact can be considered **Possible/Occasional**, particularly with the construction activities in the water bodies. When taking into account the Impact Consequence (Low), the **Impact Significance** is rated **Minor**.

With reference to surface hydrology, the quarry lake is an artificial water body with no natural surface inlet – its water level is kept regulated and relatively constant through an overflow outflow channel, hence surface currents are expected to be minimal. As such, and given the suspended nature of the boardwalk, the changes to surface hydrology within the quarry lake are not expected to be measurable. Moreover, the edges of the quarry lake are largely lined with granite, hence the risks of erosion are negligible. Therefore, the **Impact Intensity** is considered **Negligible**, and the Impact Significance correspondingly **Negligible**.

Table 11-8: Summary of Impact Evaluation during Construction Phase for BBTP / Study Area D (Little Guilin Quarry Lake)

Receptor Sensitivity	Predicted Impact	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Priority 2	Surface water quality	Medium	Low	Possible/Occasional	Minor
	Surface hydrology	Negligible	Negligible	Less Likely / Rare	Negligible

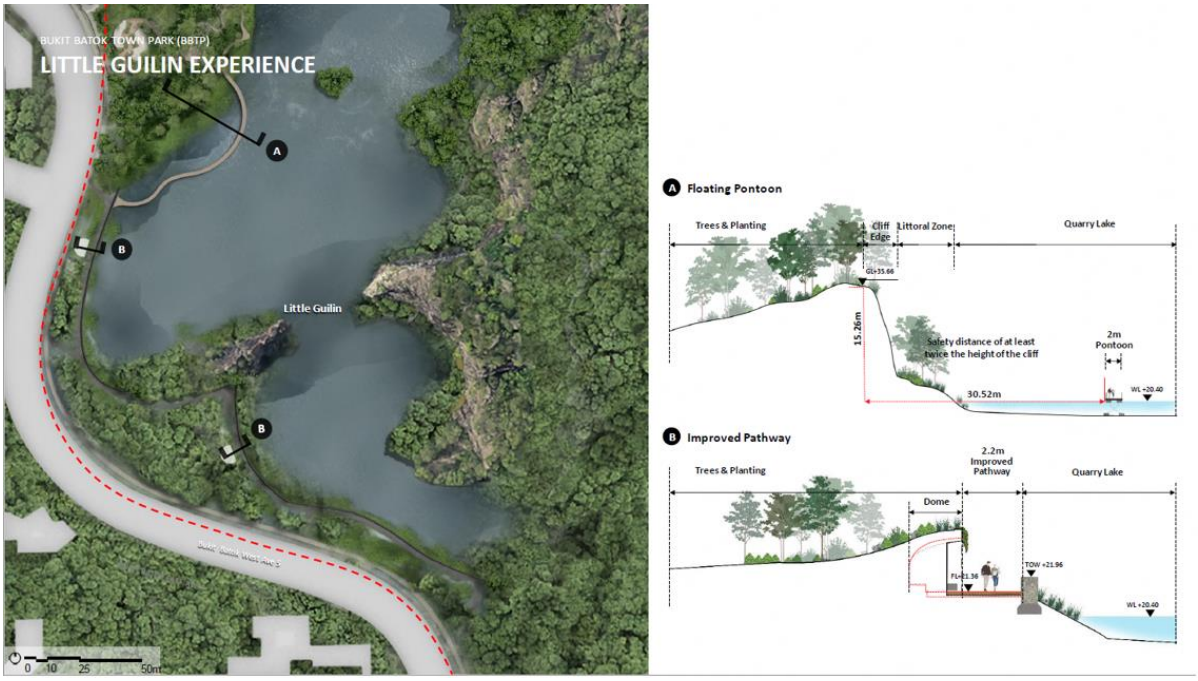


Figure 11-5: Proposed trail and boardwalk at the BBTP Little Guilin Quarry Lake

Seng Chew Quarry Lake: Construction activities relevant to the Viewing Deck may have an impact on the quarry's water quality.

The primary concern relates to the potential erosion following land clearing and construction activities for the building of the viewing deck at the fringe of the water body. ECM will be

implemented and therefore, the potential impacts can be mitigated. Quantity of eroded soil will be controlled and prevented from entering the water body. If sediments do wash into the water body, eventually they will settle to the quarry bed and turbidity will recover. The **Impact Intensity** is considered **Medium**, considering the proximity of construction activities to the water.

The **Impact Consequence** is therefore considered **Low** by taking into account the Receptor Sensitivity as Priority 2 and Impact Intensity as Medium.

The appointed contractors are expected to deploy sufficient erosion control measures during the construction phase to minimise potential impacts. As such, the projected impacts are expected to be **Less Likely / Rare**. Taking this into account, the **Impact Significance** therefore falls in the **Minor** category.

With reference to surface hydrology, given that the construction works only involve a small viewing deck, the **Impact Intensity** is considered **Negligible**, and the Impact Significance correspondingly **Negligible**, consistent with that for Little Guilin Quarry Lake.

Table 11-9: Summary of Impact Evaluation during Construction Phase for BBTP / Study Area D (Seng Chew Quarry Lake)

Receptor Sensitivity	Predicted Impact	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Priority 2	Surface water quality	Medium	Low	Less Likely/Rare	Minor
	Surface hydrology	Negligible	Negligible	Less Likely / Rare	Negligible

11.4.2.2 Operational Phase

Little Guilin Quarry Lake and Seng Chew Quarry Lake: The completion of the construction should see the incorporation of measures to minimise surface erosion and contamination into the water body. Impacts to both quarry lakes will likely be related to the possibility of littering by visitors. Mitigating strategies will include signs to remind the visitors to not litter; increasing the numbers of bins for waste and scheduled maintenance works to remove waste. The **Impact Intensity** is expected to be **Low** and therefore the corresponding **Impact Consequence** is expected to be **Very Low** when the Receptor Sensitivity is considered Priority 2. **Likelihood** of the deterioration of the water body is expected to be **Less Likely / Rare**. Taking all the above into consideration, the **Impact Significance** is expected to be **Negligible**.

With reference to surface hydrology during the operational phase, the increase in surface runoff to the quarry lakes relative to baseline conditions is expected to be negligible. Moreover, given that bank erosion of the quarry lake is not expected to be an issue due to the granite substrate, the Impact Significance fall in the category of **Negligible**.

Table 11-10: Summary of Impact Evaluation during Operational Phase for BBTP / Study Area D (Little Guilin Quarry Lake and Seng Chew Quarry Lake)

Receptor Sensitivity	Predicted Impact	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Priority 2	Surface water quality	Low	Very Low	Less Likely / Rare	Negligible
	Surface hydrology	Negligible	Negligible	Not expected to occur	Negligible

11.4.3 Recommended Mitigation Measures

The impact significance of the quarry lake's water during the construction and operational phases are **Minor and Negligible,** respectively. Therefore, no additional mitigation measures will be required.

11.5 BBHNP / Study Area E

11.5.1 Identification of Water Sensitive Receptors

An existing stream (SE1a) at the southern section of the site is the sole water feature at BBHNP / Study Area E. It flows southwards and recharges the groundwater of the land adjacent to an existing roadside drain along Bukit Batok West Ave 5. The stream supports aquatic habitat of medium ecological value (see section 12.4.1). Considering the near-pristine nature of this water body, its **Receptor Sensitivity** is classified as **Priority 1**.

11.5.2 Prediction and Evaluation of Water Impacts

11.5.2.1 Construction Phase

The development of the site includes several trails, namely Nature Loop as well as the Stream and Fern Trail. The Ficus and Bamboo Trails form a loop in the middle of the site while Stream and Fern Trail runs along the existing stream (Figure 11-6).

The land which receives water from the existing stream will be subjected to some development works, including the construction of ponds.

The majority of the related work shall involve the implementation of erosion control measures of the existing stream's banks. This will result in minor changes to the stream's geomorphological features. Further, surface runoff from adjacent land will be diverted to the stream. During storm events, volumetric discharge of the stream is expected to increase as a result of this change.

Construction work is likely to be restricted to the banks only; no activities are expected in the flooded areas of the stream. Disturbances to the stream banks as a result of the construction activities may result in the erosion of soil into the stream. While mitigation measures against soil erosion will be implemented, it is inevitable that some of the soil material will be eroded into the stream. The **Impact Intensity** is therefore **Low**; and taking the Receptor Sensitivity classification of Priority 1, the **Impact Consequence** is therefore considered **Low**.

While construction activities from adjacent areas can be mitigated with various measures (e.g., erosion control), in-stream work will certainly impact the existing stream (i.e. water quality degradation, change of channel morphology and flow). The **Likelihood** is therefore **Possible / Occasional**. As a result, the **Impact Significant** is **Minor**.

With reference to surface hydrology, the increased surface runoff expected during the construction stage is minimal given the small footprint and short-term nature of the construction works relative to the much larger catchment area of the stream. There remains a risk of erosion given the steep topography at this area. Therefore, the **Impact Intensity** is taken to be **Low**, and **Impact Significance** to be **Minor**.

Table 11-11: Summary of Impact Evaluation during Construction Phase for BBHNP / Study Area E

Receptor Sensitivity	Predicted Impact	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Priority 1	Surface water quality	Low	Low	Possible / Occasional	Minor
	Surface hydrology	Low	Low	Possible / Occasional	Minor

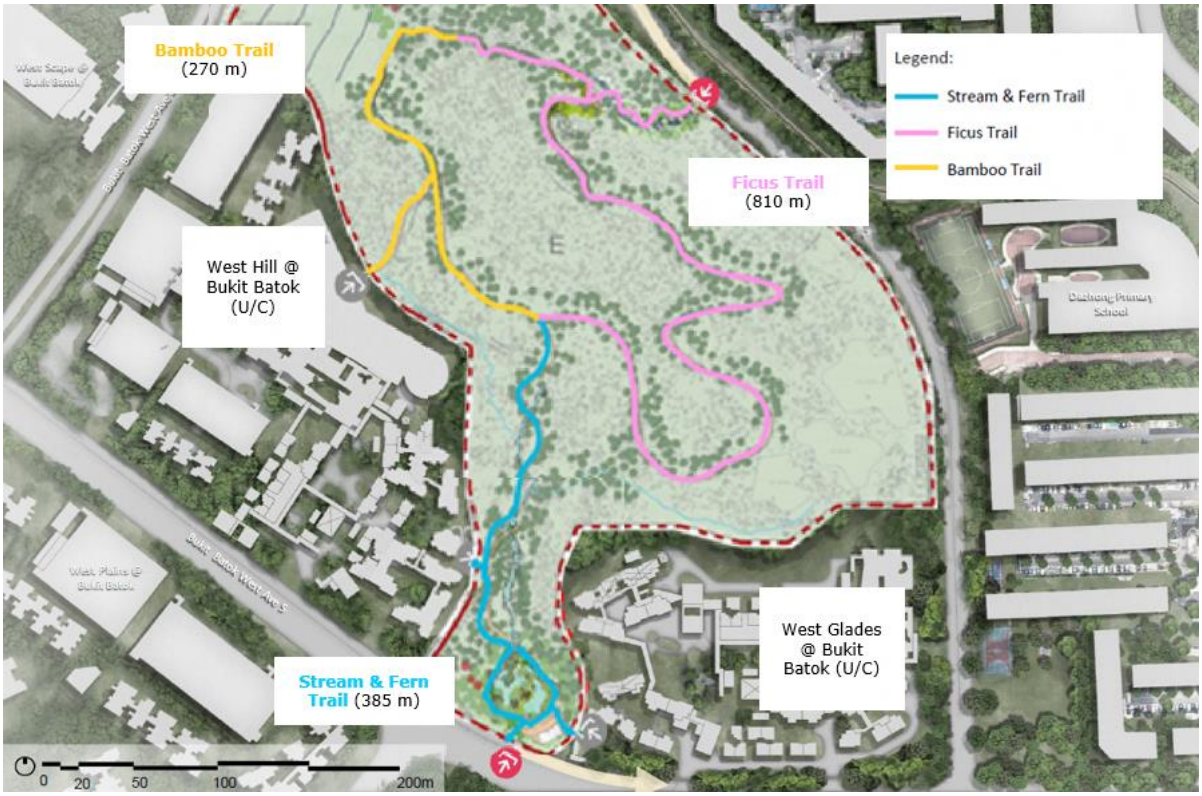


Figure 11-6: The proposed trails at BBHNP / Area E

11.5.2.2 Operational Phase

The upper reaches of the stream shall be adequately buffered by the vegetated area that separates it from the trail. At the lower reaches, before discharging into the roadside drain, water will be impounded to form ponds. These water features form parts of the arrival node. Concentration of visitors are likely to be high here. Visitors also have access to the ponds which then increases the likelihood of water quality degradation. With signs as reminders to visitors to not litter; the provision of adequate waste bins as well as routine maintenance will mitigate any potential ill-effects. Taking the above into consideration, the **Impact Intensity** is expected to be **Low**. As the stream is subjected to some modifications, altering its morphology and increasing flows, the Receptor Sensitivity is considered Priority 2. Taking this into consideration, the **Impact Consequence** is thus expected to be **Very Low**. Factoring this and the **Likelihood** of impacts to the stream during the operational phase as **Possible / Occasional**, the Impact Significance is therefore rated **Minor**.

With reference to surface hydrology, the stream hydrology may be altered during the operation phase, given the slight modification of the ground cover, and the placement of structures such as boardwalk and stepping stones in the water. Therefore, the **Impact Intensity** is taken to be **Low**, and **Impact Significance** to be **Minor**.

Table 11-12: Summary of Impact Evaluation during Operational Phase for BBHNP / Study Area E

Receptor Sensitivity	Predicted Impact	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Priority 2	Surface water quality	Low	Very Low	Possible / Occasional	Minor
	Surface hydrology	Low	Very Low	Possible / Occasional	Minor

11.5.3 Recommended Mitigation Measures

The Impact Significance of the stream during the construction and operational phases are both **Minor**. Therefore, no additional mitigation measures will be required.

12. BIODIVERSITY IMPACT EVALUATION AND MITIGATION

12.1 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 impact assessment. Minimum controls for each potential impact occurring from the construction and operational phases are listed in Table 12-1. These measures should be proposed in tandem with other environmental receptors (e.g., air and noise).

Table 12-1: Description of Minimum Controls Assumed to be Implemented at Construction and Operational Phases

Phase	Work Activities	Minimum Controls
Construction	General	• Install hoarding that is embedded at least 300 mm into the ground to delineate worksite involving the frequent use of heavy machinery (i.e., BBNP slope stabilisation works, BBNP Main Entrance and Proposed trails towards quarry, BBTP Main Entrance, BBHNP Arrival Node and Wetland) • Avoid fogging by implementing preventive measures for mosquito to remove sources of stagnant water or water-bearing receptacles (e.g., provide well-maintained pitched roof, clear discarded items daily, store materials appropriately, level up ground depression/uneven surfaces, ensure effective drainage flow) • Restricted Working Hours (RWH): The Contractor shall ensure that general construction activities are confined to daytime (0800-1800 hours) only, Monday to Saturday for all parks, except for safety-critical works • Practice due diligence in proper storage and handling of machinery to prevent release of chemicals, fuels or other potentially harmful materials • Transfer of fuel shall be done over contaminant trays and mats to prevent spillage into the ground • Ensure oil-containing equipment or machineries are inspected for leaks before being put into use • Provide emergency spill kits on site in the event of any fuel spillages. The emergency response team shall also be competent in the use of these spill kits • Chemical and fuel in drums, carboys, containers, etc shall be stored in a designated storage area within a building or covered shed with concrete floors and containment facilities to contain any leak or spillage • A full containment should be provided for bulk storage oil tanks, including skid tanks • Ensure all hazardous substance and chemical containers are labelled as per the GHS requirement • Ensure a chemical inventory is maintained to track the movement of all hazardous substance and chemicals • Return the chemicals back to its designated storage areas when not in use • Transfer of chemicals shall be done over contaminant trays and mats to prevent spillage into the ground • All leaks and spillages in the storage area or construction site shall be collected and sent to a licensed toxic waste collector for proper disposal • Ensure TIWs are stored in a designated storage area within a building or covered shed with concrete floors and containment facilities to contain any leak or spillage • Maintain a TIW register, which is to be updated on a weekly basis

Phase	Work Activities	Minimum Controls
		• TIW shall be collected regularly by a licensed TIW collector for off-site disposal • Ensure leaks and spillages in the TIW storage area or construction site are collected and sent to a licensed toxic waste collector for proper disposal
	Vegetation clearance	• Set up Tree Protection Zones (TPZs) around trees or other plant specimens to be retained within the worksites, within which no construction works are allowed. This should be advised by certified arborists and in accordance with NParks' guidelines. • Conduct inspections of fauna prior to felling or removal of vegetation. This should be done by an ecologist who is able to identify wildlife and/or active nesting structures, such as bird nests, tree hollows and/or burrows, and bamboo clusters • Implement soil erosion control measures prior to vegetation clearance. The ECM plan should be formulated by a QECP (Section 11.1) • Use only fully biodegradable wildlife-friendly erosion control blankets to avoid trapping fossorial fauna such as snakes
	Earthworks (excavation, aboveground construction)	• Implement soil erosion control measures (Section 11.1) • Use only fully biodegradable wildlife-friendly erosion control blankets to avoid trapping fossorial fauna such as snakes • Ensure proper storage of materials likely to leach harmful chemicals and fuel-powered equipment by storing them away from waterbodies and/or sensitive habitats (Section 11.1) • Implement dust control measures (Section 9.1) • Ensure noise levels are within approved limits, and to implement noise barriers where required (Section 8.1)
	Setting up of worksite, stockpiling	• Locate facilities other than the proposed construction worksites (e.g., site offices, storage. yards, rest areas, access route) within the worksite itself or on existing built-up areas/agreed working spaces; no clearing of additional habitats
Operational	General	• Ensure noise levels are within approved limits (Section 8.1) • Ensure dust levels are within approved limits (Section 9.1) • Avoid fogging by implementing preventive measures for mosquito to remove sources of stagnant water or water-bearing receptacles (e.g., provide well-maintained pitched roof, clear discarded items daily, store materials appropriately, level up ground depression/uneven surfaces, ensure effective drainage flow) • The Wildlife Act, Section 5, 2020. "A person must not intentionally release any wildlife in any place unless the person has the Director-General's written approval to do so". "A person who contravenes (the above) shall be liable on conviction to a fine not exceeding $5,000 • The Wildlife Act, Section 5, 2020. "A person must not intentionally kill, trap, take or keep any wildlife in any place unless the person has the Director-General's approval to do so". "A person who contravenes (the above) shall be liable on conviction –

Phase	Work Activities	Minimum Controls
		○ in the case where the offence is committed in respect of a protected wildlife, to a fine not exceeding $50,000 or to imprisonment for a term not exceeding 2 years or to both; and ○ in any other case – ▪ for a first offence, to a fine not exceeding $10,000 or to imprisonment for a term not exceeding 6 months or to both; and ▪ for a second or subsequent offence, to a fine not exceeding $20,000 or to imprisonment for a term not exceeding 12 months or to both.”

12.2 BBNP / Study Area B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

12.2.1 Assessment of Ecological Value

12.2.1.1 Habitats

The ecological value of seven (7) terrestrial habitats and four (4) aquatic habitats within the Study Area was assessed.

One (1) terrestrial habitat (native-dominated secondary forest) was assessed to have overall high ecological value, i.e., Priority 1. Three (3) terrestrial habitats (abandoned kampong and/or plantation with native recruitment, abandoned kampong and/or plantation, and grassland) and all four (4) aquatic habitats (Stream SB1a, Stream SB2a, Stream SB2b, Quarry QB) were assessed to have overall medium ecological value, i.e., Priority 2. Three (3) terrestrial habitats (scrubland, farm and urban vegetation) were assessed to have overall low ecological value, i.e., Priority 3. A summary of the assessment of ecological value is detailed in Table 12-2 and Table 12-3. The paragraphs below summarise assignation of ecological value for each habitat type.

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

Native-dominated secondary forests are regrowth forests, usually on land cleared before the 1950s, that are dominated by native plant species. In Study Area B1 (west of Lorong Sesuai), the canopy of this habitat type comprises mainly *Syzygium grande* and *Ixonanthes reticulata*, with common native species such as the tiup-tiup (*Adinandra dumosa*) in the understorey and threatened species such as the elephant fern (*Angiopteris evecta*), and *Dialium platysepalum* on hilly terrain. Native-dominated secondary forests typically have high flora and fauna species richness (Score 3) and are known to support few unique flora and fauna species (Score 1). Due to the complexities and intricacies of this habitat type, it is challenging to recreate or replicate the native-dominated secondary forest to its ecologically optimal structure and species composition within 30 years. Native-dominated secondary forests are hence scored medium in irreplaceability (Score 2). However, this habitat type is currently considered rare in Singapore (Score 3) with increasing urbanisation.

With two (2) criteria assessed to be high (Score 3), one (1) criterion assessed to be medium (Score 2), and one (1) criterion assessed to be low (Score 1), the overall score for the abandoned kampong and/or plantation habitat with native recruitment is nine (9), which translates to high ecological value across all terrestrial habitats in Singapore.

II. Grassland (Medium Ecological Value; Priority 2)

Grasslands are open, level, and continuous areas dominated by grasses (Family Poaceae) and other low-growing plants. This habitat type was only encountered in Study Areas B4 along forest fringes in the eastern and northern parts and is mainly dominated by elephant grass (*Pennisetum purpureum*). Grasslands are generally low in flora and fauna species richness (Score 1), although the species that inhabit them are unique, and are unlikely to be found in other terrestrial habitats (Score 3). Although they are uncommon in Singapore (Score 2), most flora species in grasslands are fast-growing, they are also easily replaced (Score 1).

With one (1) criterion assessed to be high (Score 3), one (1) criterion medium (Score 2), and two (2) criteria low (Score 1), the overall score for the grassland habitat is seven (7), which translates to medium ecological value across all terrestrial habitats in Singapore.

III. Abandoned kampong and/or plantation with Native Recruitment (Medium Ecological Value; Priority 2)

Abandoned kampong and/or plantations with native recruitment are regrowth forests developed from abandoned villages, orchards, or plantations, usually dominated by fruit trees, cultivated crops, or ornamental plants, but richer in native species due to its close proximity to a native-dominated secondary forest. While higher native recruitment is evident, this habitat type was assessed following typical abandoned kampong and/or plantations, with plant receptors accounted for in the separate assessment of flora. In Study Areas B1 (west of Lorong Sesuai), B2, B3, and C1, this habitat type is mostly dominated by rubber (*Hevea brasiliensis*), with the canopy being interspersed by common native species such as terentang (*Campnosperma auriculatum*) and *Litsea elliptica*. Abandoned kampong and/or plantations generally have medium flora and fauna species richness (Score 2), supporting few unique flora and fauna species (Score 1). As the main composition of this habitat type can be easily replanted and be established within 30 years, abandoned kampong and/or plantations are easy to recreate or replace, rendering it a low score in irreplaceability (Score 1). Nonetheless, this habitat type is uncommon in Singapore (Score 2) due to increasing urbanisation.

With two (2) criteria assessed to be medium (Score 2) and two (2) criteria low (Score 1), the overall score for the abandoned kampong and/or plantation habitat with native recruitment is six (6), which translates to medium ecological value across all terrestrial habitats in Singapore.

IV. Abandoned kampong and/or plantation (Medium Ecological Value; Priority 2)

Abandoned kampong and/or plantations are regrowth forests developed from abandoned villages, orchards, or plantations, usually dominated by fruit trees, cultivated crops, or ornamental plants. In Study Areas B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2, the canopy is mostly dominated by rubber (*Hevea brasiliensis*), *Ficus variegata* and interspersed in certain areas with fruit trees such as durian (*Durio zibethinus*). Abandoned kampong and/or plantations generally have medium flora and fauna species richness (Score 2), supporting few unique flora and fauna species (Score 1). As the main composition of this habitat type can be easily replanted and be established within 30 years, abandoned kampong and/or plantations are easy to recreate or replace, rendering it a low score in irreplaceability (Score 1). Nonetheless, this habitat type is uncommon in Singapore (Score 2) due to increasing urbanisation.

With two (2) criteria assessed to be medium (Score 2) and two (2) criteria low (Score 1), the overall score for the abandoned kampong and/or plantation habitat is six (6), which translates to medium ecological value across all terrestrial habitats in Singapore.

V. Stream SB1a (Medium Ecological Value; Priority 2)

Stream SB1a is a mostly closed-canopy forest stream in BBNP / Study Area B1 fed by two tributaries, one in BBNP / Study Area B1 and the other in Study Area C1. The stream is a slow-flowing and mostly closed-canopy forest stream with well-vegetated banks, including several bamboo clusters. Forest streams often have complex hydrological requirements, on top of moderate topographical, biological material and water quality requirements to reach ecologically optimal structure and species composition. Forest streams generally have high flora and fauna species richness (Score 3), albeit they are not known to support any unique flora and fauna species (Score 0). Such intricacy results in the habitat being difficult to recreate or replace, giving it a medium score in irreplaceability (Score 2). Moreover, with increasing urbanisation, forest streams are currently uncommon in Singapore (Score 2).

With one (1) criterion assessed to be high (Score 3), two (2) criteria medium (Score 2) and one (1) criterion zero (Score 0), the overall score for the forest stream habitat is seven (7), which translates to medium ecological value across all freshwater habitats in Singapore.

VI. Stream SB2a (Medium Ecological Value; Priority 2)

Stream SB2a is a slow-flowing dense-canopy forest stream with steep and heavily eroded banks in Study Area B2. Forest streams often have complex hydrological requirements, on top of moderate topographical, biological material and water quality requirements to reach ecologically optimal structure and species composition. Forest streams generally have high flora and fauna species richness (Score 3), albeit they are not known to support any unique flora and fauna species (Score 0). Such intricacy results in the habitat being difficult to recreate or replace, giving it a medium score in irreplaceability (Score 2). Moreover, with increasing urbanisation, forest streams are currently uncommon in Singapore (Score 2).

With one (1) criterion assessed to be high (Score 3), two (2) criteria medium (Score 2) and one (1) criterion zero (Score 0), the overall score for the forest stream habitat is seven (7), which translates to medium ecological value across all freshwater habitats in Singapore.

VII. Stream SB2b (Medium Ecological Value; Priority 2)

Stream SB2b is a closed-canopy forest stream with well-vegetated banks in Study Area B2. Forest streams often have complex hydrological requirements, on top of moderate topographical, biological material and water quality requirements to reach ecologically optimal structure and species composition. Forest streams generally have high flora and fauna species richness (Score 3), albeit they are not known to support any unique flora and fauna species (Score 0). Such intricacy results in the habitat being difficult to recreate or replace, giving it a medium score in irreplaceability (Score 2). Moreover, with increasing urbanisation, forest streams are currently uncommon in Singapore (Score 2).

With one (1) criterion assessed to be high (Score 3), two (2) criteria medium (Score 2) and one (1) criterion zero (Score 0), the overall score for the forest stream habitat is seven (7), which translates to medium ecological value across all freshwater habitats in Singapore.

VIII. Quarry Lake QB (Medium Ecological Value; Priority 2)

Quarry lakes are formed from the remnants of former quarries in Singapore, which were used to supply granite in the 1970s. Poh Kim Quarry (QB) is located in BBNP / Study Area B1. The quarry lake is a large waterbody surrounded mostly by exposed steep walls and overhanging vegetation. Quarry lakes generally have medium flora and fauna species richness (Score 2), although they are not known to support any unique flora and fauna species (Score 0). However, they form unique habitats that are difficult to replace (Score 3) and are fairly uncommon in Singapore as they are formed solely from former quarries (Score 2).

With one (1) criterion assessed to be high (Score 3), two (2) criteria medium (Score 2) and one (1) criterion zero (Score 0), the overall score for the quarry lake habitat is seven (7), which translates to medium ecological value across all freshwater habitats in Singapore.

IX. Scrubland (Low Ecological Value; Priority 3)

Scrublands are open canopy vegetation dominated by shrubs, climbers, and/or ferns. Varying floristic compositions were observed within Study Areas B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2. For example, large patches of resam (*Dicranopteris* linearis) and simpoh air (*Dillenia suffruticosa*) were seen in Study Areas B1 (west of Lorong Sesuai) and B2, while *Dioscorea sansibarensis*, *Alocasia longiloba*, giant taro (*Alocasia macrorrhizos*), and other herbaceous plant species along the forest edges of Study Areas B1 (west of Lorong Sesuai) and C2. Scrublands often have low flora and fauna species richness (Score 1) and are not known to support any unique flora and fauna species (Score 0). As shrubs that make up scrublands colonise rapidly and can take over land with minimal human intervention, scrublands are easy to recreate or replace (Score 1). Nonetheless, this habitat type is uncommon in Singapore (Score 2) due to increasing urbanisation.

With one (1) criterion assessed to be medium (Score 2), two (2) criteria low (Score 1) and one (1) criterion zero (Score 0), the overall score for the scrubland habitat is four (4), which translates to low ecological value across all terrestrial habitats in Singapore.

X. Farm (Low Ecological Value; Priority 3)

Small patches of farm were recorded in Study Areas B3 and B4. In Study Area B3, the farm area is mostly a community farm plot comprising of torch ginger (*Etlingera elatior*), banana (*Musa cultivar*), and Indonesian bayleaf (*Syzygium polyanthum*). In Study Area B4, two patches of actively managed farms were recorded, with other edible shrubs and trees such as pandan (*Pandanus amaryllifolius*) and lime (*Citrus* sp.) observed. Typically, farms have low flora and fauna species richness (Score 1), with few unique flora and fauna species recorded (Score 1). This habitat type is common nationally (Score 1) and can be easily reconstructed through human intervention, rendering it a low score in irreplaceability (Score 1).

With four (4) criteria assessed to be low (Score 1), the overall score for the farm habitat is four (4), which translates to low ecological value across all terrestrial habitats in Singapore.

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

Urban vegetation in BBNP / Study Area B1 (west of Lorong Sesuai) mostly consist of managed vegetation and lawn areas that undergo frequent maintenance. In different localities, planted species range from threatened native species like Critically Endangered *Shorea ovalis* ssp. *Ovalis* and *Dipterocarpus cornutus*, to exotic tree species such *Adinobotrys atropurpureus*. Urban vegetation along the boundaries of Study Areas B2, B3, B4, and C2 mostly comprises cow grass

(*Anoxopus compressus*). In Study Area C1, urban vegetation in the southern part consists of planted exotic and native trees such as rain tree (*Samanea saman*), *Lagerstroemia floribunda* as well as *Ficus variegata*. Typically, urban vegetation has low flora and fauna species richness (Score 1), with few unique flora and fauna species recorded (Score 1). This habitat type is common nationally (Score 1) and can be easily reconstructed through human intervention, rendering it a low score in irreplaceability (Score 1).

With four (4) criteria assessed to be low (Score 1), the overall score for the urban vegetation habitat is four (4), which translates to low ecological value across all terrestrial habitats in Singapore.

Table 12-2: National assessment of ecological value of each terrestrial habitat type in BBNP / Study Areas B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Criterion	Terrestrial habitat						
	Native-dominated Secondary Forest	Grassland	Abandoned kampong and/or plantation with Native Recruitment	Abandoned kampong and/or plantation	Scrubland	Farm	Urban Vegetation
Flora and fauna species richness	3	1	2	2	1	1	1
Irreplaceability	2	1	1	1	1	1	1
National rarity of habitat	3	2	2	2	2	1	1
Unique flora and fauna species	1	3	1	1	0	1	1
Total score	**9**	**7**	**6**	**6**	**4**	**4**	**4**
Ecological value	**High**	**Medium**	**Medium**	**Medium**	**Low**	**Low**	**Low**

Table 12-3: National assessment of ecological value of each aquatic habitat type in BBNP / Study Areas B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Criterion	Aquatic habitat			
	Stream SB1a	Stream SB2a	Stream SB2b	Quarry Lake QB
Flora and fauna species richness	3	3	3	2
Irreplaceability	2	2	2	3
National rarity of habitat	2	2	2	2
Unique flora and fauna species	0	0	0	0
Total score	**7**	**7**	**7**	**7**
Ecological value	**Medium**	**Medium**	**Medium**	**Medium**

12.2.1.2 Flora

The ecological value of 547 plant species in BBNP / Study Area B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2 was assessed. Plant species that could not be determined to its species level with certainty was excluded for assessment of ecological value. The list of species assessed is reflected in **Appendix 9**.

Of the species assessed, 154 are assigned the value of Priority 1 (i.e., high ecological value), 126 are of Priority 2 (i.e., medium ecological value), and 267 are of Priority 3 (i.e., low ecological value). Altogether, 32 species had their ecological values raised after assessment— 24 from Priority 2 to Priority 1, seven (7) from Priority 3 to Priority 1, and one (1) from Priority 3 to Priority 2.

One hundred and twenty-five (125) species of conservation significance were assessed with a high ecological value (Priority 1), except for two (2) species, *Angiopteris evecta* and *Bridelia stipularis*. The ecological value of these two (2) species was reduced from Priority 1 to Priority 2 due to their widespread local and national distribution.

Seven (7) native fig species (i.e., *Ficus aurata var. aurata, F. fistulosa, F. grossularioides* var. *grossularioides, F. heteropleura, F. microcarpa, F. punctata and F. variegata*) that were accorded with an initial level of Priority 2, were raised to Priority 1 as they are regarded as keystone species. For the same reason, six (6) exotic and cryptogenic fig species (i.e., *F. auriculata, F. benjamina, F. benghalensis, F. elastica, F. hispida, and F.* cf. *rumphii*) had their initial ecological value raised from Priority 3 to Priority 1.

The ecological value of three (3) bamboo species, *Bambusa bambos, B. heterostachya* and *B. vulgaris*, were raised from Priority 3 to Priority 1. Albeit of exotic origin, these bamboos are potential habitat for bamboo bats (*Tylonycteris* spp.) that are known to roost within the bamboo internodes.

Other exotic species like the rain tree (*Samanea saman*) was also raised from Priority 3 to Priority 2 after assessment. Similarly, the ecological value of 16 common native species were raised from Priority 2 to Priority 1 due to their restricted local and national distribution since these species are mostly observed within restricted to old secondary forests and/or primary forests in Singapore. On the other hand, 61 common native species had their priority levels reduced from Priority 2 to Priority 3 as specimens of these species are locally and nationally widespread.

12.2.1.3 Fauna

The ecological value of 466 faunal species for BBNP / Study Area B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2 recorded from the baseline assessment were assessed together with probable species of conservation significance. All 111 faunal species of conservation significance (recorded and probable) were accorded a Priority 1 sensitivity level and deemed to be of high ecological value. The list of species assessed is reflected in **Appendix 4**.

12.2.2 Identification of Biodiversity Sensitive Receptors

Habitats and plant species that fall within the impact zone of the worksites were identified as biodiversity sensitive receptors (Figure 12-1). Faunal species that were recorded or deemed probable during baseline study were also identified as biodiversity sensitive receptors.

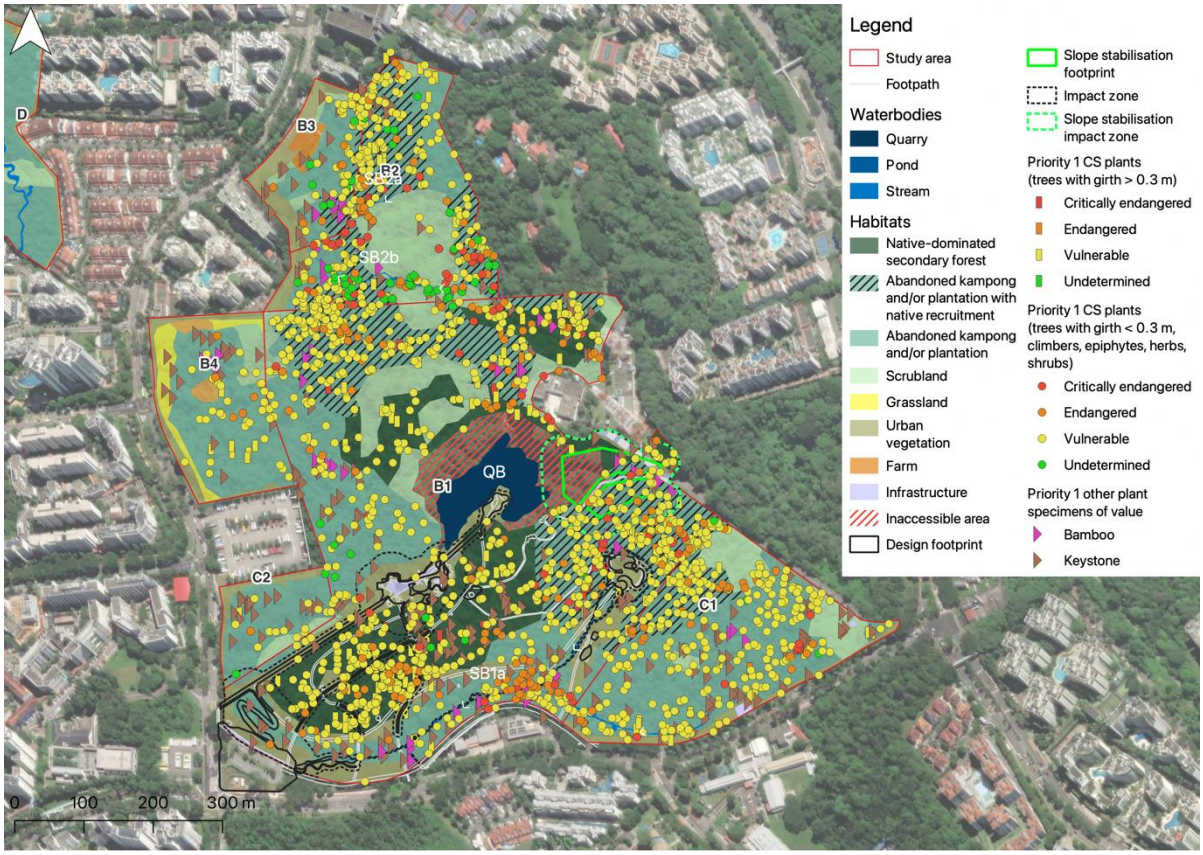


Figure 12-1: Impact Zone for Habitat and Species Receptors in BBNP / Study Area B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

12.2.2.1 Habitats

Following the assessment of ecological value for habitats (**Section 12.2.1.1**), all habitats within the development area and within 30 m (for the Main Entrance, Plaza and Play Area, slope stabilisation works) and 5 m (for boardwalks, trails, and stream edge enhancement) from the proposed development area were identified as the sensitive receptors for habitats (Figure 12-1).

12.2.2.2 Flora

Following the assessment of ecological value for all plant species (Section 12.2.1.2), some flora receptors were selected for the assessment of ecological impacts. The selection was based on the following: (1) Priority 1 Conservation Significance ("CS") species, large specimens, other specimens of value and/or common native trees that had their ecological value raised in Section 12.2.1.2 and lie inside the worksites or impact zones of the proposed developments, (2) Priority 1 CS species

that make up ≤1% of the total CS specimen count, (3) Priority 1 keystone species that are of conservation significance and/or are considered as large specimens (i.e., *Ficus* species), and (4) species that are associated with important fauna.

12.2.2.3 Fauna

Following the assessment of ecological value for faunal species (Section 12.2.1.3), all species with a Priority 1 sensitivity level were identified as the sensitive receptors. Species of conservation significance deemed of probable occurrence were also identified as sensitive receptors, with the only exception being the unidentified bamboo bat (*Tylonycteris* sp.). As species-level identification was not possible, both bamboo bat species (*Tylonycteris fulvida* and *T. malayana*) in Singapore were identified as sensitive receptors instead, as both species are threatened, and were deemed of probable occurrence. A total of 111 sensitive receptors were identified in sites B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2, of which 19 were recorded from the field assessment, and 92 were deemed of probable occurrence. Breaking down the sensitive receptors by taxon, there are 12 aculeate hymenopterans, 28 butterflies, 11 odonates, 10 reptiles, 32 birds, six (6) non-volant mammals, eight (8) bats, three (3) decapod crustaceans.

12.2.3 Prediction and Evaluation of Biodiversity Impacts

In this section, the identified biodiversity sensitive receptors were evaluated based on impact intensity and likelihood, to derive the impact significance. The various levels of impact intensity and likelihood for each impact type during the construction and operational phases were defined for the biodiversity sensitive receptors. Some assumptions were made in defining the impact intensity, as detailed in the sections below.

For both the construction and operational phases, the full lists of the priority level, impact intensity, impact consequence, impact likelihood, as well as the resulting impact significance for each biodiversity sensitive receptor is provided in **Appendices 7-9**.

12.2.3.1 Construction Phase

Habitats

Three (3) construction phase impacts were identified and assessed for the habitat receptors: loss of habitat, habitat degradation, and formation of edge effects. The impact significance ranged from Negligible to Moderate for habitat receptors at BBNP / Study Areas B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2. A summary of the key biodiversity habitat receptors impacted during construction phase is shown in Table 12-4 and detailed assessment in **Appendix 8.**

Loss of Habitat

Loss of habitat will only occur in four (4) terrestrial habitat types at BBNP / Study Areas B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2: native-dominated secondary forest, abandoned kampong and/or plantation with native recruitment, abandoned kampong and/or plantation, and urban vegetation. Based on the area of habitat loss, the impact significance is Moderate for the native-dominated secondary forest (affected by slope stabilisation works only) and Minor for the other three (3) habitat types. The remaining habitat types: grassland, scrubland, farm, Stream SB1a, Stream SB2a, Stream SB2b, and Quarry lake QB are not directly impacted by the worksites, and hence have a Negligible impact significance.

Habitat Degradation

As a result of minimum control measures in place, the likelihood of habitat degradation for all habitats were deemed to be Less Likely. Impact significance for each habitat type is hence Negligible or Minor.

Formation of Edge Effects

Due to vegetation removal, new habitat edges will be formed and edge effects such as changes in microclimatic conditions are expected for some habitat types. However, as the increase in perimeter-to-area ratio after vegetation removal mostly results in a Low impact intensity, the impact significance is Negligible or Minor.

Table 12-4: Summary of Construction Phase Impacts to Habitat Receptors in BBNP / Study Areas B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
Loss of habitat	-	• Native-dominated secondary forest (affected by slope stabilisation works only)	• Abandoned kampong and/or plantation with native recruitment (affected by slope stabilisation works only) • Abandoned kampong and/or plantation • Urban vegetation	• Grassland • Scrubland • Farm • Stream SB1a • Stream SB2a • Stream SB2b • Quarry lake QB
Habitat degradation	-	-	• Native-dominated secondary forest • Abandoned kampong and/or plantation with native recruitment • Stream SB1a • Quarry lake QB	• Abandoned kampong and/or plantation • Grassland • Scrubland • Farm • Urban vegetation • Stream SB2a • Stream SB2b
Formation of edge effects	-	-	• Native-dominated secondary forest • Abandoned kampong and/or plantation • Urban vegetation	• Abandoned kampong and/or plantation with native recruitment • Grassland • Scrubland • Farm • Stream SB1a • Stream SB2a • Stream SB2b • Quarry lake QB

Flora

A total of 117 sensitive flora species receptors recorded in BBNP / Study Area B1 (West of Lorong Sesuai) were selected for the assessment of ecological impacts (**Section 12.2.2.2**). A summary of the impact to flora receptors is provided in Table 12-5. The detailed evaluation for each species is provided in **Appendix 9**.

Mortality

Three (3) flora species, *Canthiumera robusta*, *Oxyceros* cf *bispinosus* and *Strophanthus caudatus* are likely to experience Major impacts owing to mortality. Only one specimen of each species was recorded in the Study Area. This led to their impact intensity to be High. It is Certain that the specimens will be impacted by slope stabilisation works. As such, this caused their impact significance to be Major.

Three (3) flora species are likely to experience Moderate impacts. All these species were assessed with Low impact intensity as 10–50% of the specimens will be impacted by the proposed developments. However, since these specimens lie within the construction footprints and would be affected by slope stabilisation works, it is Certain (likelihood) that they would be cleared. Hence, the impact significance is Moderate.

The remaining 102 species are assessed with Negligible impact significance as none of the specimens will be directly affected by land clearance.

Decline in Plant Health and Survival
For this impact type, all remaining specimens of the 114 flora receptors were assessed. The impact significance was assessed to be Major for one (1) species, Moderate for 9 species, Minor for 21 species and Negligible for the remaining 83 species.

The only specimen belonging to *Antidesma coriaceum* is located within the impact zone of the slope stabilisation works. Since the specimen is located within a forested site, the slope stabilisation works that involves vegetation clearance will Likely result in the formation of a new forest edge within the impact zone. Hence, the impact significance is assessed as Major. Similarly, for the 19 species, except *Dialium platysepalum*, that are assessed with Moderate impact significance, less than 50% of its specimens will likely be indirectly affected by this impact type because of the slope stabilisation works.

Nine (9) species that have 10–50% of their specimens (i.e., Low impact intensity) located within the impact zone of the slope stabilisation works were assessed with Moderate impact significance.

Twenty-one (21) species were assessed with a Minor impact significance. Nine (9) out of 21 species have 10–50% of their specimens within the impact zone and were deemed Possible to experience decline in plant health and survival. For the remaining 12 species, this impact type is Less Likely or Not Expected to Occur.

For the remaining 83 flora species, they are either Less Likely or Not Expected to be affected by decline in plant health as the proposed construction will be executed on the existing footpaths/trails and/or built-up areas, assuming that minimal clearance would be carried out. Hence, the impact significance is assessed as Negligible.

Table 12-5: Summary of Construction Phase Impacts to Flora Receptors at BBNP / Study Area B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Mortality	3 (affected by slope stabilisation works only)	3 (affected by slope stabilisation works only)	9	102
Decline in plant health and survival	1 (affected by slope stabilisation works only)	9 (affected by slope stabilisation works only)	21	83

Fauna

Six (6) construction phase impacts were identified and assessed for faunal receptors: (1) loss of or reduction in habitats and food sources, (2) accidental injury or mortality, (3) human-wildlife conflict, (4) loss of or reduction in ecological connectivity for faunal movement, (5) light disturbances, and (6) human disturbances. The impact significance ranged from Negligible to Moderate. The more

substantial impacts arising from each impact type are briefly summarised below. A summary of the impacts to fauna receptors is given in Table 11-6 and detailed assessment in **Appendix 7**.

Table 12-6: Summary of Construction Phase Impacts to Fauna Receptors at BBNP / Study Area B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Loss of or reduction in habitats and food sources	0	95	0	16
Accidental injury or mortality	2 (affected by slope stabilisation works only)	14	4	91
Human-wildlife conflict	0	19	15	77
Loss of or reduction in ecological connectivity for faunal movement	0	2	69	40
Light disturbances	0	0	96	15
Human disturbances	0	52	44	15

Loss of or Reduction in Habitats and Food Sources

Site clearance for the creation of the new trails, boardwalks, Main Entrance, and slope stabilisation works is expected to cause habitat loss. Slope stabilisation works will also directly affect two bamboo clusters that are potential roosting sites for bamboo bats (*Tylonycteris* spp.). However, the habitat loss is expected to be less than 10% for each habitat type. Hence, for all species the impact intensity was assigned as Low. The likelihood of this impact type was deemed to be Certain for all species except the 16 aquatic species as aquatic habitats are Not Expected to be lost. The resulting impact significance is Moderate for 95 species, and Negligible for 16 species.

Accidental Injury or Mortality

Accidental injury or mortality of fauna during the construction phase was deemed Negligible for species predominantly volant and highly mobile, and thus able to move away from construction activities.

Aquatic/amphibious species are Possible to experience accidental injury and mortality as the construction machinery, vehicles, machinery, and personnel are largely restricted to terrestrial worksites, except for minor boardwalk construction and enhancement works at the waterbodies. The impact significance is therefore Minor.

For bamboo bats (*Tylonycteris* spp.), they are Likely to be affected as the bamboo clusters are located within the impact zone of the slope stabilisation works. Hence, the impact significance is Major.

For the remainder of species that are less mobile, or ground-dwelling that are unable to move quickly, they would be more susceptible to this impact. Hence their likelihood is Possible. Some examples are reptiles of probable occurrence such as black-headed collared snake (*Sibynophis melanocephalus*), gold-ringed cat snake (*Boiga melanota*), king cobra (*Ophiophagus hannah*), and

Malayan box terrapin (*Cuora amboinensis*). On the other hand, certain more mobile species would also be susceptible to accidental injury, as they would be able to enter the construction site, thus risking entrapment. This includes mammals such as long-tailed macaque (*Macaca fascicularis*), Sunda pangolin (*Manis javanica*), and Sunda colugo (*Galeopterus variegatus*). After considering the key minimum control measure of the erection of hoarding around worksites involving heavy machinery to prevent fauna entry, avoidance of fogging as a vector control measure, no night works (except for beam launching and security-critical works), and fauna inspections before any vegetation clearance, the impact significance for these species is Moderate.

Human-wildlife Conflict

Human-wildlife conflict between faunal species and construction site personnel is deemed to be Negligible for species not perceived as nuisances or threats to construction personnel, such as butterflies, odonates, and birds that would avoid human presence. The likelihood is Less Likely for predominantly ground-dwelling species, as they can be excluded with proper site hoarding, and Possible for the remainder of species. Human-wildlife interactions may escalate into conflicts for many reasons. Nuisance species, such as long-tailed macaques (*Macaca fascicularis*), may be attracted to food waste or other materials within the worksite, and lead to negative interactions with site personnel. A lack of understanding regarding how to safely interact with wildlife may also lead to conflict with these species. Certain species are threats to human safety, and may elicit fear in construction personnel when encountered, resulting in conflict. This includes venomous snakes of probable occurrence such as Malayan blue coral snake (*Calliophis bivirgatus*) and king cobra (*Ophiophagus hannah*), and aculeate hymenopterans that may sting. The impact significance is hence assessed to be Moderate for these species.

Loss of or Reduction in Ecological Connectivity for Faunal Movement

The likelihood of the loss of or reduction in ecological connectivity for faunal movement was deemed Not Expected to Occur for terrestrial species as hoardings are expected to be erected only around worksites involving heavy machinery (i.e., Main Entrance, Plaza and Play Area, Proposed trails towards quarry), which are situated at currently built-up or open areas. However, the stream edge restoration could hinder aquatic species such as the Asian softshell turtle (*Amyda cartilaginea*) and Malayan box terrapin (*Cuora amboinensis*; probable species) traversing via waterways. The likelihood for these species is Possible, hence the impact significance is Moderate.

Light Disturbances

It is Less Likely for all fauna species to experience light disturbances as no night works is expected to occur aside from safety-critical works. Hence, the impact significance for all species is Minor or Negligible.

Human Disturbances

Human disturbance at the construction phase was deemed Not Expected to Occur or Less Likely for species that are tolerant or not adversely impacted by human presence. Examples are insects and mammals such as long-tailed macaque (*Macaca fascicularis*). Their impact significance is Negligible or Minor. However, most animals are sensitive to human presence, and would move away from an approaching human, with extremely sensitive species leaving the site entirely. For this site, most human activities would be confined to the worksite which is a small construction footprint relative to the larger existing area. The likelihood is thus Possible, and the impact significance was assessed as Moderate for these species.

12.2.3.2 Operational Phase

Habitats

Three (3) operational phase impacts were identified and assessed for the habitat receptors: habitat degradation, changes in microclimatic conditions, and introduction of exotic species (aquatic habitats only). The impact significance ranged from Negligible to Moderate for habitat receptors at BBNP / Study Areas B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2. A summary of the key biodiversity habitat receptors impacted during operational phase is shown in Table 12-7 and detailed assessment in **Appendix 8**.

Habitat Degradation

Although the upgraded Proposed trails towards quarry and activity plaza area would likely see an increase in human activity with the re-opening of BBNP, the adjacent native-dominated secondary forest is Less Likely to experience habitat degradation. This is because of the consolidation of the peripheral activity spaces to the plaza area would reduce the overall human access to the native-dominated secondary forest patch. Hence, the impact significance is Minor. For the remaining habitats, impact significance is Negligible or Minor.

Changes in Microclimatic Conditions

As the overall development is small-scale and involves heavy landscaping and limited hardscape, the likelihood of changes in microclimatic conditions as a result of micro-urban heat island effect is Not Expected to Occur and impact significance is Negligible for all habitat types.

Introduction of Exotic Species

BBNP has been accessible to the public for several decades and the presence of exotic fauna species in its aquatic habitats is not unfamiliar. Stream SB1a contains a mixture of native and exotic species such as the globally Vulnerable Asian softshell turtle (*Amyda cartilaginea*), Malayan forest betta (*Betta pugnax*) and non-native banded panchax (*Aplocheilus lineatus*) and American bullfrog (*Lithobates catesbeianus*). Introduction of exotic species to Stream SB1a is expected to change the balance of native and exotic species, rendering impact intensity to be Medium and impact consequence to be Low. On the other hand, quarry lake QB is dominated by exotic species like the giant snakehead (*Channa micropeltes*) and Indochinese glass-perchlet (*Parambassis siamensis*), which means any introduction of exotic species would have Very Low impact consequence. Although the aquatic habitats will become more accessible to the public with trails along stream SB1a and boardwalk along the edge of quarry lake QB, the habitats are currently already accessible to the public. Hence, the likelihood of increased risk of introduction of exotic species is Less Likely. Consequentially, impact significance for stream SB1a and quarry lake QB is Minor. Streams SB2a and SB2b are not impacted by the development and hence have Minor impact significance.

Table 12-7: Summary of Operational Phase Impacts to Habitat Receptors in BBNP / Study Areas B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
Habitat degradation	-	-	• Native-dominated secondary forest • Abandoned kampong and/or plantation with native recruitment • Abandoned kampong	• Grassland • Scrubland • Farm • Stream SB2a • Stream SB2b • Quarry lake QB

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
			• and/or plantation • Urban vegetation • Stream SB1a	
Changes in microclimatic conditions	-	-	-	• Native-dominated secondary forest • Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation • Grassland • Scrubland • Farm • Urban vegetation • Stream SB1a • Stream SB2a • Stream SB2b • Quarry lake QB
Introduction of exotic species (aquatic habitats only)	-	-	• Stream SB1a • Stream SB2a • Stream SB2b • Quarry lake QB	-

Flora

For this assessment, all flora species receptors, except for *Canthiumera robusta*, *Oxyceros* cf. *bispinosus* and *Strophanthus caudatus,* that are assumed to be cleared during construction phase, were assessed for only one (1) impact type, poaching. A summary of the impact to flora receptors is provided in Table 12-8. The detailed evaluation for each species is provided in **Appendix 9**.

As BBNP is already accessible to the public, the re-opening of the park is Less Likely to result in an increase in poaching activities. Hence, the impact significance for all plants species is Minor to Negligible.

Table 12-8: Summary of Operational Phase Impacts to Flora Receptors at BBNP / Study Area B1 (West of Lorong Sesuai), B2, B3, B4. C1 and C2)

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Poaching	0	0	103	11

Fauna

Six (6) operational phase impacts were identified and assessed for faunal receptors: (1) accidental injury or mortality, (2) human-wildlife conflict, (3) poaching, (4) loss of or reduction in ecological connectivity for faunal movement, (5) light disturbances, and (6) human disturbances. The impact significance ranged from Negligible to Major. Only the most substantive impact for each impact type is presented below. A summary of the impact to fauna receptors is given in

Table 12-9 and detailed in **Appendix 7**.

Table 12-9: Summary of Operational Phase Impacts to Fauna Receptors at BBNP / Study Area B1 (West of Lorong Sesuai), B2, B3, B4. C1 and C2)

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Accidental injury or mortality	0	0	36	73
Human-wildlife conflict	0	0	34	75
Poaching	0	0	23	86
Loss or reduction of ecological connectivity for faunal movement	0	0	69	40
Light disturbances	0	0	57	52
Human disturbances	0	0	96	13

Accidental Injury or Mortality

Accidental injury or mortality because of bird-building collisions was deemed Not Expected to Occur as there are no major buildings or structures that will be constructed in BBNP. Hence the impact on birds is Negligible.

Roadkills were deemed Less Likely to occur as the adjacent roads already experience high traffic volumes that are unlikely to increase significantly despite the expected rise in visitorship post-construction. Hence, the impact is Minor for non-volant mammals and terrestrial reptiles.

Human-wildlife Conflict

The likelihood of human-wildlife conflict during the operational phase was deemed Not Expected to Occur or Less Likely for aquatic species, non-stinging insects, birds, bats, non-volant mammals, and reptiles that are not known to be implicated in human-wildlife conflict within the setting of a nature recreational site. Hence, the impact significance is either Negligible or Minor.

Species possibly implicated in human-wildlife conflict include wrongly perceived nuisance species, such as long-tailed macaque (*Macaca fascicularis*) and the smooth otter (*Lutrogale perspicillata*; probable species), which members of the public may try to approach closely. Species that may possibly cause harm to visitors, especially persons who lack awareness on how to behave during animal encounters, are for example venomous snakes of probable occurrence including the gold-ringed cat snake (*Boiga melanota*), king cobra (*Ophiophagus hannah*), Malayan blue coral snake (*Calliophis bivirgatus*), and bees that may sting. However, givern that BBNP is already operating as a public green space, there are already measures in place to mitigate human-wildlife conflict. Hence the likelihood of this impact is Less Likely. The impact significance is assessed to be Minor for these species.

Poaching

The likelihood of poaching is deemed Not Expected to Occur, impact significance Negligible for most species that are not susceptible to poaching (e.g., bees, odonates, butterflies, snakes, bats). 23 species are susceptible to poaching. Examples include straw-headed bulbul (*Pycnonotus zeylanicus*), white-rumped shama (*Copsychus malabaricus*), Sunda pangolin (*Manis javanica*), and common birdwing butterfly (*Troides helena cerberus*; probable species). As the Study Area is currently already accessible to the public, the likelihood of increased risk of poaching is Less Likely and the impact significance is Minor.

Loss of or Reduction in Ecological Connectivity for Faunal Movement

The likelihood of the loss of or reduction in ecological connectivity for faunal movement was deemed Not Expected to Occur for all species. This is because the future site is composed mostly of narrow trails and elevated boardwalks, which would not fragment the existing connectivity, or increase barriers to faunal movement. The impact significance is hence expected to be Negligible/Minor for all species.

Light Disturbances
The likelihood of light disturbance during the operational phase was deemed Not Expected to Occur for all species as lighting will only be provided along the trail toward the quarry and existing PCN at the southern part of the park, which are already currently lit (i.e., no worse off from baseline), thus the impact significance is expected to be Negligible/Minor. Furthermore, lights will be removed from the remaining existing trails that are currently lit, providing a positive impact for light-sensitive fauna.

Human Disturbances
Human disturbance was deemed Not Expected to Occur or Less Likely for species that are tolerant or not adversely impacted by human presence or their accompanying pets (e.g., dogs). Their impact significance is Negligible or Minor. For the more sensitive animals, human traffic will be confined within the Operation Hub and trails/boardwalks. Moreover, given that BBNP is already operating as a public green space, there are already measures in place to mitigate human disturbance. Hence the likelihood of this impact is Less Likely. The impact significance is Minor for these species.

12.2.4 Recommended Mitigation Measures
In this section, mitigation measures for the proposed developments in BBNP / Study Area B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2 are discussed. Mitigations are to be implemented according to the hierarchy described in Section 5.6.

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

Avoid
The key mitigation measures to avoid biodiversity impacts through the design of the proposed development at BBNP / Study Area B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2 are summarised in Table 12-10 and detailed in the paragraphs below.

Table 12-10: Key Recommended Design Measures to Avoid Biodiversity Impacts at BBNP / Study Area B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Receptor	Impact Type	Mitigation Measures
Habitats	Loss of habitat	• Avoid areas of high conservation value
Flora species	Mortality	• Avoid areas of high conservation value • Adjust design footprint to avoid Priority 1 plant species
	Decline in plant health and survival	• Adjust design footprint to ensure Priority 1 plant species are not within the impact zones
Fauna species	Loss of or reduction in habitats and food sources for fauna	• Avoid areas of high conservation value
	Loss of or reduction in ecological connectivity for faunal movement	• Avoid changes to watercourses

Avoid Areas of High Conservation Value
As loss of habitat will result in Moderate impacts, it is recommended to avoid clearing vegetation where possible, especially in areas of high conservation value (**Figure 6-24**). Heavy structures within these areas should be avoided as they contain several plant specimens of conservation

significance, large plant specimens, other plant specimens of value, and/or sensitive habitats. Any habitat enhancement/rehabilitation works and construction of low-impact structures and on-grade trails within these areas should be carried out sensitively.

Adjust Design Footprint to Avoid Priority 1 Plant Species
The footprints of the Main Entrance, slope stabilisation works, boardwalks, and trails should be adjusted during the detailed design stage to avoid Priority 1 plant species and ensure that they are not within the impact zones.

Avoid Changes to Watercourses
Changes to watercourses can impede the movement of aquatic fauna. By designing the boardwalks and trails near the waterbodies in a sensitive manner, changes to the watercourses can be avoided.

Minimise
The key mitigation measures to minimise biodiversity impacts through the design of the proposed development at BBNP / Study Area B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2 are summarised in Table 12-11 and detailed in the paragraphs below.

Table 12-11: Key Recommended Design Measures to Minimise Biodiversity Impacts at BBNP / Study Areas B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Receptor	Impact Type	Mitigation Measures
Habitats	Habitat degradation	• Put up signages to remind visitors not to litter or pollute the habitats
	Introduction of exotic species (aquatic habitats only)	• Put up signages to remind visitors not to release exotic species
Flora species	Mortality	• Design the boardwalks and trails to deter visitors from trampling/ venturing off-trail (e.g., install railings)
	Poaching	• Design the boardwalks and trails to deter visitors from trampling/ venturing off-trail (e.g., install railings) • Put up signages to remind visitors not to stray off-trail • Design for dense landscaping along the sides of the proposed trails and boardwalks to deter visitors from venturing off-trail • Transplant plant specimens of conservation significance away from publicly accessible areas
	Decline in plant health and survival	• Design for dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions
Fauna species	Accidental injury and mortality	• Integrate road-calming measures
	Human-wildlife conflict	• Design bins to be wildlife-proof • Put up signages to educate visitors on appropriate behaviours when encountering fauna
	Light disturbances	• Incorporate wildlife-friendly lighting
	Human disturbances	• Design the boardwalks and trails to deter visitors from venturing off-trail (e.g., install railings) • Design for dense landscaping along the sides of the proposed trails and boardwalks to deter visitors from venturing off-trail
	Poaching	• Design the boardwalks and trails to deter visitors from venturing off-trail (e.g., install railings) • Design for dense landscaping along the sides of the proposed trails and boardwalks to deter visitors from venturing off-trail

Put up Signages

A variety of educational signages are recommended to remind park visitors to observe good park etiquette, including not littering or polluting the habitats, not straying off-trail, and appropriate behaviours when encountering fauna. This could help minimise habitat degradation, poaching of plants, and human-wildlife conflict during the operational phase.

Design Boardwalks and Trails to Deter Visitors from Venturing Off-trail
Boardwalks and trails could be designed with railings on both sides to discourage park visitors from venturing off-trail, hence minimising the likelihood of trampling resulting in plant mortality and poaching of plants.

Transplant Plant Specimens of Conservation Significance
By transplanting plant specimens of conservation significance well away from areas that will be made publicly accessible, the likelihood of poaching may be reduced.

Design for Dense Landscaping and In-fill Planting
Where vegetation will be cleared for construction activities, provisions for dense landscaping and in-fill planting should be made to revegetate those areas, minimising the likelihood of decline in plant health and survival caused by changes in microclimatic conditions. In-fill planting involves planting of native plants, particularly pioneer trees to jump start forest succession. It makes use of the existing framework of forest canopy and emergent, while selectively removing undesirable exotic species. Plant species of various other habits should also be planted (i.e., shrubs, ground cover), Ideally, the plants should be planted to emulate the framework of a forest (i.e., canopy, understorey, undergrowth). Dense landscaping and in-fill planting should also be provided for at existing gaps in forested areas and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions and to deter visitors from venturing off-trail.

Integrate Road-calming Measures
Although the expected increase in vehicular traffic resulting from the increased visitorship to the park is not significant, since the roads that are adjacent to the park currently already experience heavy vehicular traffic, road-calming measures should be adopted for the roads. Such measures include speed bumps and restrictions on the maximum speed limit.

Design Bins to be Wildlife-proof
Food is an attractant for wildlife, and anthropogenic sources of food such as rubbish tend to be more easily accessible to fauna and higher in caloric yield than their natural food sources. Minimising human-wildlife conflicts would require proper waste management within the future park, such as designing bins to be wildlife-proof.

Incorporate Wildlife-friendly Lighting
It is recommended that the park and its associated facilities be closed to public during the night (1900–0700 h), wildlife-friendly lighting should be incorporated if park closure at night is not feasible. Wildlife-friendly lighting strategies are summarised in Figure 12-2.

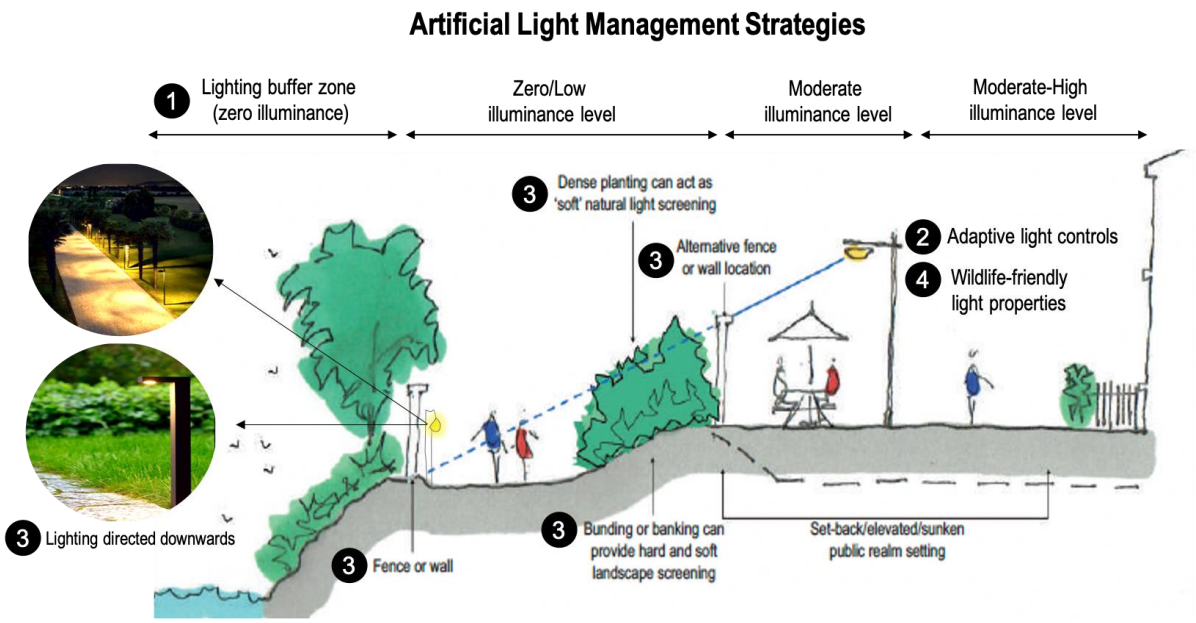


Figure 12-2: Summary of Artificial Light Management Strategies

Rehabilitate/Restore

The key mitigation measures to rehabilitate/restore biodiversity impacts through the design of the proposed development at BBNP / Study Area B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2 are summarised in Table 12-12 and detailed in the paragraphs below. Measures to restore ecological connectivity across the adjacent roads (Figure 6-23) are not considered as mitigation measures in this Impact Assessment as resources to implement them are not available in this Project.

Table 12-12: Key Recommended Design Measures to Rehabilitate/Restore Biodiversity at Study BBNP / Areas B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Receptor	Impact Type	Mitigation Measures
Habitats	Formation of edge effects	• Design for dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions • Design for assisted natural regeneration at the degraded patch of abandoned kampong and/or plantation that lines Stream SB1a
	Habitat degradation	• Carry out bank stabilisation for Stream SB1a • Convert concrete-lined drains to soft-bank streams
Flora species	Decline in plant health and survival	• Design for dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions
	Poaching	• Design for dense landscaping along the sides of the proposed trails and boardwalks to deter visitors from venturing off-trail
Fauna species	Loss of or reduction in ecological connectivity for faunal movement	• Carry out bank stabilisation for Stream SB1a • Convert concrete-lined drains to soft-bank streams

Design for Dense Landscaping and In-fill Planting

Where there are existing gaps in the forested areas at BBNP / Study Area B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2, in-fill planting should be carried out to revegetate those areas to

enhance the habitats there and minimise edge effects and the likelihood of decline in plant health and survival caused by changes in microclimatic conditions. In-fill planting involves planting of native plants, particularly pioneer trees to jump start forest succession. It makes use of the existing framework of forest canopy and emergent, while selectively removing undesirable exotic species.

Carry Out Stream Bank Stabilisation

Based on the severity of stream bank erosion hazard identified in the Baseline Study, bank stabilisation works are recommended at Stream SB1a where the bank erosion hazard scores exceed 60% (Figure 12-3). Stabilising the banks in the highlighted areas can improve water quality by reducing siltation and prevent future land slips. This can in turn compensate for the negative impacts of stream habitat degradation during the construction phase, as well as the reduction in ecological connectivity that aquatic species may experience during the stream enhancement works. Soil bioengineering methods that require little machinery and will reinforce themselves as the living plant material grows, can be considered. Examples of such methods include gabion walls, log crib walls, and live fascines.

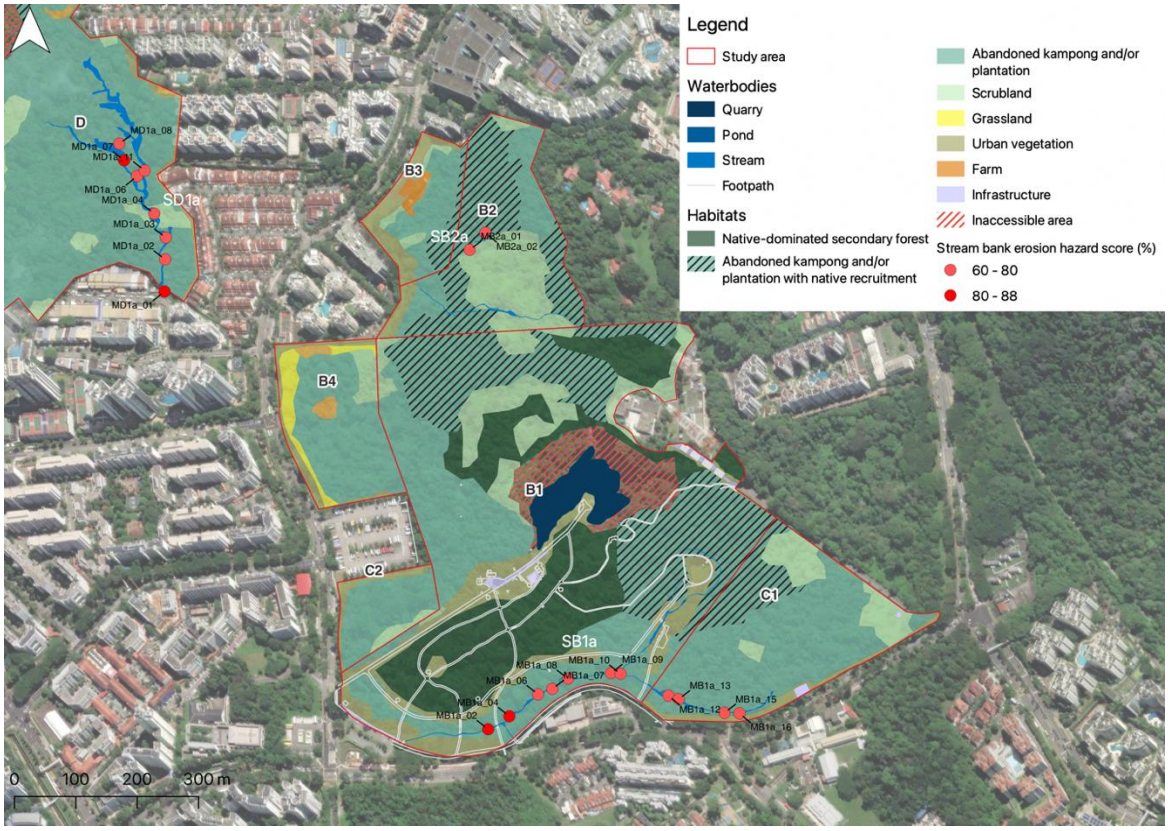


Figure 12-3: Proposed Locations of Stream Bank Stabilisation where Stream Bank Erosion Hazard Score Exceeds 60

Convert Concrete-lined Drains to Soft-bank Streams

The concrete-lined section of Stream SB1a in BBNP / Study Area B1 is approximately 50-m long (Figure 12-4). The concrete here can be removed/broken down as part of the overall stream enhancement works. As the banks of the stream are steep and at risk of erosion, the removal of the concrete should be coupled with regrading and replanting. This can compensate for the negative impacts of stream habitat degradation during the construction phase, as well as the reduction in ecological connectivity that aquatic species may experience during the stream enhancement works.

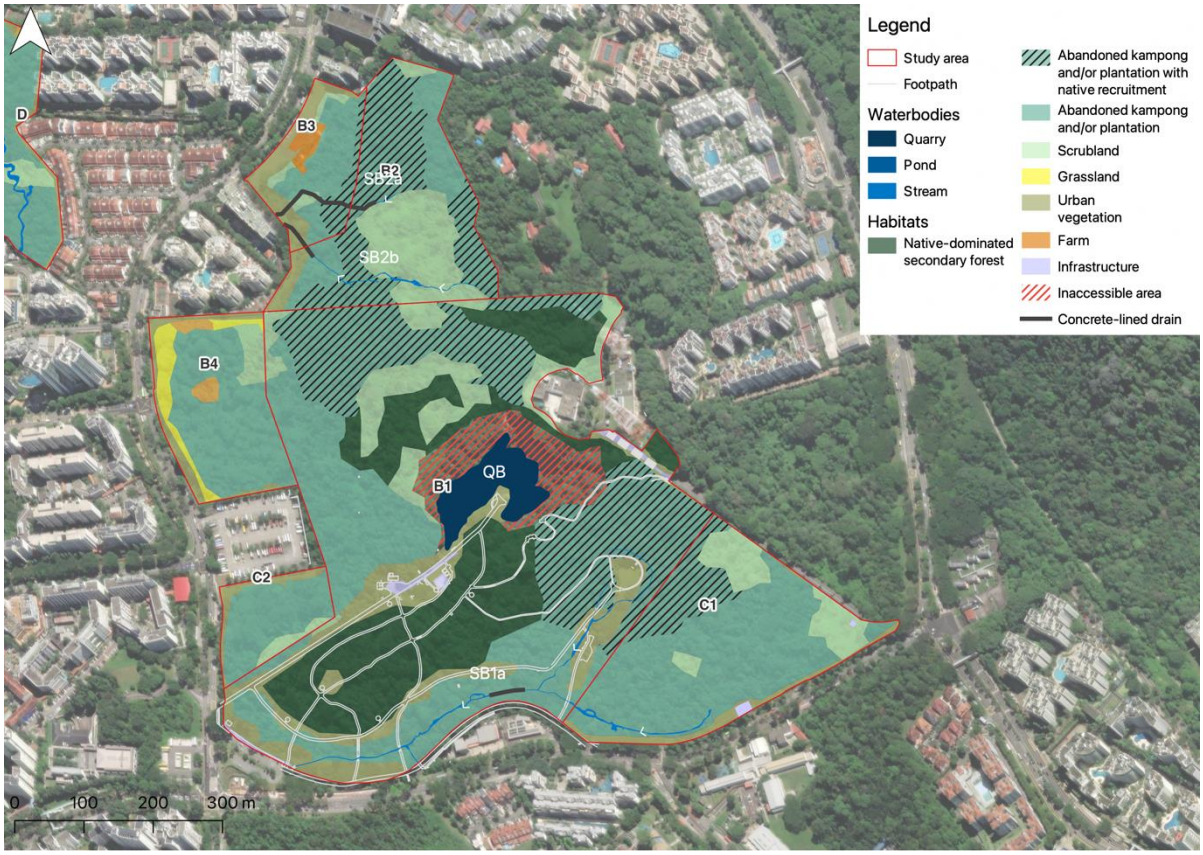


Figure 12-4: Proposed Locations for Conversion of Concrete-lined Drains to Soft-bank Streams

Design for Assisted Natural Regeneration

Assisted natural regeneration involves in-fill planting as described above. Within the abandoned kampong and/or plantation habitat type across BBNC, undesirable and storm-vulnerable exotic trees are abundant. These species are fast-growing and compete for resources with native trees. In addition, undesirable tree species, which include *Elaeis guineensis* and *Hevea brasiliensis*, are known food sources for Eurasian wild boars (*Sus scrofa*). Wild boars can inhibit natural forest regeneration by rooting up soil, feeding on native seedlings, and damaging native saplings (NSS, 2012). A reduction in the number of *Elaeis guineensis* and *Hevea brasiliensis* specimens could help to control the wild boar population and allow natural forest regeneration. Storm-vulnerable exotic tree species including *Acacia auriculiformis*, *Falcataria moluccana*, and *Spathodea campanulata* also pose a safety risk to park visitors. Specimens near (future) areas of human activity should be removed unless they bear other important ecological features such as raptor nests.

Areas within BBNP / Study Area B1 where assisted natural regeneration should be prioritised was identified during the baseline study. This area comprises a degraded patch of abandoned kampong and/or plantation that lines Stream SB1a (Figure 12-5). This patch was found to be dominated by *Hevea brasiliensis* as well as the exotic climber *Dioscorea sansibarensis* and exotic shrub *Dracaena fragrans*. There were several gaps in the canopy along the stream because of tree falls. In this area, the assisted natural regeneration should consider (1) the phasing out of *Hevea brasiliensis*, (2) removal of *Dioscorea sansibarensis* to reduce competition with the Endangered *Ficus sagittata*, (3) removal of large clusters of *Dracaena fragrans*, (4) removal of large pieces of debris/trash (e.g., car tyres), (5) retention of bamboo clusters, and (6) planting of native riparian species for stream enhancement.

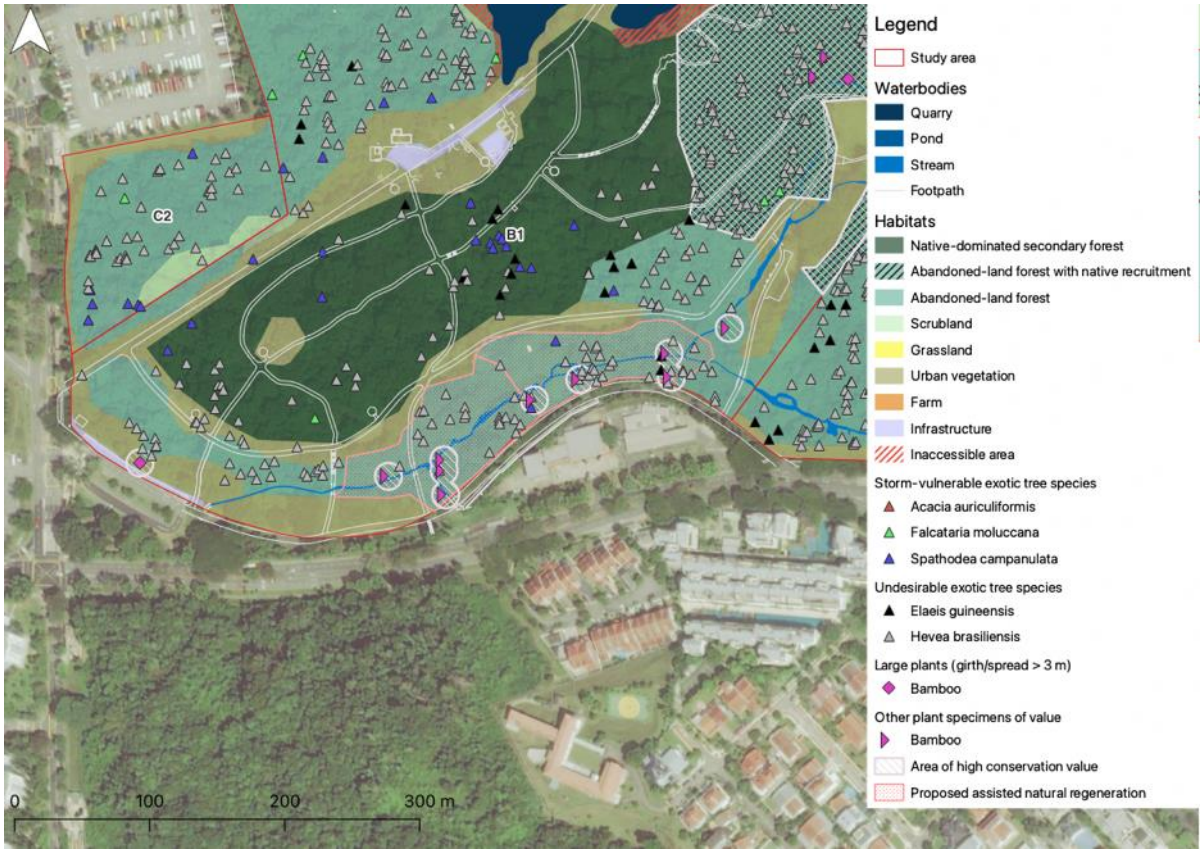


Figure 12-5: Proposed Area for Assisted Natural Regeneration in BBNP / Study Area B1

12.2.4.2 Construction Phase

Key measures to avoid and minimise biodiversity impacts during the construction phase are briefly described below and further elaborated in the proposed EMMP.

Avoid

The key mitigation measures to avoid biodiversity impacts during the construction phase at BBNP / Study Area B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2 are summarised in Table 12-13.

Table 12-13: Key Recommended Measures to Avoid Biodiversity Impacts during the Construction Phase at BBNP / Study Areas B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Receptor	Impact Type	Mitigation Measures
Habitats	Loss of habitat	• Erect hoardings to delineate worksites involving heavy machinery (i.e., Main Entrance, Plaza and Play Area, Proposed trails towards quarry) • For worksites involving manual work only (i.e., trails and boardwalks), ensure the extent of the working space is clearly demarcated on-site and cross-checked by a Flora Specialist to avoid unnecessary vegetation clearance
	Habitat degradation	• Ensure construction works, material and waste storage, access routes, etc., are kept within the boundaries of the worksite or agreed working space
Flora species	Mortality	• Arborists to determine suitable Tree Protection Zones (TPZs) for any trees that will be retained within the worksites • Ensure construction works, material and waste storage, access routes, etc., are kept within the boundaries of the worksite or agreed working space • Transplant or salvage saplings of conservation significance

Receptor	Impact Type	Mitigation Measures
		• Adjust the construction footprint of boardwalks and trails to avoid Priority 1 plant species, in consultation with a Flora Specialist
	Decline in plant health and survival	• Adjust the construction footprint of boardwalks and trails to ensure the Priority 1 plant species are not within the impact zones • Transplant affected specimens beyond the impact zones
Fauna species	Loss of or reduction in habitats and food sources	• Erect hoardings to delineate worksites involving heavy machinery (i.e., Main Entrance, Plaza and Play Area, Proposed trails towards quarry) • For worksites involving manual work only (i.e., trails and boardwalks), ensure the extent of the working space is clearly demarcated on-site and cross-checked by a Flora Specialist to avoid unnecessary vegetation clearance • During trail construction, only understory plants are removed, when necessary. Where possible, removed plants to be replanted elsewhere in BBNP
	Loss of or reduction in ecological connectivity for faunal movement	• Avoid changes to watercourses

Minimise

The key mitigation measures to minimise biodiversity impacts during the construction phase at BBNP / Study Area B1 (west of Lorong Sesuai), B2, B3, B4, C1, and C2 are summarised in Table 12-14.

Table 12-14: Key Recommended Measures to Minimise Biodiversity Impacts during the Construction Phase at BBNP / Study Areas B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Receptor	Impact Type	Mitigation Measures
Habitats	Habitat degradation	• Ensure ECM are implemented prior to site clearance. The ECM plan should be formulated by Qualified Erosion Control Personnel (QECP) • Implement dust control measures such as dust screens and water suppression systems • Conduct regular monitoring to identify any impacts to habitats adjacent to the worksite. This includes visual inspection of surrounding aquatic habitats (i.e., Stream SB1a, Quarry lake QB) and monthly wildlife monitoring in habitats adjacent to the site • Conduct regular site inspections to ensure contractor compliance with the EMMP • Conduct regular inspections in the surrounding habitats to ensure no removal of vegetation has occurred beyond the agreed worksite boundaries
	Formation of edge effects	• Implement dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions • Implement assisted natural regeneration at the degraded patch of abandoned kampong and/or plantation that lines Stream SB1a • Plant up the surface of the stabilised slope (e.g., with climbers) such that it is not left as a bare concrete surface • Conduct regular site inspections to ensure contractor compliance with the EMMP
Flora species	Mortality	• Conduct regular inspections in the surrounding habitats to ensure no removal of vegetation has occurred beyond the agreed worksite boundaries • Conduct regular site inspections to ensure contractor compliance with the EMMP
	Decline in plant health and survival	• Implement dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions • Implement assisted natural regeneration at the degraded patch of abandoned kampong and/or plantation that lines Stream SB1a • Conduct regular site inspections to ensure contractor compliance with the EMMP
Fauna species	Accidental injury and mortality	• Erect hoardings around worksites involving heavy machinery (i.e., Main Entrance, Plaza and Play Area, Proposed trails towards quarry) to prevent fauna entry

Receptor	Impact Type	Mitigation Measures
		• Conduct regular site inspections to ensure contractor compliance with the EMMP • Conduct regular trainings and toolbox briefings for site personnel on biodiversity awareness and actions to take when encountering wildlife • Formulate a wildlife response plan to be executed when trapped/ injured/dead/ dangerous fauna is found on-site • Ensure good housekeeping such as the provision of wildlife-proof food waste bins and enclosed eating areas • Conduct bamboo bat rescue and translocation • Conduct daily checks for roadkill and fauna entrapment within the worksite
	Human-wildlife conflict	• Erect hoardings around worksites involving heavy machinery (i.e., Main Entrance, Plaza and Play Area, Proposed trails towards quarry) to prevent fauna entry • Conduct regular site inspections to ensure contractor compliance with the EMMP • Conduct regular trainings and toolbox briefings for site personnel on biodiversity awareness and actions to take when encountering wildlife • Formulate a wildlife response plan to be executed when trapped/ injured/dead/ dangerous fauna is found on-site • Ensure good housekeeping such as the provision of wildlife-proof food waste bins and enclosed eating areas • Train site personnel that feeding of wildlife is strictly prohibited
	Human disturbances	• Restrict entry of site personnel beyond the worksite

12.2.4.3 Operational Phase

Although most of the biodiversity impacts associated with the operational activities can be addressed through the design measures (Section 12.2.4.1), additional measures related to the operation and management of the park are proposed to further avoid and minimise the impacts.

Table 12-15: Key Recommended Measures to Minimise Biodiversity Impacts during the Operational Phase at BBNP / Study Areas B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Receptor	Impact Type	Mitigation Measures
Habitats	Habitat degradation	• Carry out regular maintenance of the park (e.g., removal of litter, emptying of trash, ensure integrity of railings along trails and boardwalks) • Conduct regular patrols to deter visitors from straying off-trail
	Introduction of exotic species to aquatic habitats	• Conduct regular patrols to deter visitors from releasing exotic species into waterbodies • Conduct outreach programmes to educate visitors on the harmful effects of introduction of exotic species • Conduct regular removal of exotic species from aquatic habitats
Flora species	Poaching	• Conduct regular patrols to deter visitors from straying off-trail • Transplant specimens of conservation significance away from publicly accessible areas
Fauna species	Poaching	• Conduct regular patrols to deter poaching activities
	Light disturbances	• Close the park and associated facilities to the public during the night (1900–0700 h)
	Human disturbances	• Conduct regular post-construction biodiversity monitoring to determine if the increased visitorship has affected fauna species

12.2.5 Residual Impacts

12.2.5.1 Construction Phase

Habitats

The summary of residual impacts during construction phase on key biodiversity habitat receptors is shown in Table 12-16 and detailed assessment in **Appendix 8**.

Loss of Habitat

Despite the proposed mitigation measures, as the physical design of the development is overall minimal and has been optimised to the meet the necessary functions of the park, the assessment of residual impacts due to loss of habitats largely remains the same as Section 12.2.3.1. Native-

dominated secondary forest (affected by slope stabilisation works only) is expected to still have a Moderate impact significance, abandoned kampong and/or plantation with native recruitment (affected by slope stabilisation works only), abandoned kampong and/or plantation, and urban vegetation Minor, and the remaining habitat types Negligible.

Habitat Degradation

As a result of minimum control measures, and regular compliance inspections and monitoring, the likelihood of habitat degradation for all habitats is still deemed to be Less Likely. Impact significance for each habitat type is hence Negligible or Minor. Further, stream enhancement works may compensate for the negative impacts of habitat degradation during the construction phase, resulting in overall positive impacts.

Formation of Edge Effects

Dense landscaping and in-fill planting can help to minimise the formation of edge effects within impacted habitats, especially abandoned kampong and/or plantation with native recruitment, where there is extensive vegetation removal for slope stabilisation works. Planting up of the stabilised slope surface (e.g., with climbers) can also help ameliorate micro-heat island effects. As such, the impact significance for these two habitat types has been reduced from Moderate to Minor. The assessment of residual impacts for the other habitat types remains Negligible or Minor.

Table 12-16: Summary of Construction Phase Residual Impacts to Habitat Receptors in BBNP / Study Areas B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
Loss of habitat	-	• Native-dominated secondary forest (affected by slope stabilisation works only)	• Abandoned kampong and/or plantation with native recruitment (affected by slope stabilisation works only) • Abandoned kampong and/or plantation • Urban vegetation	• Grassland • Scrubland • Farm • Stream SB1a • Stream SB2a • Stream SB2b • Quarry lake QB
Habitat degradation	-	-	• Native-dominated secondary forest • Abandoned kampong and/or plantation with native recruitment • Stream SB1a (positive impacts with stream enhancement) • Quarry lake QB	• Abandoned kampong and/or plantation • Grassland • Scrubland • Farm • Urban vegetation • Stream SB2a • Stream SB2b
Formation of edge effects	-	-	• Native-dominated secondary forest • Abandoned kampong and/or plantation	• Abandoned kampong and/or plantation with native recruitment • Grassland • Scrubland

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
			• Urban vegetation	• Farm • Stream SB1a • Stream SB2a • Stream SB2b • Quarry lake QB

Flora

Like the pre-mitigation impact assessment, all 117 flora species receptors were assessed for two (2) ecological impact types, (1) mortality and (2) decline in plant health and survival. The assessment considered mitigation measures for flora species, such as salvaging or transplanting small saplings of conservation significance. A summary of the impacts to flora receptors is provided in Table 12-17. The detailed evaluation for each species is provided in **Appendix 9**.

Mortality

For this impact type, the impact significance for three (3) flora species that were initially assessed with Major impact significance was reduced to Negligible, assuming that the key mitigation measure, such as salvaging procedures, took place before the start of the slope stabilisation works.

Out of three (3) plant species that were initially assessed with Moderate impact significance, the impact significance for two (2) is reduced to Negligible, assuming that these specimens are salvaged or transplanted from their existing location. However, one (1) species, *Bambusa vulgaris*, which is affected by slope stabilisation works only, remained as Moderate. It is unlikely for specimens of *B. vulgaris* to be transplanted due to their large specimen sizes.

It is to note that this assessment does not take into the consideration of the success rate of these specimens after they have been salvaged/transplanted from their existing habitat. It is possible that some specimens may still be subjected to mortality after the process of salvaging/transplantation.

The remaining two (2) and 114 species are assessed as Minor and Negligible, respectively.

Decline in Plant Health and Survival

With proposed mitigation measures such as transplanting affected specimens beyond the impact zones, in-fill planting and/or dense planting at areas that were cleared or at areas that are currently bare mentioned in Section 12.2.4, the likelihood of this impact on flora specimens can be reduced. With that, the likelihood of *Antidesma coriaceum* is reduced from 'Likely' to 'Possible' and this reduced the impact significance from Major to Moderate. Similarly, this also reduced the impact significance of nine (9) species that were initially assessed as Moderate, to Minor.

There is no change to the impact significance of the 21 flora species that were initially assessed as Minor since the impact has been reduced to a level that is as low as reasonably practicable. As for the remaining 83 species, there is no change to the impact significance that were initially assessed as Negligible.

Table 12-17: Summary of Construction Phase Residual Impacts to Flora Receptors at BBNP / Study Area B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2)

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Mortality	0	1 (1 species affected by slope stabilisation works only)	2	114
Decline in plant health and survival	0	1 (affected by slope stabilisation works only)	30 (12 species affected by slope stabilisation works only)	83

Fauna

Loss of or Reduction in Habitats and Food Sources

A residual Moderate impact from loss of or reduction in habitats and food sources remains Certain despite mitigation measures to avoid/minimise the habitat loss attributed to the slope stabilisation works. This is because the extent of the slope stabilisation works could not be reduced for safety reasons.

Accidental Injury or Mortality, Human-wildlife Conflict, and Human Disturbances

The likelihood of accidental injury or mortality, human-wildlife conflict, and human disturbance can be reduced if mitigation measures recommended in Section 12.2.4 are followed, thus reducing the impact significance from Moderate to Minor.

For bamboo bats (*Tylonycteris* spp.), however, the likelihood can only be reduced to Possible despite conducting bamboo bat rescue and translocation with good due diligence. Hence, the impact significance is Minor.

A summary of residual impacts to fauna receptors is given in Table 12-18 and detailed in **Appendix 7**.

Table 12-18: Summary of Construction Phase Residual Impacts to Fauna Receptors at BBNP / Study Area B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2)

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Loss or reduction in habitats and food sources	0	95	0	14
Accidental injury or mortality	0	0	19	90
Human-wildlife conflict	0	0	34	75
Loss of or reduction of ecological connectivity for faunal movement	0	0	69	40
Light disturbances	0	0	96	13
Human disturbances	0	0	96	13

12.2.5.2 Operational Phase

Habitats

The summary of residual impacts during operational phase on key biodiversity habitat receptors is shown in Table 12-19 and detailed assessment in **Appendix 8**.

Habitat Degradation

On top of regular park maintenance, the proposed mitigation measure of signages helps establish expected park etiquette more clearly. As such, the likelihood of habitat degradation occurring can be reduced from Possible to Less Likely and the residual impact significance is Negligible for most habitat types. The impact significance for native-dominated secondary forest remains Minor as it is deemed as low as reasonably practicable.

Changes in Microclimatic Conditions

As the overall development type is still largely green, the likelihood of changes in microclimatic conditions occurring remains Not Expected to Occur and hence impact significance remains Negligible for all habitat types.

Introduction of Exotic Species

Despite the proposed signages and regular patrols, likelihood of increased risk of introduction of exotic species to aquatic habitats remains Less Likely. Consequently, impact significance for all the aquatic habitats remain Minor.

Table 12-19: Summary of Operational Phase Impacts to Habitat Receptors in BBNP / Study Areas B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
Habitat degradation	-	-	• Native-dominated secondary forest • Abandoned kampong and/or plantation with native recruitment	• Abandoned kampong and/or plantation • Grassland • Scrubland • Farm • Urban vegetation • Stream SB1a • Stream SB2a • Stream SB2b • Quarry lake QB
Changes in microclimatic conditions	-	-	-	• Native-dominated secondary forest • Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation • Grassland • Scrubland • Farm • Urban vegetation • Stream SB1a • Stream SB2a • Stream SB2b • Quarry lake QB

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
Introduction of exotic species (aquatic habitats only)	-	-	• Stream SB1a • Stream SB2a • Stream SB2b • Quarry lake QB	-

Flora

With the adoption of mitigation measures such as installing signages to remind visitors to stay on designated boardwalk/trails, executing dense landscaping within the borders of the proposed boardwalk/trails as well as conducting regular patrols to deter visitors from straying off-trail, this may help to reduce the likelihood of poaching remains Less Likely as most of these measures are already being implemented. Hence, their impact significance remains Minor to Negligible.

As for the 78 flora species and 11 flora species that were initially assessed with Minor and Negligible impact significance respectively, there is no change to their impact significance since the impact has been reduced to a level that is as low as reasonably practicable.

Table 12-20: Summary of Operational Phase Residual Impacts to Flora Receptors at BBNP / Study Area B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Poaching	0	0	103	11

Fauna

With the adoption of appropriate mitigation measures such as installation of signages to educate visitors on appropriate behaviours when encountering fauna, provision of wildlife-proof bins, installation of railings along trails and boardwalks to prevent visitors from straying off-trail, and conducting regular patrols, all impacts are reduced to a residual impact significance of Minor or Negligible (Table 12-21).

Table 12-21: Summary of Operational Phase Residual Impacts to Fauna Receptors at BBNP / Study Area B1 (West of Lorong Sesuai), B2, B3, B4, C1, and C2)

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Accidental injury or mortality	0	0	36	73
Human-wildlife conflict	0	0	34	75
Poaching	0	0	23	86
Loss/reduction of ecological connectivity for faunal movement	0	0	69	40
Light disturbances	0	0	57	52
Human disturbances	0	0	96	13

12.3 BBTP / Study Area D

12.3.1 Assessment of Ecological Value

12.3.1.1 Habitats

The ecological value of five (5) terrestrial habitats and three (3) aquatic habitats within the Study Area was assessed.

Two (2) terrestrial habitats (abandoned kampong and/or plantation with native recruitment and abandoned kampong and/or plantation) and three (3) aquatic habitats (stream SD1a, quarry lake QD1, and quarry lake QD2) were assessed to have overall medium ecological value, i.e., Priority 2. Three (3) terrestrial habitats (scrubland, farm, and urban vegetation) were assessed to have overall low ecological value, i.e., Priority 3. A summary of the national assessment of ecological value is detailed in Table 12-22. The paragraphs below summarise the assignation of ecological value for each habitat type.

I. Abandoned kampong and/or plantation with Native Recruitment (Medium Ecological Value; Priority 2)

Abandoned kampong and/or plantations with native recruitment are regrowth forests developed from abandoned villages, orchards, or plantations, usually dominated by fruit trees, cultivated crops, or ornamental plants, but richer in native species. While higher native recruitment is evident, this habitat type was assessed following typical abandoned kampong and/or plantations, with plant receptors accounted for in the separate assessment of flora. In BBTP / Study Area D, this habitat type is mostly dominated by rubber (*Hevea brasiliensis*), with native tree species such as *Adinandra dumosa* and *Campnosperma auriculatum* in the understorey. Abandoned kampong and/or plantations generally have medium flora and fauna species richness (Score 2), supporting few unique flora and fauna species (Score 1). As the main composition of this habitat type can be easily replanted and be established within 30 years, abandoned kampong and/or plantations are easy to recreate or replace, rendering it a low score in irreplaceability (Score 1). Nonetheless, this habitat type is uncommon in Singapore (Score 2) due to increasing urbanisation.

With two (2) criteria assessed to be medium (Score 2) and two (2) criteria low (Score 1), the overall score for the abandoned kampong and/or plantation habitat with native recruitment is six (6), which translates to medium ecological value across all terrestrial habitats in Singapore.

II. Abandoned kampong and/or plantation (Medium Ecological Value; Priority 2)

Abandoned kampong and/or plantations are regrowth forests developed from abandoned villages, orchards, or plantations, usually dominated by fruit trees, cultivated crops, or ornamental plants. In BBTP / Study Area D, the canopy is mostly dominated by rubber (*Hevea brasiliensis*), which is interspersed with fruit trees such as rambutan (*Nephelium lappaceum* var. *lappaceum*) and durian (*Durio zibethinus*). The understorey consisted of other fruit trees such as jackfruit (*Artocarpus heterophyllus*), and ornamental plants such as betel (*Piper betel*) were found throughout the habitat. Abandoned kampong and/or plantations generally have medium flora and fauna species richness (Score 2), supporting few unique flora and fauna species (Score 1). As the main composition of this habitat type can be easily replanted and be established within 30 years, abandoned kampong and/or plantations are easy to recreate or replace, rendering it a low score in irreplaceability (Score 1). Nonetheless, this habitat type is uncommon in Singapore (Score 2) due to increasing urbanisation.

With two (2) criteria assessed to be medium (Score 2) and two (2) criteria low (Score 1), the overall score for the abandoned kampong and/or plantation habitat is six (6), which translates to medium ecological value across all terrestrial habitats in Singapore.

III. Stream SD1a (Medium Ecological Value; Priority 2)

Stream SD1a is a mostly closed-canopy forest stream in BBTP / Study Area D flowing from north to south. The stream is moderate flowing with steep and well-vegetated banks, although most areas have been heavily eroded. Factors such as a clayey-sandy substrate downstream makes it an ideal habitat for native decapods like the maculate freshwater crab (*Parathelphusa maculata*). Forest streams often have complex hydrological requirements, on top of moderate topographical, biological material and water quality requirements to reach ecologically optimal structure and species composition. Forest streams generally have high flora and fauna species richness (Score 3), albeit they are not known to support any unique flora and fauna species (Score 0). Such intricacy results in the habitat being difficult to recreate or replace, giving it a medium score in irreplaceability (Score 2). Moreover, with increasing urbanisation, forest streams are currently uncommon in Singapore (Score 2).

With one (1) criterion assessed to be high (Score 3), two (2) criteria medium (Score 2) and one (1) criterion zero (Score 0), the overall score for the forest stream habitat is seven (7), which translates to medium ecological value across all freshwater habitats in Singapore.

IV. Quarry Lake QD1 (Medium Ecological Value; Priority 2)

Quarry lakes are formed from the remnants of former quarries in Singapore, which were used to supply granite in the 1970s. Seng Chew Quarry (QD1) is a quarry lake located in the north-western regions of BBTP / Study Area D. The quarry lake is a waterbody surrounded mostly by exposed steep walls and overhanging vegetation, with evidence of recent erosion and slope failure. Quarry lakes generally have medium flora and fauna species richness (Score 2), although they are not known to support any unique flora and fauna species (Score 0). However, they form unique habitats that are difficult to replace (Score 3) and are fairly uncommon in Singapore as they are formed solely from former quarries (Score 2).

With one (1) criterion assessed to be high (Score 3), two (2) criteria medium (Score 2) and one (1) criterion zero (Score 0), the overall score for the quarry lake habitat is seven (7), which translates to medium ecological value across all freshwater habitats in Singapore.

V. Quarry Lake QD2 (Medium Ecological Value; Priority 2)

Quarry lakes are formed from the remnants of former quarries in Singapore, which were used to supply granite in the 1970s. Little Guilin Quarry (QD2) is a quarry lake located in the southern regions of BBTP / Study Area D. The quarry lake is a large waterbody surrounded mostly by exposed steep walls and overhanging vegetation. Quarry lakes generally have medium flora and fauna species richness (Score 2), although they are not known to support any unique flora and fauna species (Score 0). However, they form unique habitats that are difficult to replace (Score 3) and are fairly uncommon in Singapore as they are formed solely from former quarries (Score 2).

With one (1) criterion assessed to be high (Score 3), two (2) criteria medium (Score 2) and one (1) criterion zero (Score 0), the overall score for the quarry lake habitat is seven (7), which translates to medium ecological value across all freshwater habitats in Singapore.

VI. Scrubland (Low Ecological Value; Priority 3)

Scrublands are open canopy vegetation dominated by shrubs, climbers, and/or ferns. In BBTP / Study Area D, it occurs as patches interspersed within the abandoned kampong and/or plantation. Generally, they were dominated by herbaceous plants such as simpoh air (*Dillenia suffruticosa*), although there is a small patch in the south dominated by the *Phanera semibifida* var. *semibifida* climbers, and another one in the eastern corner dominated by ornamentals and crop plants such as *Manihot carthagenensis*. Scrublands often have low flora and fauna species richness (Score 1) and are not known to support any unique flora and fauna species (Score 0). As shrubs that make up scrublands colonise rapidly and can take over land with minimal human intervention, scrublands are easy to recreate or replace (Score 1). Nonetheless, this habitat type is uncommon in Singapore (Score 2) due to increasing urbanisation.

With one (1) criterion assessed to be medium (Score 2), two (2) criteria low (Score 1) and one (1) criterion zero (Score 0), the overall score for the scrubland habitat is four (4), which translates to low ecological value across all terrestrial habitats in Singapore.

VII. Farm (Low Ecological Value; Priority 3)

Farmland was found along the forest edges of BBTP / Study Area D. Northern farm patches in BBTP / Study Area D consisted of fruit crops such as banana (*Musa cultivar*) and jackfruit (*Artocarpus heterophyllus*), while southern farmland consisted of a community farm with edible plants. Typically, farms have low flora and fauna species richness (Score 1), with few unique flora and fauna species recorded (Score 1). This habitat type is common nationally (Score 1) and can be easily reconstructed through human intervention, rendering it a low score in irreplaceability (Score 1).

With four (4) criteria assessed to be low (Score 1), the overall score for the farm habitat is four (4), which translates to low ecological value across all terrestrial habitats in Singapore.

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

Urban vegetation in BBTP / Study Area D was mostly found along forest edges. On the eastern side, the habitat type mostly consisted of managed turf with a few planted *Tabebuia rosea*. On the western side, urban vegetation mostly consisted of parkland, with some planted *Swietenia macrophylla*. Typically, urban vegetation has low flora and fauna species richness (Score 1), with few unique flora and fauna species recorded (Score 1). This habitat type is common nationally (Score 1) and can be easily reconstructed through human intervention, rendering it a low score in irreplaceability (Score 1).

With four (4) criteria assessed to be low (Score 1), the overall score for the urban vegetation habitat is four (4), which translates to low ecological value across all terrestrial habitats in Singapore.

Table 12-22: National assessment of ecological value of each habitat type in BBTP / Study Area D

Criterion	Terrestrial habitat					Aquatic habitat		
	Abandoned kampong and/or plantation with Native Recruitment	Abandoned kampong and/or plantation	Scrubland	Farm	Urban Vegetation	Stream SD1a	Quarry Lake QD1	Quarry Lake QD2
Flora and fauna species richness	2	2	1	1	1	3	3	2
Irreplaceability	1	1	1	1	1	2	2	3
National rarity of habitat	2	2	2	1	1	2	2	2
Unique flora and fauna species	1	1	0	1	1	0	0	0
Total score	6	6	4	4	4	7	7	7
Ecological value	**Medium**	**Medium**	**Low**	**Low**	**Low**	**Medium**	**Medium**	**Medium**

12.3.1.2 Flora

The ecological value of 366 plant species in BBTP / Study Area D was assessed. Plant species that could not be determined to its species level with certainty was excluded for assessment of ecological value. The list of species assessed is reflected in **Appendix 10**.

Of the species assessed, 96 are assigned the value of Priority 1 (i.e., high ecological value), 115 are of Priority 2 (i.e., medium ecological value), and 151 are of Priority 3 (i.e., low ecological value). Altogether, 18 species had their ecological values raised after assessment— 15 from Priority 2 to Priority 1, three (3) from Priority 3 to Priority 1, and one (1) from Priority 3 to Priority 2.

Seventy-seven (77) species of conservation significance are assessed with a high ecological value (Priority 1). This does not include five (5) species of conservation significance, *Angiopteris evecta, Aporosa benthamiana*, *Bridelia stipularis, Clerodendrum villosum, and Guioa pubescens*. The ecological value of these species were reduced from Priority 1 to Priority 2 due to their widespread local and national distribution.

Seven (7) native fig species (i.e., *Ficus aurata* var. *aurata, F. fistulosa, F. grossularioides* var. *grossularioides, F. heteropleura, F. microcarpa, F. punctata* and *F. variegata*) that were accorded with an initial level of Priority 2, were raised to Priority 1 as they are regarded as keystone species. For the same reason, one (1) cryptogenic fig species, (*F. benjamina*) had its initial ecological value raised from Priority 3 to Priority 1.

The ecological value of two (2) bamboo species, *Bambusa heterostachya* and *B. vulgaris*, were raised from Priority 3 to Priority 1. Albeit of exotic origin, these bamboos are potential habitat for bamboo bats (*Tylonycteris* spp.) that are known to roost within the bamboo internodes.

Other exotic species like the rain tree (*Samanea saman*) was also raised from Priority 3 to Priority 2 after assessment. Similarly, the ecological value of eight (8) common native species were raised from Priority 2 to Priority 1 due to their restricted local and national distribution since these species are mostly observed within restricted to old secondary forests and/or primary forests in Singapore.

On the other hand, 13 common native species had their priority levels reduced from Priority 2 to Priority 3 as specimens of these species are locally and nationally widespread.

12.3.1.3 Fauna

The ecological value of 372 faunal species for BBTP / Study Area D recorded from the baseline assessment were assessed together with probable species of conservation significance. All 106 faunal species of conservation significance (recorded and probable) were accorded a Priority 1 sensitivity level and deemed to be of high ecological value. The list of species assessed is reflected in **Appendix 11**.

12.3.2 Identification of Biodiversity Sensitive Receptors

Habitats and plant species that fall within the impact zone of the worksites were identified as biodiversity sensitive receptors (Figure 12-6). Faunal species that were recorded or deemed probable during baseline study were also identified as biodiversity sensitive receptors.

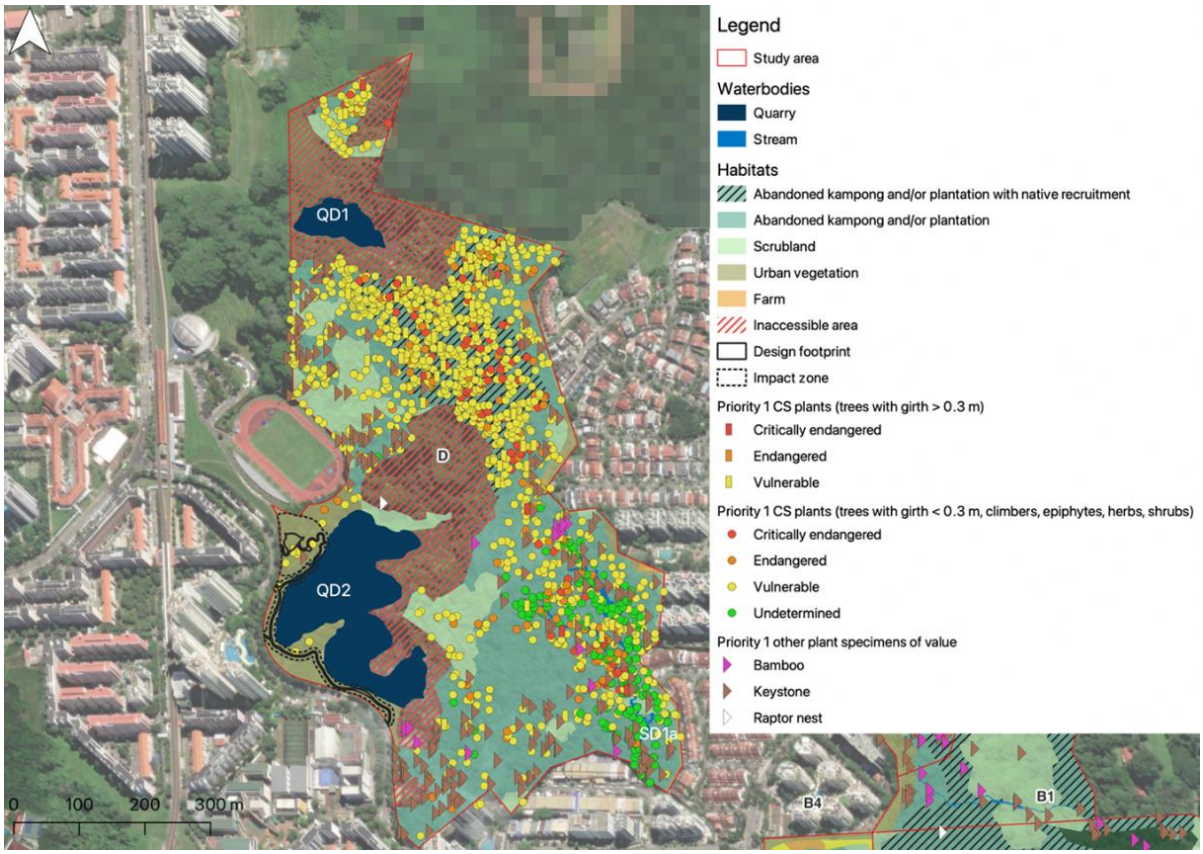


Figure 12-6: Impact Zone for Habitat and Species Receptors in BBTP / Study Area D

12.3.2.1 Habitats

Following the assessment of ecological value for habitats (Section 12.3.1.1), all habitats within the development area and within 30 m (for main park entrance) and 5 m (for boardwalks and trails) from the proposed development area were identified as the sensitive receptors for habitats (Figure 12-6).

12.3.2.2 Flora

Following the assessment of ecological value for all plant species (Section 12.3.1.2), some flora receptors were selected for the assessment of ecological impacts. The selection was based on the following: (1) Priority 1 CS species, large specimens, other specimens of value and/or common

native trees that had their ecological value raised in Section 12.3.1.2 and lie inside the worksites or impact zones of the proposed developments, (2) Priority 1 CS species that make up ≤1% of the total CS specimen count, (3) Priority 1 keystone species that are of conservation significance and/or are considered as large specimens (i.e., *Ficus* spp.), and four (4) species that are associated with important fauna.

12.3.2.3 Fauna

Following the assessment of ecological value for faunal species (Section 12.3.1.3), all species with a Priority 1 sensitivity level were identified as the sensitive receptors. Species of conservation significance deemed of probable occurrence were also identified as sensitive receptors, with the only exception being the unidentified bamboo bat (*Tylonycteris* sp.). As species-level identification was not possible, both bamboo bat species (*Tylonycteris fulvida* and *T. malayana*) in Singapore were identified as sensitive receptors instead, as both species are threatened, and were deemed of probable occurrence. A total of 106 sensitive receptors were identified in Area D, of which 17 were recorded from the field assessment, and 89 were deemed of probable occurrence. Breaking down the sensitive receptors by taxon, there are 12 aculeate hymenopterans, 29 butterflies, nine (9) odonates, eight (8) reptiles, 32 birds, six (6) non-volant mammals, eight (8) bats, and two (2) decapod crustaceans.

12.3.3 Prediction and Evaluation of Biodiversity Impacts

In this section, the identified biodiversity sensitive receptors were evaluated based on impact intensity and likelihood, to derive the impact significance. The various levels of impact intensity and likelihood for each impact type during the construction and operational phases were defined for the biodiversity sensitive receptors. Some assumptions were made in defining the impact intensity, as detailed in the sections below.

For both the construction and operational phases, the full list of the priority level, impact intensity, impact consequence, impact likelihood, as well as the resulting impact significance for each biodiversity sensitive receptor is provided in **Appendices 10–12**.

12.3.3.1 Construction Phase

<u>Habitats</u>

Three (3) construction phase impacts were identified and assessed for the habitat receptors: loss of habitat, habitat degradation, and formation of edge effects. The impact significance was Negligible or Minor for habitat receptors at BBTP / Study Area D. A summary of the key biodiversity habitat receptors impacted during construction phase is shown in Table 12-23 and detailed assessment in Appendix 12.

Loss of Habitat

Loss of habitat will only occur in the urban vegetation at BBTP / Study Area D. Based on the area of habitat loss, the impact significance is Minor for this habitat type. The remaining habitat types are not directly impacted by the worksites, and hence have a Negligible impact significance.

Habitat Degradation

As a result of minimum control measures in place, the likelihood of habitat degradation for all habitats were deemed to be Less Likely. Impact significance for each habitat type is hence Negligible or Minor.

Formation of Edge Effects

Due to vegetation removal, new habitat edges will be formed and edge effects such as changes in microclimatic conditions are expected for urban vegetation (Priority 3). The increase in perimeter-

to-area ratio after vegetation removal results in a High impact intensity, which translates into Low impact consequence. While the construction of the main park entrance and experience are rather considerable in size and may require some tree removal, the impacted urban vegetation habitat is already at the edge, and likelihood of formation of edge effects occurring is Less Likely. As such, impact significance for the habitat is Minor. For the remaining habitat types, impact significance is Negligible since no development is expected to occur.

Table 12-23: Summary of Construction Phase Impacts to Habitat Receptors in BBTP / Study Area D

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
Loss of habitat	-	-	• Urban vegetation	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation • Scrubland • Farm • Stream SD1a • Quarry lake QD1 • Quarry lake QD2
Habitat degradation	-	-	• Urban vegetation • Quarry lake QD2	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation • Scrubland • Farm • Stream SD1a • Quarry lake QD1
Formation of edge effects	-	-	• Urban vegetation	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation • Scrubland • Farm • Stream SD1a • Quarry lake QD1 • Quarry lake QD2

Flora

A total of 75 sensitive flora species receptors recorded in BBTP / Study Area D were selected for the assessment of ecological impacts (Section 12.3.2.2). A summary of the impact to flora receptors is provided in Table 12-24. The detailed evaluation for each species is provided in **Appendix 10**.

Mortality

All 75 species are assessed with Negligible impact significance as none of the specimens will be directly affected by the development.

Decline in Plant Health and Survival

For this impact type, all remaining specimens of the 75 flora receptors were assessed. The impact significance for all flora receptors, except *Morinda elliptica*, was assessed as Negligible. It is assumed that *M. elliptica* has already have been adapted to the urbanised environment since it was recorded within the urban vegetation. It is less likely that the only specimen recorded on site will be impacted by the proposed works of the main entrance. Hence, it was also assessed with Minor impact significance.

Table 12-24: Summary of Construction Phase Impacts to Flora Receptors at BBTP / Study Area D

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Mortality	0	0	0	75
Decline in plant health and survival	0	0	1	74

Fauna

Six (6) construction phase impacts were identified and assessed for faunal receptors: (1) loss of or reduction in habitats and food sources, (2) accidental injury or mortality, (3) human-wildlife conflict, (4) loss of or reduction in ecological connectivity for faunal movement, (5) light disturbances, and (6) human disturbances. The impact significance ranged from Negligible to Moderate. The more substantial impacts arising from each impact type are briefly summarised below. A summary of the impacts to fauna receptors is given in Table 12-25 and detailed in **Appendix 11**.

Table 12-25: Summary of Construction Phase Impacts to Fauna Receptors at BBTP /Study Area D

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Loss of or reduction in habitats and food sources	0	39	0	65
Accidental injury or mortality	0	12	1	91
Human-wildlife conflict	0	18	14	72
Loss of or reduction in of ecological connectivity for faunal movement	0	0	62	42
Light disturbances	0	0	92	12
Human disturbances	0	28	62	14

Loss of or Reduction in Habitats and Food Sources

Site clearance for the creation of the Main Entrance is expected to cause habitat loss amounting to less than 10% for urban vegetation. The likelihood of this impact type was deemed to be Certain for 39 species that may utilise the urban vegetation and the resulting impact significance is Moderate.

Accidental Injury or Mortality

Accidental injury or mortality of fauna during the construction phase was deemed Negligible for species predominantly volant and highly mobile, and thus able to move away from construction activities. Similarly, the impact significance is also Negligible for stream inhabitants and bamboo bats (*Tylonycteris* spp.), which are not affected by construction activities.

The arboreal and highly agile Horsfield's flying squirrel (*Iomys horsfieldii*) was assigned a Minor impact significance.

For the remainder of species that are less mobile, or ground-dwelling that are unable to move quickly, they would be more susceptible to this impact. Hence their likelihood is Possible. Some examples are reptiles of probable occurrence such as black-headed collared snake (*Sibynophis melanocephalus*), gold-ringed cat snake (*Boiga melanota*), king cobra (*Ophiophagus hannah*), and Malayan box terrapin (*Cuora amboinensis*). On the other hand, certain more mobile species would also be susceptible to accidental injury, as they would be able to enter the construction site, thus risking entrapment. This includes mammals such as long-tailed macaque (*Macaca fascicularis*), Sunda pangolin (*Manis javanica*; probable species), and Sunda colugo (*Galeopterus variegatus*). After considering the key minimum control measure of the erection of hoarding around worksites involving heavy machinery (i.e., Main Entrance) to prevent fauna entry, avoidance of fogging as a vector control measure, no night works (except for safety-critical works), and fauna inspections before any vegetation clearance, the impact significance for these species is Moderate.

Human-wildlife Conflict

Human-wildlife conflict between faunal species and construction site personnel is deemed to be Negligible for species not perceived as nuisances or threats to construction personnel, such as butterflies, odonates, and birds that would avoid human presence. The likelihood is Less Likely for predominantly ground-dwelling species, bats, and reptiles that are less tolerant of human presence such as the Barred kukri snake (*Oligodon signatus*; probable species) and the White-bellied rat snake (*Ptyas fusca*; probable species). For the remainder of the species that display a higher tolerance to human presence, the likelihood is Possible. Human-wildlife interactions may escalate into conflicts for many reasons. Nuisance species, such as long-tailed macaques (*Macaca fascicularis*), may be attracted to food waste or other materials within the worksite, and lead to negative interactions with site personnel. Smooth otter (*Lutrogale perspicillata*), a recorded species at quarry lake QD2, though not an aggressive species, might display defensive behaviour in close proximity to human. A lack of understanding regarding how to safely interact with wildlife may also lead to conflict with these species. Certain species are threats to human safety, and may elicit fear in construction personnel when encountered, resulting in conflict. This includes venomous snake such as king cobra (*Ophiophagus hannah*; probable species), and aculeate hymenopterans that may sting. The impact significance is hence assessed to be Moderate for these species.

Loss of or Reduction in Ecological Connectivity for Faunal Movement

The likelihood of the loss of or reduction in ecological connectivity for faunal movement was deemed Not Expected to Occur for all 104 species as hoardings are expected to be erected only around worksites involving heavy machinery (i.e., Main Entrance), which will occur adjacent to the road (Bukit Batok East Avenue 5). Similarly, the likelihood is also Not Expected to Occur for stream inhabitants and bamboo bats (*Tylonycteris* spp.), which are not affected by construction activities.

Light Disturbances
It is Less Likely for all fauna species to experience light disturbances as no night works is expected to occur aside from safety-critical works. Hence, the impact significance for all species is Minor or Negligible.

Human Disturbances
Human disturbance at the construction phase was deemed Not Expected to Occur or Less Likely for species that are tolerant or not adversely impacted by human presence. Examples are insects and mammals such as long-tailed macaque (*Macaca fascicularis*). The likelihood is also Not Expected to Occur for stream inhabitants, which are not affected by construction activities and far from possible human disturbances during construction. For these species, their impact significance is Negligible or Minor. On the other hand, animals that are sensitive to human presence would move away from an approaching human, with extremely sensitive species leaving the site entirely. The likelihood is thus Possible, and the impact significance was assessed as Moderate for these species.

12.3.3.2 Operational Phase

Habitats

Three (3) operational phase impacts were identified and assessed for the habitat receptors: habitat degradation, changes in microclimatic conditions, and introduction of exotic species (aquatic habitats only). The impact significance ranged from Negligible to Minor for habitat receptors at BBTP / Study Area D. A summary of the key biodiversity habitat receptors impacted during operational phase is shown in Table 12-26 and detailed assessment in **Appendix 12**.

Habitat Degradation
Human accessibility and habitat degradation are most expected near areas of development, such as the urban vegetation. While impact intensity was assessed to be High for the habitat type, impact consequence was Low due to its low sensitivity (Priority 3). Urban vegetation remains easily accessible to the public and habitat degradation is already evident. As such, likelihood of habitat degradation occurring is Possible, and consequently, impact significance is Minor. Similarly, habitat degradation at the quarry lake QD2 is also Minor since accessibility to the waterbody is increased with the constructed boardwalk and habitat degradation (e.g., littering) is already evident. For the remaining habitats, impact significance is Negligible due to limited accessibility.

Changes in Microclimatic Conditions
As the overall development is small-scale and involves heavy landscaping and limited hardscape, the likelihood of changes in microclimatic conditions because of micro-urban heat island effect is Not Expected to Occur and impact significance is Negligible for all habitat types.

Introduction of Exotic Species
The quarry lakes QD1 and QD2 are dominated by exotic species like Midas cichlid (*Amphilophus citrinellus*), giant gourami (*Osphronemus goramy*) and red-eared slider (*Trachemys scripta*), which means any introduction of exotic species would have Very Low impact consequence. As quarry lake QD2 is already easily accessible, likelihood of increased risk of introduction of exotic species is Less Likely and impact significance is Negligible. Quarry lake QD1 and the native-dominated Stream SD1a are not impacted by the development and the impact significance is Negligible and Minor, respectively.

Table 12-26: Summary of Operational Phase Residual Impacts to Habitat Receptors at BBTP / Study Area D

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
Habitat degradation	-	-	• Urban vegetation • Quarry lake QD2	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation • Scrubland • Farm • Stream SD1a • Quarry lake QD1
Changes in microclimatic conditions	-	-	-	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation • Scrubland • Farm • Urban vegetation • Stream SD1a • Quarry lake QD1 • Quarry lake QD2
Introduction of exotic species (aquatic habitats only)	-	-	• Stream SD1a	• Quarry lake QD1 • Quarry lake QD2

Flora

For this assessment, the remaining specimens of all 75 flora species receptors were assessed for only one (1) impact type, poaching. A summary of the impact to flora receptors is provided in Table 12-27. The detailed evaluation for each species is provided in Appendix 10. Altogether, four (4) species were assessed with Minor impact significance while the remaining 71 species are Negligible.

Two (2) bamboo species, *Bambusa heterostachya* and *B. vulgaris* are assessed with Medium impact intensity due to its ethnobotanical properties. However, since the specimens of these species are too large to be poached, it is unlikely for poaching to occur.

One orchid species, *Arundina graminifolia*, and one pitcher species, *Nepenthes rafflesiana*, are assessed with High impact intensity. However, since the specimens of these species are inaccessible to public, poaching is Not Expected to Occur.

For the remaining 71 species, all of them are assessed with Low impact intensity, given that they do not possess any ethnobotanical and/or aesthetic values. Based on the distribution of the specimens (i.e., clustered and/or spread out), poaching is Less Likely or Not Expected to Occur. Hence, they are assessed with Negligible impact significance.

Table 12-27: Summary of Operational Phase Impacts to Flora Receptors at BBTP / Study Area D

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Poaching	0	0	4	71

Fauna

Six (6) operational phase impacts were identified and assessed for faunal receptors: (1) accidental injury or mortality, (2) human-wildlife conflict, (3) poaching, (4) loss of or reduction in ecological connectivity for faunal movement, (5) light disturbances, and (6) human disturbances. The impact significance ranged from Negligible to Moderate. Only the most substantive impact for each impact type is presented below. A summary of the impact to fauna receptors is given in Table 12-28 and detailed in Appendix 11.

Table 12-28: Summary of Operational Phase Impacts to Fauna Receptors at BBTP / Study Area D

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Accidental injury or mortality	0	0	34	70
Human-wildlife conflict	0	0	31	73
Poaching	0	0	23	81
Loss or reduction of ecological connectivity for faunal movement	0	0	62	42
Light disturbances	0	0	56	48
Human disturbances	0	0	92	12

Accidental Injury or Mortality

Accidental injury or mortality because of bird-building collisions was deemed Not Expected to occur as there are no major buildings or structures that will be constructed in BBTP. Roadkills were deemed Less Likely to occur as the adjacent roads already experience moderate traffic volumes that are unlikely increase significantly despite the expected rise in visitorship post-construction. Hence, the impact is Minor for non-volant mammals and terrestrial reptiles.

Human-wildlife Conflict

The likelihood of human-wildlife conflict during the operational phase was deemed Not Expected to Occur or Less Likely for aquatic species, non-stinging insects, birds, non-volant mammals, bats, and reptiles that are not known to be implicated in human-wildlife conflict within the setting of a nature recreational site. Hence, the impact significance is either Negligible or Minor.

Species possibly implicated in human-wildlife conflict include species that can have negative interactions with pets (e.g., dogs) or wrongly perceived as nuisances, such as long-tailed macaque (*Macaca fascicularis*) and the smooth otter (*Lutrogale perspicillata*), which members of the public may try to approach closely. Species that may possibly cause harm to visitors, especially persons who lack awareness on how to behave during animal encounters, are for example venomous snakes of probable occurrence including the gold-ringed cat snake (*Boiga melanota*), king cobra

(*Ophiophagus hannah*), and bees that may sting. However, given that BBTP is already operating as a public green space, there are already measures in place to mitigate human-wildlife conflict. Hence, the likelihood of this impact is Less Likely, impact significance is assessed to be Minor for these species.

Poaching
The likelihood of poaching is deemed Not Expected to Occur, impact significance Negligible for most species that are not susceptible to poaching (e.g., bees, odonates, butterflies, decapod crustaceans, snakes, some birds, bats, and arboreal mammals). Since the proposed trail is not near the streams in BBTP / Study Area D, the likelihood for aquatic species of conservation significance is listed as Less Likely even though they are susceptible to poaching. Twenty-two (22) species are susceptible to poaching. Examples include straw-headed bulbul (*Pycnonotus zeylanicus*), white-rumped shama (*Copsychus malabaricus*; probable species), Sunda pangolin (*Manis javanica*; probable species), and common birdwing butterfly (*Troides helena cerberus*; probable species). As the Study Area is currently already accessible to the public, the increased risk of poaching is Less Likely and the impact significance is Minor.

Loss of or Reduction in Ecological Connectivity for Faunal Movement
The likelihood of the loss of or reduction in ecological connectivity for faunal movement was deemed Not Expected to Occur for all species. This is because the future site is composed mostly of narrow trails with the forested areas, which would not fragment the existing connectivity, or increase barriers to faunal movement. The impact significance is hence expected to be Negligible/Minor for all species.

Light Disturbances
The likelihood of light disturbance during the operational phase was deemed Not Expected to Occur for all species as lighting will only be provided along the Main Entrance which is already currently lit along the concrete pathway adjacent to Bukit Batok East Ave 5 (i.e., no worse off from baseline), thus the impact significance is expected to be Negligible/Minor.

Human Disturbances
Human disturbance was deemed Not Expected to Occur or Less Likely for species that are tolerant or not adversely impacted by human presence or their accompanying pets (e.g., dogs). Their impact significance is Negligible or Minor. The likelihood is also Not Expected to Occur for stream inhabitants since the trail is not near these species. However, the expected increase and continual presence of visitors till 1900h during operation may cause more sensitive animals to move away, although human traffic will be confined within the Main Entrance, and trails/boardwalks. Nevertheless, given that BBTP is already operating as a public green space, there are already measures in place to mitigate human disturbances. Hence, the likelihood of this impact is Less Likely, impact significance is assessed to be Minor for these species.

12.3.4 Recommended Mitigation Measures
In this section, mitigation measures for the proposed developments in BBTP / Study Area D are discussed. Mitigations are to be implemented according to the hierarchy described in **Section 5.6**.

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

Avoid

The key mitigation measures to avoid biodiversity impacts through the design of the proposed development at BBTP / Study Area D are summarised in
Table 12-29 and detailed in the paragraphs below.

Table 12-29: Key Recommended Design Measures to Avoid Biodiversity Impacts at BBTP / Study Area D

Receptor	Impact Type	Mitigation Measures
Habitats	Loss of habitat	• Avoid areas of high conservation value
Flora species	Mortality	• Avoid areas of high conservation value • Adjust design footprint to avoid Priority 1 plant species
	Decline in plant health and survival	• Adjust design footprint to ensure Priority 1 plant species are not within the impact zones
Fauna species	Loss of or reduction in habitats and food sources for fauna	• Avoid areas of high conservation value

Avoid Areas of High Conservation Value

As loss of habitat will result in Moderate impacts, it is recommended to avoid clearing vegetation where possible, especially in areas of high conservation value (Figure 6-24). Heavy structures within these areas should be avoided as they contain several plant specimens of conservation significance, large plant specimens, other plant specimens of value, and/or sensitive habitats. Any habitat enhancement/rehabilitation works and construction of low-impact structures and on-grade trails within these areas should be carried out sensitively.

Adjust Design Footprint to Avoid Priority 1 Plant Species

The footprints of the Main Entrance, boardwalks, and trails should be adjusted during the detailed design stage to avoid Priority 1 plant species and ensure that they are not within the impact zones.

Minimise

The key mitigation measures to minimise biodiversity impacts through the design of the proposed development at BBTP / Study Area D are summarised in Table 12-30 and detailed in the paragraphs below.

Table 12-30: Key Recommended Design Measures to Minimise Biodiversity Impacts at BBTP / Study Area D

Receptor	Impact Type	Mitigation Measures
Habitats	Habitat degradation	• Put up signages to remind visitors not to litter or pollute the habitats
	Introduction of exotic species (aquatic habitats only)	• Put up signages to remind visitors not stray off-trail • Design the boardwalks and trails to deter visitors from venturing off-trail (e.g., install railings) • Design for dense landscaping along the sides of the proposed trails and boardwalks to deter visitors from venturing off-trail
Flora species	Mortality	• Design the boardwalks and trails to deter visitors from trampling/ venturing off-trail (e.g., install railings)
	Poaching	• Design the boardwalks and trails to deter visitors from trampling/ venturing off-trail (e.g., install railings) • Put up signages to remind visitors not to stray off-trail • Design for dense landscaping along the sides of the proposed trails and boardwalks to deter visitors from venturing off-trail

Receptor	Impact Type	Mitigation Measures
	Decline in plant health and survival	• Design for dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions
Fauna species	Accidental injury and mortality	• Integrate road-calming measures
	Human-wildlife conflict	• Design bins to be wildlife-proof • Put up signages to educate visitors on appropriate behaviours when encountering fauna
	Light disturbances	• Incorporate wildlife-friendly lighting
	Human disturbances	• Design the boardwalks and trails to deter visitors from venturing off-trail (e.g., install railings) • Design for dense landscaping along the sides of the proposed trails and boardwalks to deter visitors from venturing off-trail
	Poaching	• Design the boardwalks and trails to deter visitors from venturing off-trail (e.g., install railings) • Design for dense landscaping along the sides of the proposed trails and boardwalks to deter visitors from venturing off-trail

Put up Signages

A variety of educational signages are recommended to remind park visitors to observe good park etiquette, including not littering or polluting the habitats, not straying off-trail, and appropriate behaviours when encountering fauna. This could help minimise habitat degradation, poaching of plants, human-wildlife conflict, and introduction of exotic species into Stream SD1a during the operational phase.

Design Boardwalks and Trails to Deter Visitors from Venturing Off-trail

Boardwalks and trails could be designed with railings on both sides to discourage park visitors from venturing off-trail, hance minimising the likelihood of trampling resulting in plant mortality, poaching of plants, and introduction of exotic species into Stream SD1a.

Transplant Plant Specimens of Conservation Significance

By transplanting plant specimens of conservation significance well away from areas that will be made publicly accessible, the likelihood of poaching may be reduced.

Design for Dense Landscaping and In-fill Planting

Where vegetation will be cleared for construction activities, provisions for dense landscaping and in-fill planting should be made to revegetate those areas, minimising the likelihood of decline in plant health and survival caused by changes in microclimatic conditions. In-fill planting involves planting of native plants, particularly pioneer trees to jump start forest succession. It makes use of the existing framework of forest canopy and emergent, while selectively removing undesirable exotic species. Plant species of various other habits should also be planted (i.e., shrubs, ground cover), Ideally, the plants should be planted to emulate the framework of a forest (i.e., canopy, understorey, undergrowth). Dense landscaping and in-fill planting should also be provided for at existing gaps in forested areas and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions and deter visitors from venturing off-trail.

Integrate Road-calming Measures

Although the expected increase in vehicular traffic resulting from the increased visitorship to the park is not significant, since the roads that are adjacent to the park currently already experience heavy vehicular traffic, road-calming measures should be adopted for the roads. Such measures include speed bumps and restrictions on the maximum speed limit.

Design Bins to be Wildlife-proof

Food is an attractant for wildlife, and anthropogenic sources of food such as rubbish tend to be more easily accessible to fauna and higher in caloric yield than their natural food sources. Minimising human-wildlife conflicts would require proper waste management within the future park, such as designing bins to be wildlife-proof.

Incorporate Wildlife-friendly Lighting

It is recommended that the park and its associated facilities be closed to public during the night (1900–0700 h), wildlife-friendly lighting should be incorporated if park closure at night is not feasible. Wildlife-friendly lighting strategies are summarised in Figure 12-2.

Rehabilitate/Restore

The key mitigation measures to rehabilitate/restore biodiversity impacts through the design of the proposed development at BBTP / Study Area D are summarised in Table 12-31 and detailed in the paragraphs below. Measures to restore ecological connectivity across the adjacent roads (Figure 6-23) are not considered as mitigation measures in this Impact Assessment as resources to implement them are not available in this Project.

Table 12-31: Key Recommended Design Measures to Minimise Biodiversity Impacts at BBTP / Study Area D

Receptor	Impact Type	Mitigation Measures
Habitats	Formation of edge effects	• Design for dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions
Flora species	Decline in plant health and survival	• Design for dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions
	Poaching	• Design for dense landscaping along the sides of the proposed trails and boardwalks to deter visitors from venturing off-trail

Design for Dense Landscaping and In-fill Planting

Where there are existing gaps in the forested areas at BBTP / Study Area D, in-fill planting should be carried out to revegetate those areas to enhance the habitats there and minimise edge effects and the likelihood of decline in plant health and survival caused by changes in microclimatic conditions. In-fill planting involves planting of native plants, particularly pioneer trees to jump start forest succession. It makes use of the existing framework of forest canopy and emergent, while selectively removing undesirable exotic species.

12.3.4.2 Construction Phase

Key measures to avoid and minimise biodiversity impacts during the construction phase are briefly described below and further elaborated in the proposed EMMP.

Avoid

The key mitigation measures to avoid biodiversity impacts during the construction phase at BBTP / Study Area D are summarised in Table 12-32.

Table 12-32: Key Recommended Measures to Avoid Biodiversity Impacts during the Construction Phase at BBTP / Study Area D

Receptor	Impact Type	Mitigation Measures
Habitats	Loss of habitat	• Erect hoardings to delineate worksites involving heavy machinery (i.e., Main Entrance) • For worksites involving manual work only (i.e., trails and boardwalks), ensure the extent of the working space is clearly demarcated on-site and cross-checked by a Flora Specialist to avoid unnecessary vegetation clearance
	Habitat degradation	• Ensure construction works, material and waste storage, access routes, etc., are kept within the boundaries of the worksite or agreed working space
Flora species	Mortality	• Arborists to determine suitable Tree Protection Zones (TPZs) for any trees that will be retained within the worksites • Ensure construction works, material and waste storage, access routes, etc., are kept within the boundaries of the worksite or agreed working space • Transplant or salvage saplings of conservation significance • Adjust the construction footprint of boardwalks and trails to avoid Priority 1 plant species, in consultation with a Flora Specialist
	Decline in plant health and survival	• Adjust the construction footprint of boardwalks and trails to ensure the Priority 1 plant species are not within the impact zones
Fauna species	Loss of or reduction in habitats and food sources	• Erect hoardings to delineate worksites involving heavy machinery (i.e., Main Entrance, Plaza and Play Area) • For worksites involving manual work only (i.e., trails and boardwalks), ensure the extent of the working space is clearly demarcated on-site and cross-checked by a Flora Specialist to avoid unnecessary vegetation clearance • Only understory plants are removed when necessary, and to be replanted elsewhere in BBTP where possible

Minimise

The key mitigation measures to minimise biodiversity impacts during the construction phase at BBTP / Study Area D are summarised in Table 12-33.

Table 12-33: Key Recommended Measures to Minimise Biodiversity Impacts during the Construction Phase at BBTP Study Area D

Receptor	Impact Type	Mitigation Measures
Habitats	Habitat degradation	• Ensure ECM are implemented prior to site clearance. The ECM plan should be formulated by Qualified Erosion Control Personnel (QECP) • Implement dust control measures such as dust screens and water suppression systems • Conduct regular monitoring to identify any impacts to habitats adjacent to the worksite. This includes visual inspection of surrounding aquatic habitats (i.e., Stream SD1a, Quarry lake QD1, Quarry lake QD2) and monthly wildlife monitoring in habitats adjacent to the site • Conduct regular site inspections to ensure contractor compliance with the EMMP • Conduct regular inspections in the surrounding habitats to ensure no removal of vegetation has occurred beyond the agreed worksite boundaries
	Formation of edge effects	• Implement dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions • Conduct regular site inspections to ensure contractor compliance with the EMMP

Receptor	Impact Type	Mitigation Measures
Flora species	Mortality	• Conduct regular inspections in the surrounding habitats to ensure no removal of vegetation has occurred beyond the agreed worksite boundaries • Conduct regular site inspections to ensure contractor compliance with the EMMP
	Decline in plant health and survival	• Implement dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions • Conduct regular site inspections to ensure contractor compliance with the EMMP
Fauna species	Accidental injury and mortality	• Erect hoardings around worksites involving heavy machinery (i.e., Main Entrance) to prevent fauna entry • Conduct regular site inspections to ensure contractor compliance with the EMMP • Conduct regular trainings and toolbox briefings for site personnel on biodiversity awareness and actions to take when encountering wildlife • Formulate a wildlife response plan to be executed when trapped/ injured/dead/ dangerous fauna is found on-site • Ensure good housekeeping such as the provision of wildlife-proof food waste bins and enclosed eating areas • Conduct daily checks for roadkill and fauna entrapment within the worksite
	Human-wildlife conflict	• Erect hoardings around worksites involving heavy machinery (i.e., Main Entrance) to prevent fauna entry • Conduct regular site inspections to ensure contractor compliance with the EMMP • Conduct regular trainings and toolbox briefings for site personnel on biodiversity awareness and actions to take when encountering wildlife • Formulate a wildlife response plan to be executed when trapped/ injured/dead/ dangerous fauna is found on-site • Ensure good housekeeping such as the provision of wildlife-proof food waste bins and enclosed eating areas • Train site personnel that feeding of wildlife is strictly prohibited
	Human disturbances	• Restrict entry of site personnel beyond the worksite

12.3.4.3 Operational Phase

Although most of the biodiversity impacts associated with the operational activities can be addressed through the design measures (Section 12.3.4.1), additional measures related to the operation and management of the park are proposed to further avoid and minimise the impacts.

Table 12-34: Key Recommended Measures to Minimise Biodiversity Impacts during the Operational Phase at BBTP / Study Area D

Receptor	Impact Type	Mitigation Measures
Habitats	Habitat degradation	• Carry out regular maintenance of the park (e.g., removal of litter, emptying of trash, ensure integrity of railings along trails and boardwalks) • Conduct regular patrols to deter visitors from straying off-trail
	Introduction of exotic species to aquatic habitats	• Conduct regular patrols to deter visitors from releasing exotic species into waterbodies • Conduct outreach programmes to educate visitors on the harmful effects of introduction of exotic species
Flora species	Poaching	• Conduct regular patrols to deter visitors from straying off-trail • Transplant specimens of conservation significance away from publicly accessible areas
Fauna species	Poaching	• Conduct regular patrols to deter poaching activities
	Light disturbances	• Close the park and associated facilities to the public during the night (1900–0700 h)
	Human disturbances	• Conduct regular post-construction biodiversity monitoring to determine if the increased visitorship has affected fauna species

12.3.5 Residual Impacts

12.3.5.1 Construction Phase

Habitats

The summary of residual impacts during construction phase on key biodiversity habitat receptors is shown in Table 12-35 and detailed assessment **in Appendix 12.**

Loss of Habitat

Despite the proposed mitigation measures, as the physical design of the development is overall minimal and has been optimised to the meet the necessary functions of the park, the assessment of residual impacts due to loss of habitats largely remains the same as Section 12.3.3.1. Impact significance remains Negligible or Minor.

Habitat Degradation

As a result of minimum control measures, and regular compliance inspections and monitoring, the likelihood of habitat degradation for all habitats is still deemed to be Less Likely. Impact significance for each habitat type remains Negligible or Minor.

Formation of Edge Effects

Dense landscaping and in-fill planting can help to minimise the formation of edge effects within impacted habitats. Nonetheless, given that likelihood of formation of edge effects occurring to impacted habitat types is already Less Likely, the assessment of residual impacts remains Negligible or Minor.

Table 12-35: Summary of Construction Phase Residual Impacts to Habitat Receptors at BBTP / Study Area D

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
Loss of habitat	-	-	• Urban vegetation	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation • Farm • Scrubland • Stream SD1a • Quarry lake QD1 • Quarry lake QD2
Habitat degradation	-	-	• Urban vegetation • Quarry lake QD2	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation • Scrubland • Farm • Stream SD1a • Quarry lake QD1
Formation of edge effects	-	-	• Urban vegetation	• Abandoned kampong

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
				and/or plantation with native recruitment • Abandoned kampong and/or plantation • Scrubland • Farm • Stream SD1a • Quarry lake QD1 • Quarry lake QD2

Flora

Like the pre-mitigation impact assessment, all 75 flora species receptors were assessed for two (2) ecological impact types, (1) mortality and (2) decline in plant health and survival. The assessment considered mitigation measures for flora species, as mentioned in Section 12.3.4. A summary of the impacts to flora receptors is provided in Table 12-36. The detailed evaluation for each species is provided in **Appendix 10**.

Mortality

There is no change to the impact significance for all 75 flora species that were initially assessed as Negligible.

Decline in Plant Health and Survival

There is no change to the impact significance of one (1) flora species, *Morinda elliptica*, that was initially assessed as Minor since the impact has been reduced to a level that is as low as reasonably practicable. As for the remaining 74 species, there is no change to the impact significance that were initially assessed as Negligible.

Table 12-36: Summary of Construction Phase Residual Impacts to Flora Receptors at BBTP / Study Area D

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Mortality	0	0	0	75
Decline in plant health and survival	0	0	1	74

Fauna

Loss of or Reduction in Habitats and Food Sources

Residual impact likelihood from loss of or reduction in habitats and food sources can be reduced to Possible if mitigation measures to avoid/minimise the impact are carried out. This is especially with regards to the Main Entrance construction whereby only understory plants are removed when necessary, and the removed plants are re-planted elsewhere in BBTP. Consequently, the residual umpact significance is Minor or Negligible for all species.

Accidental Injury or Mortality, Human-wildlife Conflict, and Human Disturbances

The likelihood of accidental injury or mortality, human-wildlife conflict, and human disturbance can be reduced if mitigation measures recommended in Section 12.3.4 are followed, thus reducing the impact significance from Moderate to Minor.

A summary of residual impacts to fauna receptors is given in Table 12-37.

Table 12-37: Summary of Construction Phase Residual Impacts to Fauna Receptors at BBTP / Study Area D

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Loss or reduction in habitats and food sources	0	0	39	65
Accidental injury or mortality	0	0	13	91
Human-wildlife conflict	0	0	32	72
Loss of or reduction of ecological connectivity for faunal movement	0	0	62	42
Light disturbances	0	0	92	12
Human disturbances	0	0	90	14

12.3.5.2 Operational Phase

Habitats

The summary of residual impacts during operational phase on key biodiversity habitat receptors is shown in Table 12-38 and detailed assessment in **Appendix 12**.

Habitat Degradation

On top of regular park maintenance, the proposed mitigation measure of signages helps establish expected park etiquette more clearly. As such, the likelihood of habitat degradation occurring at the urban vegetation and quarry lake QD2 can be reduced from Possible to Less Likely. Consequently, impact significance remains Minor and is reduced to Negligible respectively.

Changes in Microclimatic Conditions

As the overall development type is still largely green, the likelihood of changes in microclimatic conditions occurring remains Not Expected to Occur and hence impact significance remains Negligible for all habitat types.

Introduction of Exotic Species

With the proposed signages, regular patrols, and design measures to deter visitors from venturing off-trail and accessing the aquatic habitats, the likelihood of increased risk of introduction of exotic species to aquatic habitats remains Less Likely. Consequently, impact significance remains Minor to Negligible.

Table 12-38: Summary of Operational Phase Residual Impacts to Habitat Receptors at BBTP / Study Area D

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
Habitat degradation	-	-	• Urban vegetation	• Abandoned kampong and/or plantation with native recruitment

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
				• Abandoned kampong and/or plantation • Scrubland • Farm • Stream SD1a • Quarry lake QD1 • Quarry lake QD2
Changes in microclimatic conditions	-	-	-	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation • Scrubland • Farm • Urban vegetation • Stream SD1a • Quarry lake QD1 • Quarry lake QD2
Introduction of exotic species (aquatic habitats only)	-	-	• Stream SD1a	• Quarry lake QD1 • Quarry lake QD2

Flora

There is no change to the impact significance for all the flora species since it is already as low as reasonably practicable.

Table 12-39: Summary of Operational Phase Residual Impacts to Flora Receptors at BBTP / Study Area D

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Poaching	0	0	4	71

Fauna

With the adoption of appropriate mitigation measures such as installation of signages to educate visitors on appropriate behaviours when encountering fauna, provision of wildlife-proof bins, installation of railings along trails and boardwalks to prevent visitors from straying off-trail, and conducting regular patrols to deter poaching activities, all impacts are reduced to a residual impact significance of Minor or Negligible (Table 12-40).

Table 12-40: Summary of Operational Phase Residual Impacts to Fauna Receptors at BBTP / Study Area D

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Accidental injury or mortality	0	0	34	70
Human-wildlife conflict	0	0	31	73

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Poaching	0	0	23	81
Loss/reduction of ecological connectivity for faunal movement	0	0	63	41
Light disturbances	0	0	55	49
Human disturbances	0	0	92	12

12.4 BBHNP / Study Area E

12.4.1 Assessment of Ecological Value

12.4.1.1 Habitats

The ecological value of four (4) terrestrial habitats and one (1) aquatic habitat within the Study Area was assessed.

One (1) terrestrial habitat (native-dominated secondary forest) was assessed to have overall high ecological value, i.e., Priority 1. Two (2) terrestrial habitats (abandoned kampong and/or plantation with native recruitment and abandoned kampong and/or plantation) and one (1) aquatic habitat (stream SE1a) were assessed to have overall medium ecological value, i.e., Priority 2. One terrestrial habitat (scrubland) was assessed to have overall low ecological value, i.e., Priority 3. A summary of the national assessment of ecological value is detailed in Table 12-41. The paragraphs below summarise the assignment of ecological value for each habitat type.

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

Native-dominated secondary forests are regrowth forests, usually on land cleared before the 1950s, that are dominated by native plant species. In BBHNP / Study Area E, the canopy of this habitat type comprises mainly *Syzygium grande*, interspersed by *Macaranga gigantea* in some areas. A few Tembusu (*Cyrtophyllum fragrans*) were recorded on higher terrain, and the understorey consists of common native species such as fishtail palm (*Caryota mitis*) and *Cinamommum iners*. Native-dominated secondary forests typically have high flora and fauna species richness (Score 3) and are known to support few unique flora and fauna species (Score 1). Due to the complexities and intricacies of this habitat type, it is challenging to recreate or replicate the native-dominated secondary forest to its ecologically optimal structure and species composition within 30 years. Native-dominated secondary forests are hence scored medium in irreplaceability (Score 2). However, this habitat type is currently considered rare in Singapore (Score 3) with increasing urbanisation.

With two (2) criteria assessed to be high (Score 3), one (1) criterion assessed to be medium (Score 2) and one (1) criterion low (Score 1), the overall score for the native-dominated secondary forest habitat is nine (9), which translates to high ecological value across all terrestrial habitats in Singapore.

II. Abandoned kampong and/or plantation with Native Recruitment (Medium Ecological Value; Priority 2)

Abandoned kampong and/or plantations with native recruitment are regrowth forests developed from abandoned villages, orchards, or plantations, usually dominated by fruit trees, cultivated crops, or ornamental plants, but richer in native species due to its proximity to a native-dominated secondary forest. While higher native recruitment is evident, this habitat type was assessed following typical abandoned kampong and/or plantations, with plant receptors accounted for in the separate assessment of flora. In BBHNP / Study Area E, this habitat type is mostly dominated by rubber (*Hevea brasiliensis*) with the understorey consisting of common native species such as chemperai (*Champereia manillana*), tiup-tiup (*Adinandra dumosa*) and silver back trees (*Rhodamnia cinerea*). Abandoned kampong and/or plantations generally have medium flora and fauna species richness (Score 2), supporting few unique flora and fauna species (Score 1). As the main composition of this habitat type can be easily replanted and be established within 30 years, abandoned kampong and/or plantations are easy to recreate or replace, rendering it a low score in irreplaceability (Score 1). Nonetheless, this habitat type is uncommon in Singapore (Score 2) due to increasing urbanisation.

With two (2) criteria assessed to be medium (Score 2) and two (2) criteria low (Score 1), the overall score for the abandoned kampong and/or plantation habitat with native recruitment is six (6), which translates to medium ecological value across all terrestrial habitats in Singapore.

III. Abandoned kampong and/or plantation (Medium Ecological Value; Priority 2)

Abandoned kampong and/or plantations are regrowth forests developed from abandoned villages, orchards, or plantations, usually dominated by fruit trees, cultivated crops, or ornamental plants. In BBHNP / Study Area E, the canopy in the north-eastern region is dominated by rubber (*Hevea brasiliensis*), interspersed with *Ficus apiocarpa*. In the south, a mix of exotic trees such as African tulip (*Spathodea campanulata*) and Angsana (*Pterocarpus indicus*) were observed. Abandoned kampong and/or plantations generally have medium flora and fauna species richness (Score 2), supporting few unique flora and fauna species (Score 1). As the main composition of this habitat type can be easily replanted and be established within 30 years, abandoned kampong and/or plantations are easy to recreate or replace, rendering it a low score in irreplaceability (Score 1). Nonetheless, this habitat type is uncommon in Singapore (Score 2) due to increasing urbanisation.

With two (2) criteria assessed to be medium (Score 2) and two (2) criteria low (Score 1), the overall score for the abandoned kampong and/or plantation habitat is six (6), which translates to medium ecological value across all terrestrial habitats in Singapore.

IV. Stream SE1a (Medium Ecological Value; Priority 2)

Stream SE1a is a slow-flowing and mostly closed-canopy forest stream in BBHNP / Study Area E. The stream has a man-made well mid-stream and banks which are well-vegetated or substantially covered with leaf litter. Tree ferns (*Alsophila latebrosa*) and rubber (*Hevea brasiliensis*) are dominant along the stream. Forest streams often have complex hydrological requirements, on top of moderate topographical, biological material and water quality requirements to reach ecologically optimal structure and species composition. Forest streams generally have high flora and fauna species richness (Score 3), albeit they are not known to support any unique flora and fauna species (Score 0). Such intricacy results in the habitat being difficult to recreate or replace, giving it a medium score in irreplaceability (Score 2). Moreover, with increasing urbanisation, forest streams are currently uncommon in Singapore (Score 2).

With one (1) criterion assessed to be high (Score 3), two (2) criteria medium (Score 2) and one (1) criterion zero (Score 0), the overall score for the forest stream habitat is seven (7), which translates to medium ecological value across all freshwater habitats in Singapore.

V. Scrubland (Low Ecological Value; Priority 3)

Scrublands are open canopy vegetation dominated by shrubs, climbers, and/or ferns. Majority of this habitat type in BBHNP / Study Area E is made up of simpoh air (*Dillenia suffruticosa*) clusters, with large clusters of the common native climber *Indorouchera griffithiana* observed in the west. In the east, resam (*Dicranopteris linearis*) was also observed alongside simpoh air, favouring the growth of slender pitcher plant (*Nepenthes gracilis*) clusters in the southeast. Scrublands often have low flora and fauna species richness (Score 1) and are not known to support any unique flora and fauna species (Score 0). As shrubs which constitute scrublands colonise rapidly and can take over land with minimal human intervention, scrublands are easy to recreate or replace (Score 1). Nonetheless, this habitat type is uncommon in Singapore (Score 2) due to increasing urbanisation.

With one (1) criterion assessed to be medium (Score 2), two (2) criteria low (Score 1) and one (1) criterion zero (Score 0), the overall score for the scrubland habitat is four (4), which translates to low ecological value across all terrestrial habitats in Singapore.

Table 12-41: National Assessment of Ecological Value of Each Habitat Type in BBHNP / Study Area E

Criterion	Terrestrial habitat				Aquatic habitat
	Native-dominated Secondary Forest	Abandoned kampong and/or plantation with Native Recruitment	Abandoned kampong and/or plantation	Scrubland	Stream SE1a
Flora and fauna species richness	3	2	2	1	3
Irreplaceability	2	1	1	1	2
National rarity of habitat	3	2	2	2	2
Unique flora and fauna species	1	1	1	0	0
Total score	9	6	6	4	7
Ecological value	**High**	**Medium**	**Medium**	**Low**	**Medium**

12.4.1.2 Flora

The ecological value of 193 plant species in BBHNP / Study Area E was assessed. One (1) plant species, *Combretum* sp., that could not be determined to its species level with certainty was excluded for evaluation of the ecological value. The list of species is reflected in **Appendix 6.**

Of the species assessed, 49 are assigned as Priority 1 (i.e., high ecological value), 67 as Priority 2 (i.e., medium ecological value), and 77 as Priority 3 (i.e., low ecological value). Altogether, 20 species had their ecological value raised after assessment— 14 species from Priority 2 to Priority 1 and six (6) species from Priority 3 to Priority 1.

Twenty-nine (29) species of conservation significance were assessed with a high ecological value (Priority 1). On the other hand, the ecological value of one (1) species of conservation significance, *Macaranga griffithiana*, was reduced from Priority 1 to Priority 2 due to its widespread distribution locally and nationally.

Six (6) common native fig species (i.e., *F. fistulosa, F. grossularioides* var. *grossularioides, F. heteropleura, F. variegata, F. punctata, and F. microcarpa*) that were accorded with an initial level of Priority 2, were raised to Priority 1 as they are regarded as keystone species. For the same

reason, five (5) exotic and cryptogenic fig species (i.e., *F. benjamina, F. elastica, F. hispida, F. lyrata, and F. pumila*) had their initial ecological value raised from Priority 3 to Priority 1.

The ecological value of one (1) bamboo species, *Bambusa vulgaris*, were raised from Priority 3 to Priority 1. Albeit of exotic origin, these bamboos are potential habitat for bamboo bats (*Tylonycteris* spp.) that are known to roost within the bamboo internodes.

Finally, the ecological value of seven (7) common native species were raised from Priority 2 to Priority 1 due to their restricted local and national distribution since these species are mostly observed within restricted to old secondary forests and/or primary forests in Singapore. On the other hand, 16 common native species had their priority levels reduced from Priority 2 to Priority 3 as specimens of these species are locally and nationally widespread.

12.4.1.3 Fauna

The ecological value of 209 faunal species recorded from the baseline assessment were assessed together with probable species of conservation significance. All 73 faunal species (recorded and probable) of conservation significance were accorded a Priority 1 sensitivity level and deemed to be of high ecological value. The list of species is reflected in **Appendix 14**.

12.4.2 Identification of Biodiversity Sensitive Receptors

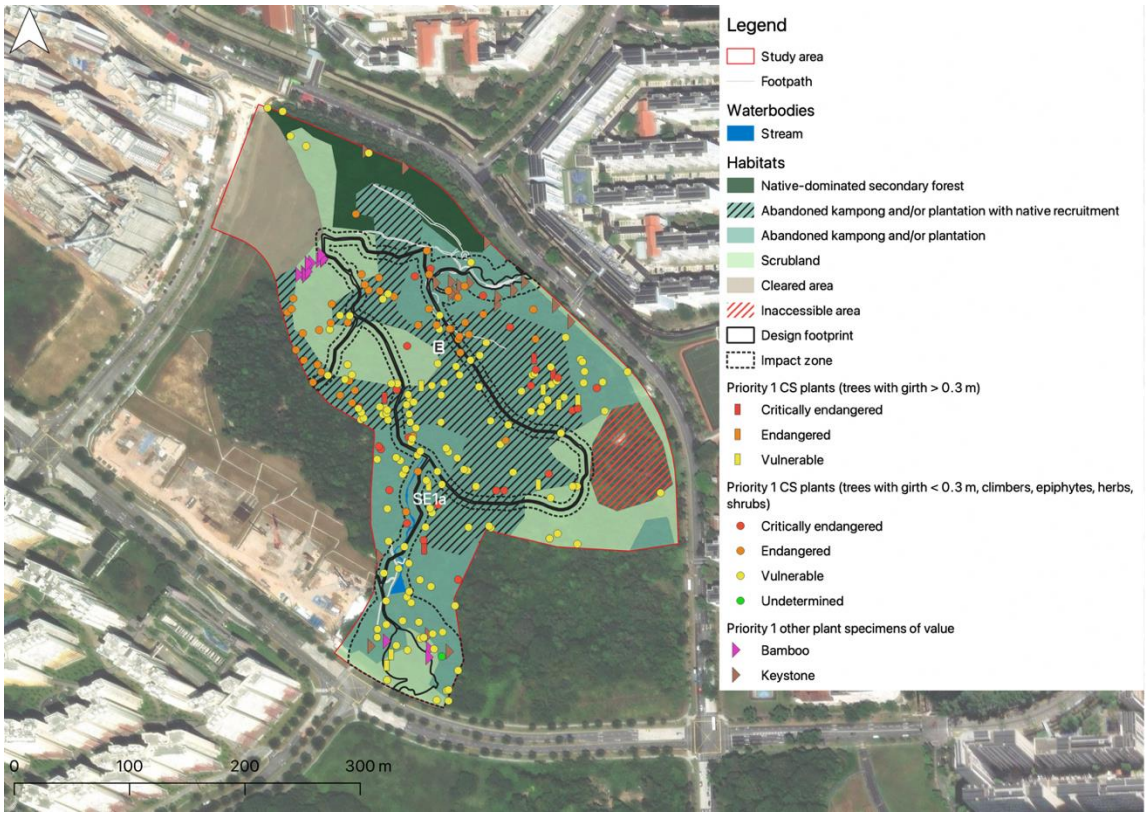


Figure 12-7: Impact Zone for Habitat and Species Receptors in BBHNP / Study Area E

Habitats and plant species that fall within the impact zone of the worksites were identified as biodiversity sensitive receptors (Figure 12-7). Faunal species that were recorded or deemed probable during baseline study were also identified as biodiversity sensitive receptors.

12.4.2.1 Habitats

Following the assessment of ecological value for habitats (Section 12.4.1.1), all habitats within the development area and within 30 m (for Arrival Node and Wetland), 10 m (for Secondary Entrance

and Pergola), and 5 m (for boardwalks, trails and stream edge enhancement) from the proposed development area were identified as the sensitive receptors for habitats (Figure 12-7).

12.4.2.2 Flora

Following the assessment of ecological value for all plant species (Section 12.4.1.2), some were selected for the assessment of ecological impacts. The selection was based on the following: (1) Priority 1 CS species, large specimens, other specimens of value and/or common native trees that had their ecological value raised in Section 12.4.1.2 that lie inside the worksites or impact zones of the proposed developments, (2) Priority 1 CS species that make up ≤1% of the total CS specimen count, (3) Priority 1 keystone species that are of conservation significance and/or are considered as large specimens (i.e., *Ficus* species), and (4) species that are associated with important fauna.

12.4.2.3 Fauna

Following the assessment of ecological value for faunal species (Section 12.4.1.3), all species with a Priority 1 sensitivity level were identified as the sensitive receptors. Species of conservation significance deemed of probable occurrence were also identified as sensitive receptors, with the only exception being the unidentified bamboo bat (*Tylonycteris* sp.). As species-level identification was not possible, both bamboo bat species (*Tylonycteris fulvida* and *T. malayana*) in Singapore were identified as sensitive receptors instead, as both species are threatened, and were deemed of probable occurrence. A total of 73 sensitive receptors were identified in Study Are E, of which five were recorded from the field assessment, and 68 were deemed of probable occurrence. Breaking down the sensitive receptors by taxon, there are 12 bees, 29 butterflies, four (4) odonates, six reptiles, 15 birds, three (3) non-volant mammals, and four (4) bats.

12.4.3 Prediction and Evaluation of Biodiversity Impacts

In this section, the identified biodiversity sensitive receptors were evaluated based on impact intensity and likelihood, to derive the impact significance. The various levels of impact intensity and likelihood for each impact type during the construction and operational phases were defined for the biodiversity sensitive receptors. Some assumptions were made in defining the impact intensity, as detailed in the sections below.

For both the construction and operational phases, the full list of the priority level, impact intensity, impact consequence, impact likelihood, as well as the resulting impact significance for each biodiversity sensitive receptor is provided in **Appendix 4-6**.

12.4.3.1 Construction Phase

<u>Habitats</u>

Three (3) construction phase impacts were identified and assessed for the habitat receptors: loss of habitat, habitat degradation, and formation of edge effects. The impact significance ranged from Negligible to Moderate for habitat receptors at BBHNP / Study Area E. A summary of the key biodiversity habitat receptors impacted during construction phase is shown in Table 12-42 and detailed assessment in **Appendix 15**.

Loss of Habitat

Loss of habitat will only occur in the three (3) terrestrial habitat types at BBHNP / Study Area E: abandoned kampong and/or plantation with native recruitment, abandoned kampong and/or plantation, and scrubland. Based on the area of habitat loss, the impact significance is Minor for all three (3) habitat types since less than 10% of the total areas of all habitat types is expected to occur. The remaining habitat types: native-dominated secondary forest and stream SE1a are not directly impacted by the worksites, and hence have a Negligible impact significance.

Habitat Degradation
As a result of minimum control measures in place, the likelihood of habitat degradation for all habitats were deemed to be Less Likely or Unlikely. Impact significance for each habitat type is hence Negligible or Minor.

Formation of Edge Effects
For the abandoned kampong and/or plantation, the majority of the development of proposed trails, and the demolition works and construction of the arrival node in the north of BBHNP, would be carried out within the existing trail footprint within BBHNP. Any vegetation clearance within the understorey layer of this habitat type will be carried out selectively with the aim of retaining as much of the existing vegetation and forest structure as possible. Hence, the likelihood of formation of edge effects for this habitat type is Less Likely. As for scrubland, although considerable development such as the main entrance and wetland creation will be carried out, this habitat is regarded as an edge habitat. As such, the likelihood of the formation of edge effects is also Less Likely. Therefore, the impact significances for the abandoned kampong and/or plantation and scrubland are Minor.

As for the Stream SE1a, considering the existing location and surrounding condition of the stream, the impact significance for Stream SE1a was qualitatively assessed to be Minor. Currently, the stream is already exposed to changes in microclimate and edge effects due to the ongoing development adjacent to BBHNP. In addition, minimal disturbances are expected along its entire length as only minimal vegetation clearance would occur within the understory of the forested area for the proposed trail construction and stream enhancement works.

For the remaining habitat types, impact significance is Negligible or Minor due to minimal development, such as trail construction, or no development.

Table 12-42: Summary of Construction Phase Impacts to Habitat Receptors in BBHNP/Study Area E

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
Loss of habitat	-	-	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation • Scrubland	• Native-dominated secondary forest • Stream SE1a
Habitat degradation	-	-	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation	• Native-dominated secondary forest • Scrubland • Stream SE1a
Formation of edge effects	-	-	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation	• Native-dominated secondary forest

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
			• Scrubland • Stream SE1a	

Flora

A total of 28 sensitive flora species receptors recorded in BBHNP / Study Area E were selected for the assessment of ecological impacts (Section 12.4.2.2). A summary of the impact to flora receptors is provided in Table 12-43. The detailed evaluation for each species is provided in **Appendix 13**.

Mortality

Four (4) flora species are likely to experience Moderate impacts owing to mortality. All of these species are of conservation significance. They were assessed with Low impact intensity as 10–50% of the specimens will be impacted by the proposed developments. However, since these specimens lie within the construction footprints, it is Certain (likelihood) that they would be cleared. Hence, the impact significance is Moderate.

Four (4) species are likely to experience Minor impacts owing to mortality. These species were assessed with Negligible impact intensity as less than 10% of the specimens will be impacted by the proposed developments. However, since these specimens lie within the construction footprints, it is Certain (likelihood) that they would be cleared. Hence, the impact significance is Minor.

The remaining 20 species are assessed with Negligible impact significance as none of the specimens will be directly affected by land clearance.

Decline in Plant Health and Survival

For this impact type, all remaining specimens of the 28 flora receptors were assessed. The impact significance was assessed to be Major for one (1) species (*Lomariopsis lineata*), Moderate for two (2) species, Minor for 11 species, and Negligible for the remaining 14 species.

Lomariopsis lineata was assessed with High impact intensity since only one specimen was recorded in the entire BBHNP / Study Area E. It may potentially be affected by the stream enhancement works. Since there would be a major change in the hydrology, it is Likely that there would be a decline in the health and survival of the specimen. Hence, the impact significance for this species is Major.

For two (2) nationally Vulnerable species, *Glochidion zeylanicum* var. *zeylanicum* and *Clerodendrum villosum*, more than 50% of their remaining specimens are within the impact zones (High impact intensity). However, it is Less Likely that these specimens may experience edge effects during the construction of the arrival node and proposed wetland area as they are situated within the scrubland and the forest edges, respectively. Hence, they are assessed with Minor impact significance.

As for the other 13 species, they were also assessed with Minor impact significance. Majority of these species will be affected only indirectly by the construction of trails. They were assessed with a Low impact intensity, since less than 50% of the remaining specimens lie within the construction impact zones. However, it is Possible that the specimens may experience edge effects during the construction since some specimens are located within the forested areas.

The remaining 12 flora species were assessed with Negligible impact significance since none of their specimens are located within the impact zones of all proposed developments, except for

Campnosperma auriculatum. For this species, although 50% of the specimens (i.e., one out of 2 specimens recorded) lies within the impact zone of the secondary entrance, it would be Not Expected for this species to be affected by this impact as the proposed construction of the secondary entrance will be executed within the existing cleared area.

Table 12-43: Summary of Construction Phase Impacts to Flora Receptors at BBHNP / Study Area E

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Mortality	0	4	4	20
Decline in plant health and survival	1	0	15	12

Fauna

Six construction phase impacts were identified and assessed for faunal receptors: (1) loss of or reduction in habitats and food sources, (2) accidental injury or mortality, (3) human-wildlife conflict, (4) loss of/reduction in ecological connectivity for faunal movement, (5) light disturbances, and (6) human disturbances. The impact significance ranged from Negligible to Major. The more substantial impacts arising from each impact type is briefly summarised below. A summary of the impact to fauna receptors is given in Table 12-44 and detailed in **Appendix 14**.

Table 12-44: Summary of Construction Phase Impacts to Fauna Receptors at BBHNP / Study Area E

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Loss of or reduction in habitats and food sources	0	69	0	4
Accidental injury or mortality	0	11	0	62
Human-wildlife conflict	0	16	8	49
Loss of or reduction in ecological connectivity for faunal movement	0	4	34	35
Light disturbances	0	0	61	12
Human disturbances	9	15	37	12

Loss of or Reduction in Habitats and Food Sources

Site clearance for the creation of trails, boardwalks, Arrival Node, and Wetland is expected to result in less than 10% habitat loss for each affected terrestrial habitat type. Hence for 69 species the impact intensity was assigned Low. The likelihood of this impact type was deemed to be Certain. Habitat loss would therefore result in Moderate impact to 69 species. For four (4) aquatic species, stream enhancement and Wetland construction works will not result in direct loss of habitat for Stream SE1a, hence the impact is Negligible.

Accidental Injury and Mortality

Accidental injury or mortality of fauna during the construction phase was deemed to be Negligible for species that are predominantly volant and mobile, which enable them to move away from construction activities. Aquatic/amphibious species are Less Likely to experience accidental injury and mortality as the construction machinery, vehicles, machinery, and personnel are largely restricted to terrestrial worksites, except for minor boardwalk construction and enhancement works at the existing waterbodies. For the remainder of species that are less mobile, or ground-dwelling that are unable to move quickly, they would be more susceptible to this impact. Hence their likelihood is Possible. Some examples are reptiles of probable occurrence such as black-headed collared snake (*Sibynophis melanocephalus*), and gold-ringed cat snake (*Boiga melanota*). On the other hand, certain more mobile species would also be susceptible to accidental injury, as they

would be able to enter the construction site, thus risking entrapment. This includes mammals such as long-tailed macaque (*Macaca fascicularis*), and Sunda pangolin (*Manis javanica*; probable species). After considering the key minimum control measure of the erection of hoarding around worksites involving heavy machinery to prevent fauna entry, avoidance of fogging as a vector control measure, no night works (except for security-critical works), and fauna inspections before any vegetation clearance, the impact significance for these species is Moderate.

Human-Wildlife Conflict
Human-wildlife conflict between faunal species and construction site personnel is deemed to be Negligible for species not perceived as nuisances or threats to construction personnel, such as butterflies, odonates, and birds that would avoid human presence. The likelihood is Less Likely for predominantly ground-dwelling species, as they can be excluded with proper site hoarding, and Possible for the remainder of species. Human-wildlife interactions may escalate into conflicts for many reasons. Nuisance species, such as long-tailed macaques (*Macaca fascicularis*), may be attracted to food waste or other materials within the worksite, and lead to negative interactions with site personnel. A lack of understanding regarding how to safely interact with wildlife may also lead to conflict with these species. Certain species are threats to human safety, and may elicit fear in construction personnel when encountered, resulting in conflict. This includes snakes of probable occurrence such as dog-toothed cat snake (*Boiga cynodon*), red-tailed racer (*Gonyosoma oxycephalum*), and black-headed collared snake (*Sibynophis melanocephalus*), and aculeate hymenopterans that may sting. The impact significance is hence assessed to be Moderate for these species.

Loss of or Reduction in Ecological Connectivity
The likelihood of the loss of or reduction in ecological connectivity for faunal movement was deemed Not Expected to Occur for volant and arboreal species that can circumvent the hoarded worksites. Hence, the impact significance is Negligible for these species.

As the entire BBHNP / Study Area E is expected to be hoarded during the construction phase, ground-dwelling reptiles and mammals such as the Sunda pangolin (*Manis javanica*; probable species) may experience impediment to movement between other forest patches, although their movement is currently already impeded by adjacent roads. Within BBHNP / Study Area E, hoardings are expected to be erected only around worksites involving heavy machinery (i.e., Arrival Node and Wetland), which are situated along the edge of the Study Area and will not result in habitat fragmentation. Hence the likelihood for these species is Less Likely and the impact significance is Minor.

Changes to the watercourse during stream edge enhancement works could hinder the movement of aquatic species, such as the Malayan box terrapin (*Cuora amboinensis*; probable species) and variable featherlegs (*Copera vittata*; probable species). The likelihood for these species is Possible, hence the impact significance is Moderate.

Light Disturbances
Night works requiring illumination of the worksite are only expected to occur for safety-critical works. This impact is Negligible or Minor for all species.

Human Disturbances
Human disturbance at the construction phase was deemed Not Expected to Occur or Less Likely for species that are tolerant or not adversely impacted by human presence. Examples are insects and mammals such as long-tailed macaque (*Macaca fascicularis*). Their impact significance is Negligible or Minor. However, most animals are sensitive to human presence, and would move away from an

approaching human, with extremely sensitive species leaving the site entirely. For this site, although most of the human activities would be confined to the worksites, the footprints of the Arrival Node, Wetland, and new boardwalks and trails are quite extensive. The likelihood is thus Likely and the impact significance was assessed as Major or Moderate for these species. Examples are Straw-headed bulbul (*Pycnonotus zeylanicus*), Blue-eared kingfisher (*Alcedo meninting*; probable species), Sunda pangolin (*Manis javanica*; probable species) and Leopard cat (*Prionailurus bengalensis*; probable species).

12.4.3.2 Operational Phase

Habitats

Three (3) operational phase impacts were identified and assessed for the habitat receptors: habitat degradation, changes in microclimatic conditions, and introduction of exotic species (aquatic habitats only). The impact significance ranged from Negligible to Minor for habitat receptors at BBHNP / Study Area E. A summary of the key biodiversity habitat receptors impacted during operational phase is shown in Table 12-45 and detailed assessment in **Appendix 15**.

Habitat Degradation

BBHNP is designed with the intention for the public to use or visit and will increase human accessibility to the surrounding natural habitats. Habitat degradation is most expected near areas of development. At stream SE1a, some changes in surface water quality are also expected. As rope railing is designed for most parts of the park which limits accessibility, the likelihood of habitat degradation occurring is Less Likely, resulting in Negligible or Minor impact significance for impacted habitat types. Habitat degradation at the native-dominated secondary forest is not expected as no development is planned.

Changes in Microclimatic Conditions

As the overall development is small-scale and involves heavy landscaping and limited hardscape, the likelihood of changes in microclimatic conditions as a result of micro-urban heat island effect is Not Expected to Occur and impact significance is Negligible for all habitat types.

Introduction of Exotic Species

Stream SE1a is presently dominated by exotic species like the Siamese fighting-fish (*Betta splendens*), guppy (*Poecilia reticulata*) and Guenther's frog (*Sylvirana guentheri*), which means any introduction of exotic species would have some impact to the aquatic habitat. Impact intensity was assessed to be Low and hence impact consequence, Very Low. As the aquatic habitat becomes easily accessible to the public with trails along it, the likelihood of the impact occurring is Certain. Consequently, the impact significance for stream SE1a due to introduction of exotic species is Minor.

Table 12-45: Summary of Operational Phase Impacts to Habitat Receptors in BBHNP/ Study Area E

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
Habitat degradation	-	-	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation	• Native-dominated secondary forest • Scrubland • Stream SE1a
Changes in microclimatic conditions	-	-	-	• Native-dominated secondary forest • Abandoned kampong and/or

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
				• plantation with native recruitment • Abandoned kampong and/or plantation • Scrubland • Stream SE1a
Introduction of exotic species (aquatic habitats only)	-	-	Stream SE1a	• -

Flora

For this assessment, all 28 flora species receptors were assessed for only one (1) impact type, poaching. A summary of the impact significance is presented in Table 12-46. The detailed evaluation for each species is provided in **Appendix 13**.

The impact significance is Negligible for all species as they are not charismatic and do not possess any ethnobotanical value, or the specimens are too big to be poached.

Table 12-46: Summary of Operational Phase Impacts to Flora Receptors at BBHNP / Study Area E

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Poaching	0	0	0	28

Fauna

Six operational phase impacts were identified and assessed for faunal receptors: (1) accidental injury or mortality, (2) human-wildlife conflict, (3) poaching, (4) loss of or reduction in ecological connectivity for faunal movement, (5) light disturbances, and (6) human disturbances. The impact significance ranged from Negligible to Major. Only the most substantive impact for each impact type is presented below. A summary of the impact to fauna receptors is given in Table 12-47 and detailed in **Appendix 14**.

Table 12-47: Summary of Operational Phase Impacts to Fauna Receptors at BBHNP / Study Area E

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Accidental injury or mortality	0	0	21	52
Human-wildlife conflict	0	15	9	49
Poaching	11	2	0	60
Loss or reduction of ecological connectivity for faunal movement	0	0	38	35
Light disturbances	16	45	0	12

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Human disturbances	3	22	36	12

Accidental Injury or Mortality
Accidental injury or mortality because of bird-building collisions was deemed Not Expected to occur as there are no major buildings or structures that will be constructed in BBHNP.

Roadkills were deemed Less Likely to occur as the increase in visitorship and associated vehicular traffic along the adjacent roads is not expected to be substantial despite the re-opening of this park. This is because the target visitors for BBHNP are mainly the residents living in the surrounding estates and no parking facilities will be provided at the park. The impact significance is thus Negligible/Minor.

Human-wildlife Conflict
The likelihood of human-wildlife conflict during the operational phase was deemed to be Not Expected to Occur or Less Likely for aquatic species, non-stinging insects, birds, bats, non-volant mammals, and reptiles that are not known to be implicated in human-wildlife conflict within the setting of a nature recreational site. Hence, the impact significance is either Negligible or Minor.

Species possibly implicated in human-wildlife conflict include wrongly perceived nuisance species, such as long-tailed macaque (*Macaca fascicularis*), which members of the public may try to approach closely. Species that may possibly cause harm to visitors, especially persons who lack awareness on how to behave during animal encounters, are for example snakes of probable occurrence including the dog-toothed cat snake (*Boiga cynodon*), black-headed collared snake (*Sibynophis melanocephalus*), and bees that may sting. The impact significance is assessed to be Moderate for these species.

Poaching
The likelihood of poaching is deemed Not Expected to Occur, impact significance Negligible for most species that are not susceptible to poaching (e.g., bees, odonates, butterflies, snakes, bats). 13 species are susceptible to poaching with the increased accessibility of the Study Area to members of the public. Examples include straw-headed bulbul (*Pycnonotus zeylanicus*), Sunda pangolin (*Manis javanica*; probable species), and leopard cat (*Prionailurus bengalensis*; probable species). Despite Singapore's stance of zero-tolerance towards illegal wildlife trade, the likelihood is still Likely given known occurrences of such activities, and the impact significance is Major for 11 CITES-listed species and Moderate for two (2) species commonly traded as pets.

Loss of or Reduction in Ecological Connectivity for Faunal Movement
The likelihood of the loss of or reduction in ecological connectivity for faunal movement was deemed Not Expected to Occur for all species. This is because the future site is composed mostly of narrow trails and elevated boardwalks, which would not fragment the existing connectivity, or increase barriers to faunal movement. The impact significance is hence expected to be Negligible/Minor for all species.

Light Disturbances
The likelihood of light disturbance during the operational phase was deemed Not Expected to Occur for aculeate hymenopterans that are not adversely affected by light. Their impact significance is Negligible.

For other insects that are slightly sensitive to light (e.g., butterflies, odonates) and diurnal reptiles, birds, and mammals, the likelihood of light disturbance was deemed Likely. The impact significance is thus Moderate.

For nocturnal and migratory species, the likelihood was deemed Likely. Although the artificial lighting will be kept at a low level as a nature area set within a forest habitat, the impact significance is still Major as the Study Area is currently unlit and closed to visitors.

Human Disturbances

Human disturbance was deemed Not Expected to Occur or Less Likely for species that are tolerant or not adversely impacted by human presence. Their impact significance is Negligible or Minor. However, the expected increase and continual presence of visitors during operation especially at night may cause more sensitive animals to move away, although human traffic will be confined within the Arrival Node and trails/boardwalks. The likelihood is therefore Possible for diurnal species and Likely for nocturnal species. For diurnal and nocturnal species that are not highly sensitive to human presence, the impact significance is Moderate. For nocturnal species that are highly sensitive to human presence, the impact significance is Major. Examples are species of probable occurrence including the buffy fish owl (*Ketupa ketupu*), leopard cat (*Prionailurus bengalensis*), and Sunda pangolin (*Manis javanica*).

12.4.4 Recommended Mitigation Measures

In this section, mitigation measures for the proposed developments in BBHNP / Study Area E are discussed. Mitigations are to be implemented according to the hierarchy described in **Section 5.6**.

12.4.4.1 Design Phase

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

Avoid

The key mitigation measures to avoid biodiversity impacts through the design of the proposed development at BBHNP / Study Area E are summarised in Table 12-48 and detailed in the paragraphs below.

Table 12-48: Key Recommended Design Measures to Avoid Biodiversity Impacts at BBHNP / Study Area E

Receptor	Impact Type	Mitigation Measures
Habitats	Loss of habitat	• Avoid areas of high conservation value
Flora species	Mortality	• Avoid areas of high conservation value • Adjust design footprint to avoid Priority 1 plant species
	Decline in plant health and survival	• Adjust design footprint to ensure Priority 1 plant species are not within the impact zones
Fauna species	Loss of or reduction in habitats and food sources for fauna	• Avoid areas of high conservation value
	Loss of or reduction in ecological connectivity for faunal movement	• Avoid changes to watercourses
	Light disturbances	• Avoid installation of artificial lights

Avoid Areas of High Conservation Value

As loss of habitat resulting in Moderate impacts, it is recommended to avoid clearing vegetation where possible, especially in areas of high conservation value (Figure 6-24). Heavy structures within these areas should be avoided as they contain several plant specimens of conservation significance, large plant specimens, other plant specimens of value, and/or sensitive habitats. Any habitat

enhancement/rehabilitation works and construction of low-impact structures and on-grade trails within these areas should be carried out sensitively.

Adjust Design Footprint to Avoid Priority 1 Plant Species
The footprints of the Arrival Node and Wetland, boardwalks, and trails should be adjusted during the detailed design stage to avoid Priority 1 plant species and ensure that they are not within the impact zones.

Avoid Changes to Watercourses
Changes to watercourses can impede the movement of aquatic fauna. By designing the boardwalks and trails near the waterbodies as well as the Wetland in a sensitive manner, changes to the existing watercourses can be avoided.

Avoid Installation of Artificial Lights
Light disturbances to fauna can be avoided by avoiding the provision of artificial lights within the park and closing the park during the night (1900–0700 h).

Minimise Biodiversity Impacts
The key mitigation measures to minimise biodiversity impacts through the design of the proposed development at BBHNP / Study Area E are summarised in Table 12-49 and detailed in the paragraphs below.

Table 12-49: Key Recommended Design Measures to Minimise Biodiversity Impacts at BBHNP / Study Area E

Receptor	Impact Type	Mitigation Measures
Habitats	Habitat degradation	• Put up signages to remind visitors not to litter or pollute the habitats
	Introduction of exotic species (aquatic habitats only)	• Put up signages to remind visitors not to release exotic species
Flora species	Mortality	• Design the boardwalks and trails to deter visitors from trampling/ venturing off-trail (e.g., install railings)
	Poaching	• Design the boardwalks and trails to deter visitors from trampling/ venturing off-trail (e.g., install railings) • Put up signage to remind visitors not to stray off-trail • Design for dense landscaping along the sides of the proposed trails and boardwalks to deter visitors from venturing off-trail • Transplant plant specimens of conservation significance away from publicly accessible areas
	Decline in plant health and survival	• Design for dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions
Fauna species	Accidental injury and mortality	• Integrate road-calming measures
	Human-wildlife conflict	• Design bins to be wildlife-proof • Put up signages to educate visitors on appropriate behaviours when encountering fauna
	Light disturbances	• Incorporate wildlife-friendly lighting
	Human disturbances	• Design the boardwalks and trails to deter visitors from venturing off-trail (e.g., install railings) • Design for dense landscaping along the sides of the proposed trails and boardwalks to deter visitors from venturing off-trail
	Poaching	• Design the boardwalks and trails to deter visitors from venturing off-trail (e.g., install railings)

Receptor	Impact Type	Mitigation Measures
		• Design for dense landscaping along the sides of the proposed trails and boardwalks to deter visitors from venturing off-trail

Put up Signage
A variety of educational signages are recommended to remind park visitors to observe good park etiquette, including not littering or polluting the habitats, not straying off-trail, and appropriate behaviours when encountering fauna. This could help minimise habitat degradation, poaching of plants, and human-wildlife conflict during the operational phase.

Design Boardwalks and Trails to Deter Visitors from Venturing Off-trail
Boardwalks and trails could be designed with railings on both sides to discourage park visitors from venturing off-trail, hance minimising the likelihood of trampling resulting in plant mortality and poaching of plants.

Transplant Plant Specimens of Conservation Significance
By transplanting plant specimens of conservation significance well away from areas that will be made publicly accessible, the likelihood of poaching may be reduced.
Design for Dense Landscaping and In-fill Planting
Where vegetation will be cleared for construction activities, provisions for dense landscaping and in-fill planting should be made to revegetate those areas, minimising the likelihood of decline in plant health and survival caused by changes in microclimatic conditions. In-fill planting involves planting of native plants, particularly pioneer trees to jump start forest succession. It makes use of the existing framework of forest canopy and emergent, while selectively removing undesirable exotic species. Plant species of various other habits should also be planted (i.e., shrubs, ground cover), Ideally, the plants should be planted to emulate the framework of a forest (i.e., canopy, understorey, undergrowth). Dense landscaping and in-fill planting should also be provided for at existing gaps in forested areas and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions and to deter visitors from venturing off-trail.

Integrate Road-calming Measures
As the expected increase in vehicular traffic resulting from the increased visitorship to the park is quite significant, road-calming measures should be adopted for the adjacent roads. Such measures include speed bumps and restrictions on the maximum speed limit.

Design Bins to be Wildlife-proof
Food is an attractant for wildlife, and anthropogenic sources of food such as rubbish tend to be more easily accessible to fauna and higher in caloric yield than their natural food sources. Minimising human-wildlife conflicts would require proper waste management within the future park, such as designing bins to be wildlife-proof.

Incorporate Wildlife-friendly Lighting
Although NParks' intention is to keep the park open till 1900 h daily during the operational phase, it is recommended that the park and its associated facilities be closed to public during the night (1900–0700 h), wildlife-friendly lighting should be incorporated if park closure at night is not feasible. Wildlife-friendly lighting strategies are summarised in Figure 12-1.

Rehabilitate/Restore
The key mitigation measures to rehabilitate/restore biodiversity impacts through the design of the proposed development at BBHNP / Study Area E are summarised in Table 12-50 and detailed in the

paragraphs below. Measures to restore ecological connectivity across the adjacent roads (Figure 6-23) are not considered as mitigation measures in this Impact Assessment as resources to implement them are not available in this Project.

Table 12-50: Key Recommended Design Measures to Minimise Biodiversity Impacts at BBHNP / Study Area E

Receptor	Impact Type	Mitigation Measures
Habitats	Formation of edge effects	• Design for dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions
Flora species	Decline in plant health and survival	• Design for dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions
Fauna species	Loss of or reduction in ecological connectivity for faunal movement	• Design for stream enhancement

Design for Dense Landscaping and In-fill Planting

Where there are existing gaps in the forested areas at BBHNP / Study Area E, in-fill planting should be carried out to revegetate those areas to enhance the habitats there and minimise edge effects and the likelihood of decline in plant health and survival caused by changes in microclimatic conditions. In-fill planting involves planting of native plants, particularly pioneer trees to jump start forest succession. It makes use of the existing framework of forest canopy and emergent, while selectively removing undesirable exotic species.

Design for Stream Enhancement

With the enhancement of Stream SE1a such as stabilising the banks, future land slips can be prevented and ecological connectivity for the movement of aquatic fauna can be maintained or even improved. Coupled with the creation of the Wetland, aquatic habitats available for aquatic fauna to exploit will be increased. To further improve the condition of Stream SE1a, which was found to have poor water quality, as indicated by the low levels of dissolved oxygen during the Baseline Study, planting of aquatic macrophytes with phyto-remediative qualities can be implemented. The macrophytes can also provide refugia for odonate larvae and perching and ovipositing opportunities for the adults.

12.4.4.2 Construction Phase

Key measures to avoid and minimise biodiversity impacts during the construction phase are briefly described below and further elaborated in the proposed EMMP.

Avoid

The key mitigation measures to avoid biodiversity impacts during the construction phase at BBHNP / Study Area E are summarised in Table 12-51.

Table 12-51: Key Recommended Measures to Avoid Biodiversity Impacts during the Construction Phase at BBHNP / Study Area E

Receptor	Impact Type	Mitigation Measures
Habitats	Loss of habitat	• Erect hoardings to delineate worksites involving heavy machinery (i.e., Arrival Node and Wetland) • For worksites involving manual work only (i.e., trails and boardwalks), ensure the extent of the working space is clearly demarcated on-site and cross-checked by a Flora Specialist to avoid unnecessary vegetation clearance

Receptor	Impact Type	Mitigation Measures
	Habitat degradation	• Ensure construction works, material and waste storage, access routes, etc., are kept within the boundaries of the worksite or agreed working space
Flora species	Mortality	• Arborists to determine suitable Tree Protection Zones (TPZs) for any trees that will be retained within the worksites • Ensure construction works, material and waste storage, access routes, etc., are kept within the boundaries of the worksite or agreed working space • Transplant or salvage saplings of conservation significance • Adjust the construction footprint of boardwalks and trails to avoid Priority 1 plant species, in consultation with a Flora Specialist
	Decline in plant health and survival	• Adjust the construction footprint of boardwalks and trails to ensure the Priority 1 plant species are not within the impact zones
Fauna species	Loss of or reduction in habitats and food sources	• Erect hoardings to delineate worksites involving heavy machinery (i.e., Arrival Node and Wetland) • For worksites involving manual work only (i.e., trails and boardwalks), ensure the extent of the working space is clearly demarcated on-site and cross-checked by a Flora Specialist to avoid unnecessary vegetation clearance • For trail construction, only understory plants are removed when necessary, and to be replanted elsewhere in BBHNP where possible
	Loss of or reduction in ecological connectivity for faunal movement	• Ensure unobstructed flow of water along existing watercourse during construction of Wetland and stream enhancement works

Minimise

The key measures to minimise biodiversity impacts during the construction phase at BBHNP / Study Area E are summarised in Table 12-52.

Table 12-52: Key Recommended Measures to Minimise Biodiversity Impacts during the Construction Phase at BBHNP / Study Area E

Receptor	Impact Type	Mitigation Measures
Habitats	Habitat degradation	• Ensure ECM are implemented prior to site clearance. The ECM plan should be formulated by Qualified Erosion Control Personnel (QECP) • Implement dust control measures such as dust screens and water suppression systems • Conduct regular monitoring to identify any impacts to habitats adjacent to the worksite. This includes visual inspection of surrounding aquatic habitats (i.e., Stream SE1a) and monthly wildlife monitoring in habitats adjacent to the site • Conduct regular site inspections to ensure contractor compliance with the EMMP • Conduct regular inspections in the surrounding habitats to ensure no removal of vegetation has occurred beyond the agree worksite boundaries
	Formation of edge effects	• Implement dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions • Conduct regular site inspections to ensure contractor compliance with the EMMP
Flora species	Mortality	• Conduct regular inspections in the surrounding habitats to ensure no removal of vegetation has occurred beyond the agreed worksite boundaries • Conduct regular site inspections to ensure contractor compliance with the EMMP
	Decline in plant health and survival	• Implement dense landscaping and in-fill planting at areas that are cleared, at existing gaps in forested areas, and along the sides of the proposed trails and boardwalks to buffer the surrounding forested areas from changes in microclimatic conditions • Conduct regular site inspections to ensure contractor compliance with the EMMP

Receptor	Impact Type	Mitigation Measures
Fauna species	Accidental injury and mortality	• Erect hoardings around worksites involving heavy machinery (i.e., Arrival Node and Wetland) to prevent fauna entry • Conduct regular site inspections to ensure contractor compliance with the EMMP • Conduct regular trainings and toolbox briefings for site personnel on biodiversity awareness and actions to take when encountering wildlife • Formulate a wildlife response plan to be executed when trapped/ injured/dead/ dangerous fauna is found on-site • Ensure good housekeeping such as the provision of wildlife-proof food waste bins and enclosed eating areas • Conduct daily checks for roadkill and fauna entrapment within the worksite
	Human-wildlife conflict	• Erect hoardings around worksites involving heavy machinery (i.e., Arrival Node and Wetland) to prevent fauna entry • Conduct regular site inspections to ensure contractor compliance with the EMMP • Conduct regular trainings and toolbox briefings for site personnel on biodiversity awareness and actions to take when encountering wildlife • Formulate a wildlife response plan to be executed when trapped/ injured/dead/ dangerous fauna is found on-site • Ensure good housekeeping such as the provision of wildlife-proof food waste bins and enclosed eating areas • Train site personnel that feeding of wildlife is strictly prohibited
	Human disturbances	• Restrict entry of site personnel beyond the worksite

12.4.4.3 Operational Phase

Although most of the biodiversity impacts associated with the operational activities can be addressed through the design measures (Section 12.4.4.1), additional measures related to the operation and management of the park are proposed to further avoid and minimise the impacts.

Table 12-53: Key Recommended Measures to Minimise Biodiversity Impacts during the Operational Phase at BBHNP / Study Area E

Receptor	Impact Type	Mitigation Measures
Habitats	Habitat degradation	• Carry out regular maintenance of the park (e.g., removal of litter, emptying of trash, ensure integrity of railings along trails and boardwalks) • Conduct regular patrols to deter visitors from straying off-trail
	Introduction of exotic species to aquatic habitats	• Conduct regular patrols to deter visitors from releasing exotic species into waterbodies • Conduct outreach programmes to educate visitors on the harmful effects of introduction of exotic species • Conduct regular removal of exotic species from aquatic habitats
Flora species	Poaching	• Conduct regular patrols to deter visitors from straying off-trail • Transplant specimens of conservation significance away from publicly accessible areas
Fauna species	Poaching	• Conduct regular patrols to deter poaching activities
	Light disturbances	• Close the park and associated facilities to the public during the night (1900–0700 h)
	Human disturbances	• Conduct regular post-construction biodiversity monitoring to determine if the increased visitorship has affected fauna species

12.4.5 Residual Impacts

12.4.5.1 Construction Phase

Habitats

The summary of residual impacts during construction phase on key biodiversity habitat receptors is shown in Table 12-54 and detailed assessment in **Appendix 15**.

Loss of Habitat

Despite the proposed mitigation measures, as the physical design of the development is overall minimal and has been optimised to the meet the necessary functions of the park, the assessment

of residual impacts due to loss of habitats largely remains the same as Section 12.4.3.1. Impact significance is either Negligible or Minor.

Habitat Degradation

As a result of minimum control measures, and regular compliance inspections and monitoring, the likelihood of habitat degradation for all habitats is still deemed to be Less Likely. Impact significance for each habitat type is hence Negligible or Minor.

Formation of Edge Effects

Although the pre-mitigated impact significance for all habitats were assessed as Minor, dense landscaping and in-fill planting can help to minimise the formation of edge effects within impacted habitats further, especially for abandoned kampong and/or plantation and stream SE1a where there is considerable development and/or vegetation removal. Where there is minimal or no development, the assessment of residual impacts for the other habitat types remains Negligible or Minor.

Table 12-54: Summary of Construction Phase Residual Impacts to Habitat Receptors in BBHNP / Study Area E

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
Loss of habitat	-	-	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation • Scrubland	• Native-dominated secondary forest • Stream SE1a
Habitat degradation	-	-	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation	• Native-dominated secondary forest • Scrubland • Stream SE1a
Formation of edge effects	-	-	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation • Scrubland • Stream SE1a	• Native-dominated secondary forest

Flora

Similar to the pre-mitigation impact assessment, all 28 flora species receptors were assessed for two (2) ecological impact types, (1) mortality and (2) decline in plant health and survival. The assessment considered mitigation measures for flora species, such as salvaging saplings of conservation significance and incorporating dense landscaping within areas that are cleared for the proposed developments and/or areas that have been cleared. A summary of the impacts to flora receptors is provided in Table 12-55. The detailed evaluation for each species is provided in **Appendix 13**.

Mortality

For this impact type, it is assumed that all seven (7) plant species of conservation significance that were initially assessed with Moderate or Minor impact significance, were salvaged from their existing locations. Hence, their impact significance was reduced to Negligible**.** It is to note that the assessment does not reflect the success rate of these specimens after they have been salvaged/transplanted from their existing habitat. Some specimens may still be subjected to mortality during or after the process of salvaging/transplantation.

As for *Bambusa vulgaris,* since the specimen is too large to be transplanted, as part of the mitigation measures, the proposed design footprint shall be adjusted to ensure that the specimen of bamboo is not impacted by the proposed trail development. There is no change to the impact significance for the remaining 20 species that were also initially assessed as Negligible.

Decline in Plant Health and Survival

Salvaging the specimen of *Lomariopsis lineata* or incorporating dense planting at areas that were cleared or bare to serve as a vegetative buffer from forest edge effects are proposed mitigation measures. Assuming that the specimen was salvaged from its existing location, the impact significance was reduced from Major to Negligible.

There is no change to the impact significance of the remaining 27 flora species that were initially assessed as Minor and Negligible respectively since the impact has been reduced to a level that is as low as reasonably practicable.

Table 12-55: Summary of Construction Phase Residual Impacts to Flora Receptors at BBHNP / Study Area E

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Mortality	0	0	0	28
Decline in plant health and survival	0	0	15	13

Fauna

Loss of or Reduction in Habitats and Food Sources

The residual likelihood from loss of or reduction in habitats and food sources can be reduced to Possible if mitigation measures to avoid/minimise the impact are carried out. This is especially with regards to trail construction whereby only understory plants are removed when necessary, and the removed plants are re-planted elsewhere in BBHNP. Consequently, the residual impact significance is Minor or Negligible for all species.

Accidental Injury or Mortality and Human-wildlife Conflict

The likelihood of accidental injury or mortality and human-wildlife conflict can be reduced if mitigation measures recommended in Section 12.4.4 are followed, thus reducing the impact significance from Moderate to Minor.

Human Disturbances

The likelihood of human disturbances can be reduced if site personnel are strictly prohibited from accessing the areas beyond the agreed working boundaries, thus reducing the impact significance from Major to Moderate.

Loss of or Reduction in Ecological Connectivity for Faunal Movement

Residual impacts from loss of or reduction in ecological connectivity for aquatic faunal movement is Minor if the unobstructed flow of water along the existing watercourse can be maintained during the construction of the Wetland and stream enhancement works. Further, the stream enhancement

and the creation of the Wetland are expected to compensate for the loss of ecological connectivity during the construction phase, potentially resulting in an overall positive impact.

A summary of residual impacts to fauna receptors is given in Table 12-56 and detailed in **Appendix 14**.

Table 12-56: Summary of Construction Phase Residual Impacts to Fauna Receptors at BBHNP / Study Area E

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Loss of or reduction in habitats and food sources	0	0	69	4
Accidental injury or mortality	0	0	11	62
Human-wildlife conflict	0	0	24	49
Loss of or reduction in ecological connectivity for faunal movement	0	0	38 (positive impacts with stream enhancement, Wetland creation)	35
Light disturbances	0	0	61	12
Human disturbances	0	24	37	12

12.4.5.2 Operational Phase

Habitats

The summary of residual impacts during operational phase on key biodiversity habitat receptors is shown in Table 12-57 and detailed assessment in **Appendix 15**.

Habitat Degradation

Putting up signages and regular park maintenance can keep the likelihood of habitat degradation occurring as Less Likely. Impact significance is hence still either Negligible or Minor for all habitat types.

Changes in Microclimatic Conditions

As the overall development type is still largely green, the likelihood of changes in microclimatic conditions occurring remains Not Expected and hence impact significance remains Negligible for all habitat types.

Introduction of Exotic Species

Despite the proposed signages and regular patrols, likelihood of introduction of exotic species to aquatic habitats remains Certain. Consequently, impact significance for Stream SE1a remains Minor.

Table 12-57: Summary of Operational Phase Impacts to Habitat Receptors in BBHNP/ Study Area E

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
Habitat degradation	-	-	• Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation	• Native-dominated secondary forest • Scrubland • Stream SE1a
Changes in microclimatic conditions	-	-	-	• Native-dominated

Impact type	Habitat types			
	Major	Moderate	Minor	Negligible
				• secondary forest • Abandoned kampong and/or plantation with native recruitment • Abandoned kampong and/or plantation • Scrubland • Stream SE1a
Introduction of exotic species (aquatic habitats only)	-	-	• Stream SE1a	-

Flora

For the 28 plant species recorded from the Study Area and selected for the assessment of ecological impacts during the operational phase, there is no further reduction in overall impact since the impact has been reduced to a level that is as low as reasonably practicable (refer to Section 12.4.3.2) (Table 12-58; **Appendix 13**).

Table 12-58: Summary of Operational Phase Residual Impacts to Flora Receptors at BBHNP / Study Area E

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Poaching	0	0	0	28

Fauna

With the adoption of appropriate mitigation measures such as installation of signages to educate visitors on appropriate behaviours when encountering fauna, provision of wildlife-proof bins, installation of railings along trails and boardwalks to prevent visitors from straying off-trail, and conducting regular patrols, Major and Moderate impacts associated with poaching during operation is reduced to residual impact significance of Minor. Major impacts associated with light and human disturbances can be reduced to Moderate or Minor if the park and its associated facilities are closed during the night (1900–0700 h). All other Moderate impacts are reduced to a residual impact significance of Minor (Table 12-59).

Table 12-59: Summary of Operational Phase Residual Impacts to Fauna Receptors at BBHNP / Study Area E

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Accidental injury or mortality	0	0	21	52
Human-wildlife conflict	0	0	24	49
Loss of/reduction in ecological connectivity for faunal movement	0	0	38	35
Poaching	0	0	13	60
Light disturbances	0	0	61	12
Human disturbances	0	3	58	12

12.5 Cumulative Impacts

The construction works at all of the parks across BBNC [i.e., BTFS (not included in this report), the eco-pedestrian bridge (not included in this report), BBNP, BBTP, BBHNP] are expected to happen

concurrently. Other known existing, committed, and planned developments within 2 km of BBNC were also identified in Table 4-3 and are considered in the cumulative impacts assessed in the sections below.

12.5.1 Construction Phase

Habitats

Three (3) construction phase impacts were identified and assessed for the habitat receptors at each of the proposed parks: loss of habitat, habitat degradation, and formation of edge effects. A summary of the most substantive impacts affecting habitat receptors at each of the parks is shown in Table 12-60 and detailed below.

Table 12-60: Summary of Construction Phase Impacts to Habitat Receptors Across BBNC

Impact type	Proposed Park			
	Major	Moderate	Minor	Negligible
Loss of habitat	-	• BBNP (attributed to slope stabilisation works only)	• BBTP • BBHNP	-
Habitat degradation	-	-	• BBNP • BBTP • BBHNP	-
Formation of edge effects	-	-	• BBNP • BBTP • BBHNP	-

Loss of Habitat

Not considering the loss of habitat at BBNP attributed to imminent and unavoidable slope stabilisation works only, an overall Minor impact is expected for habitat receptors across BBNC. For the development of the rest of the parks, the design footprints have been optimised to meet the operational needs and avoid areas that were identified of high conservation value in the Baseline Study. Hence, the overall impact is considered to have been mitigated to as low as reasonably practicable. Further, although not assessed in this report, terrestrial habitat enhancement works (subject to detailed design) is expected to compensate for some of the loss of habitat during the construction phase. The loss of habitats at BBNC is unlikely to contribute significantly to the overall loss resulting from other developments in the surrounding landscape.

Habitat Degradation

An overall Minor impact is expected for habitat degradation across BBNC, as it Less Likely to occur given the implementation of minimum control measures (Table 12-1).

Formation of Edge Effects

An overall Minor impact is expected for formation of edge effects across BBNC. At BBHNP, edge effects resulting from the ongoing development of the adjacent HDB estates (i.e., West Glades and West Hill projects) have already resulted in obvious edge effects, such as frequent tree falls.

Flora

Two (2) construction phase impacts were identified and assessed for the flora species receptors at each of the proposed parks: mortality and decline in plant health and survival. A summary of the most substantive impacts affecting flora species receptors at each of the parks in shown in Table 12-61 and detailed below.

Table 12-61: Summary of Construction Phase Impacts to Flora Receptors Across BBNC

Impact type	Proposed Park			
	Major	Moderate	Minor	Negligible
Mortality	• BBNP (attributed to slope stabilisation works only)	• BBHNP	-	• BBTP
Decline in plant health and survival	• BBNP (attributed to slope stabilisation works only) • BBHNP	-	• BBTP	-

Mortality

Aside from the Major impacts owing to mortality of Canthiumera robusta, *Oxyceros* cf. *bispinosus*, and *Strophanthus caudatus* attributed only to the slope stabilisation works at BBNP, flora species will experience an overall Moderate impact during the construction phase across BBNC. Furthermore, *C. robusta*, *O. bispinosus*, and *S. caudatus* are all represented by specimens in the other study areas of BBNC as well, most of which will not be affected by construction works. For the rest of the plant species that will experience Moderate impacts owing to mortality, most of their specimens can be avoided during the detailed design stage, where the design footprints will be adjusted.

Decline in Plant Health

Major impacts are expected at BBNP and BBHNP owing to decline in plant health and survival. Two (2) species will experience such impacts as their sole specimens are located within the impact zones of the respective parks: *Antidesma coriaceum* (BBNP) and *Lomariopsis lineata* (BBHNP). However, *L. lineata* is also represented by specimens in the other study areas of BBNC as well, most of which will not be affected. For *A. coriaceum*, decline in plant health can be mitigated by transplanting the sole specimen beyond the impact zone of the slope stabilisation works. Hence, an overall Moderate impact is expected for decline in plant health across BBNC.

Fauna

Six (6) construction phase impacts were identified and assessed for the faunal species receptors at each of the proposed parks: loss of or reduction in habitats and food sources, accidental injury or mortality, human-wildlife conflict, loss of or reduction in ecological connectivity for faunal movement, light disturbances, and human disturbances. A summary of the most substantive impacts affecting faunal species receptors at each of the parks in shown in Table 12-62 and detailed below.

Table 12-62: Summary of Construction Phase Impacts to Fauna Receptors Across BBNC

Impact Type	Proposed Parks			
	Major	Moderate	Minor	Negligible
Loss of or reduction in habitats and food sources	-	• BBNP • BBTP • BBHNP	-	-
Accidental injury or mortality	• BBNP (attributed to slope stabilisation works only)	• BBTP • BBHNP	-	--
Human-wildlife conflict	-	• BBNP • BBTP • BBHNP	-	-

Impact Type	Proposed Parks			
	Major	Moderate	Minor	Negligible
Loss of or reduction in ecological connectivity for faunal movement	-	• BBNP • BBHNP	• BBTP	-
Light disturbances	-	-	• BBNP • BBTP • BBHNP	-
Human disturbances	• BBHNP	• BBNP • BBTP	-	-

Loss of or Reduction in Habitats and Food Sources
An overall Moderate impact owing to loss of or reduction in habitats and food sources is expected across BBNC, given that less than 10% of most terrestrial habitat types will be removed during the construction phase. The design of the parks have already been optimised to meet the necessary functions and areas of high conservation value identified during the Baseline Study (Figure 6-24) have been avoided. The impact is thus considered to be as low as reasonably practicable. Further, although not assessed in this report, terrestrial habitat enhancement works (subject to detailed design) is expected to compensate for some of the loss of habitat during the construction phase. The loss of habitats at BBNC is unlikely to contribute significantly to the overall loss resulting from other developments in the surrounding landscape.

Accidental Injury or Mortality
Aside from the bamboo bats (*Tylonycteris* spp.) that may experience Major impacts owing to accidental injury or mortality when the bamboo clusters affected by the slope stabilisation works at BBNP are removed, the impact on other fauna species across BBNC is expected to be Moderate, overall.

Human-Wildlife Conflict
An overall Moderate impact owing to human-wildlife conflict is expected during the construction phase across BBNC, where construction personnel wrongly perceive species such as snakes and the long-tailed macaque (*Macaca fascicularis*) as nuisances or threats.

Loss of or Reduction in Connectivity for Faunal Movement
Moderate impacts to aquatic species are expected at BBNP and BBHNP, where stream enhancement works are proposed and their movement may be temporarily impeded during the construction phase. However, the stream enhancement, when completed, is expected to compensate for the loss of connectivity during the construction phase, potentially resulting in an overall positive impact. For terrestrial species, connectivity will not be significantly affected as heavy construction works are mostly proposed at existing built-up areas.

Light Disturbances
An overall Minor impact owing to light disturbances is expected across BBNC, even when considering the ongoing developments in the vicinity. This is because no night works are expected to take place, aside from safety-critical works.

Human Disturbances
Major impacts owing to human disturbances are expected for three (3) species at BBHNP as they currently experience little to no human disturbances and the influx of construction personnel there could be significantly felt by the animals. For BBTP and BBHNP, an overall Moderate impact owning

to human disturbances is expected during the construction phase. This can be mitigated by strictly prohibiting the access of construction personnel that beyond the worksite boundaries. However, the same should be enforced for the other construction sites surrounding BBNC to ensure that fauna residing in the habitats of BBNC are not disturbed by personnel from those sites as well.

12.5.2 Operational Phase

Habitats

Three (3) operational phase impacts were identified and assessed for the habitat receptors at each of the proposed parks: habitat degradation, changes in microclimatic conditions, and introduction of exotic species (aquatic habitats only). A summary of the most substantive impacts affecting habitat receptors at each of the parks is shown in Table 12-63 and detailed below.

Table 12-63: Summary of Operational Phase Impacts to Habitat Receptors Across BBNC

Impact type	Proposed Park			
	Major	Moderate	Minor	Negligible
Habitat degradation	-	-	• BBNP • BBTP • BBHNP	-
Changes in microclimatic conditions	-	-	-	• BBNP • BBTP • BBHNP
Introduction of exotic species (aquatic habitats only)	-	-	• BBNP • BBTP • BBHNP	-

Habitat Degradation

An overall Minor impact is expected across all three parks during the operational phase owing to habitat degradation because the sensitive habitats are either currently already accessible or will remain inaccessible to the public.

Changes in Microclimatic Conditions

Considering only the developments within the proposed parks across BBNC, Negligible impacts owing to changes in microclimatic conditions are expected as heavy landscaping and limited hardscape will be introduced. However, for BBHNP, considering the adjacent residential blocks at the HDB West Glades and West Hills estates, the micro-urban heat island effect from the new buildings could have Moderate impacts on the abandoned kampong and/or plantation and abandoned kampong and/or plantation with native recruitment.

Introduction of Exotic Species (Aquatic Habitats only)

Minor impacts are expected for all aquatic habitats across BBNC as they are currently already accessible to public or are dominated by exotic species.

Flora

One (1) operational phase impact was identified and assessed for the flora species receptors at each of the proposed parks: poaching. A summary of the most substantive impacts affecting flora species receptors at each of the parks in shown in Table 12-64 and detailed below.

Table 12-64: Summary of Operational Phase Impacts to Flora Receptors Across BBNC

Impact type	Proposed Park			
	Major	Moderate	Minor	Negligible
Poaching	-	-	• BBNP • BBTP	• BBHNP

Poaching

The overall impact significance for poaching of these species across BBNC is Minor because BBNP and BBTP already have anti-poaching measures in place.

Fauna

Six (6) construction phase impacts were identified and assessed for the faunal species receptors at each of the proposed parks: accidental injury or mortality, human-wildlife conflict, poaching, loss of or reduction in ecological connectivity for faunal movement, light disturbances, and human disturbances. A summary of the most substantive impacts affecting faunal species receptors at each of the parks in shown in Table 12-65 and detailed below.

Table 12-65: Summary of Operational Phase Residual Impacts to Fauna Receptors Across BBNC

Impact Type	Proposed Parks			
	Major	Moderate	Minor	Negligible
Accidental injury or mortality	-	-	• BBNP • BBTP • BBHNP	-
Human-wildlife conflict	-	• BBHNP	• BBNP • BBTP	-
Poaching	• BBHNP	-	• BBNP • BBTP	-
Loss or reduction of ecological connectivity for faunal movement	-	-	• BBNP • BBTP • BBHNP	-
Light disturbances	• BBHNP	-	• BBNP • BBTP	-
Human disturbances	• BBHNP	-	• BBNP • BBTP	-

Accidental Injury or Mortality

Considering the unsubstantial increase in vehicular traffic associated with the operation of BBNP, BBTP, and BBHNP, as well as the existing heavy traffic along the adjacent roads, incidents of roadkills are not expected to increase significantly as compared to the current state. Furthermore, as no major new buildings will be constructed within the parks, bird-building collisions are unlikely to occur. Hence, the overall impact owing to accidental injury or mortality of fauna is Minor. However, when viewed together with the ongoing and upcoming developments in the vicinity, including the HDB projects at West Glades, West Hills, and Tengah, JTC's Jurong Innovation District, and LTA's road widening at Bukit Batok East Avenue 6, the cumulative vehicular traffic in the BBNC region is expected to increase substantially, and impacts associated with fauna roadkill could be Moderate. With the new residential blocks at West Glades and West Hills, bird-building collisions are Possible to occur, particularly for birds residing or passing through BBHNP, and the impact significance could be Moderate.

Human-Wildlife Conflict

An overall Moderate impact owing to human-wildlife conflict is expected during the operational phase at the newly opened BBHNP, where park visitors may Possibly wrongly perceive species such as snakes and the long-tailed macaque (*Macaca fascicularis*) as nuisances or threats. Considering the presence of residents living in the upcoming HDB projects adjacent to BBHNP, however, it is Likely that such species will run into conflicts with the residents, and the impact significance could be Major.

Poaching
With the increased accessibility of BBHNP to visitors during the operational phase, Major impacts owing poaching of faunal species are expected despite Singapore's zero-tolerance stance towards illegal wildlife trade.

Loss of or Reduction in Connectivity for Faunal Movement
Within BBNP, BBTP, and BBHNP, Minor reduction in connectivity for fauna movement is expected as the parks will largely remain forested. Across the wider landscape, ongoing and upcoming developments such as the HDB projects at West Glades, West Hills, and Tengah, JTC's Jurong Innovation District, and LTA's road widening at Bukit Batok East Avenue 6, habitat patches have/will become more isolated, impeding the movement of fauna. Crossing aids such as wildlife bridges, culverts, and glide poles/trees need to be implemented to restore the connectivity between BTNR and Tengah, via BBNC.

Light Disturbances
Major impacts owing to light disturbances are expected at BBHNP, which will be newly opened to visitors up till 1900h. With the presence of new residential blocks adjacent to BBHNP, light spillage into the forested areas is also expected.

At BBNP and BBTP, although the parks are also expected to be operational during the night time, they are currently already opened to visitors at night, and the impact of light disturbances with the re-opening of the parks will not be worse off than the baseline and the impact significance is Minor.

Human Disturbances
Major impacts owing to human disturbances are expected at BBHNP. With the presence of new residential blocks adjacent to BBHNP, the constant presence of humans near the forested habitats is also expected.

At BBNP and BBTP, which currently have substantial volumes of human traffic, Minor impacts owing to human disturbances are expected as the expected increase in footfall when the parks are re-opened was deemed insignificant. This increase in visitorship is, however, expected to be compounded with the increase in residents in the vicinity of BBNC.

13. CONCLUSION

Ramboll Pte Ltd (Ramboll) has conducted an **EIA** to assesses the nature and extent of environmental impacts arising from the construction and operation of the proposed BBNP, BBTP and BBHNP, which falls within the proposed BBNC, on behalf of the project proponent, NParks. Ramboll's team includes Camphora as the Biodiversity Specialist for the Studies.

The proposed BBNC project consists of forested areas around Bukit Batok, including the Former BTFS, the eco-pedestrian bridge, BBNP, BBTP, BBCNP, and BBHNP with a total land area of over 125 ha. The Study Area provides important habitats for biodiversity, including fauna moving between the BTNR and Tengah Forest Corridor, as well as migratory birds flying along the East Asian-Australasian Flyway. The proposed BBNC will serve as an ecological corridor that will connect the BTFS, BBNP, the eco-pedestrian bridge, BBTP, BBHNP, Central Nature Park Network and the future Tengah Forest Corridor.

As the proposed alignment for the eco-pedestrian bridge was still under discussion at the time of reporting, this **Impact Assessment Report** only focuses on the discussions on the assessments for BBNP, BBTP and BBHNP.

A summary of the potential residual impact significance of the assessed environmental aspects for BBNP, BBTP and BBHNP are summarised in table below:

Table 13-1: Summary of Impact Significance

Environmental Parameter		Unmitigated Impact Significance (with minimum controls)	Residual Impact Significance (post-mitigation measures)
Construction Phase			
Noise Quality	Human Receptors	Negligible - Minor	N/A
	Ecological Receptors	Minor - Moderate	Minor
Air Quality	Human Receptors	Negligible – Moderate	Negligible – Minor
	Nature Areas	Negligible – Moderate	Negligible – Minor
Soil and Sediment		Minor	N/A
Surface Water Quality		Minor	N/A
Surface Hydrology		Negligible - Minor	N/A
Biodiversity		Negligible - Major	Negligible - Moderate
Operational Phase			
Noise Quality	Human Receptors	Negligible	N/A
	Ecological Receptors	Negligible - Minor	N/A
Air Quality	Human Receptors	Negligible	N/A
	Nature Areas	Negligible	N/A
Soil and Sediment		Negligible	N/A
Surface Water Quality		Negligible – Minor	N/A
Surface Hydrology		Negligible - Minor	N/A
Biodiversity		Negligible - Major	Negligible - Moderate
Note: 2) N/A – where the impact significance with minimum controls is scored Negligible to Minor, no mitigation measures were proposed and hence, did not warrant for further assessment.			

The findings of the EIA indicate that the predicted adverse environmental impacts arising from the construction phase can be effectively mitigated and minimised to meet regulatory limits and

acceptable residual levels. The recommended mitigation measures include design and planning measures as well as management of construction practice that will help avoid, minimise and control the potential impacts.

An EMMP (presented as Volume II, a separate document from this EIA report) has been prepared for implementation on-site during the construction phase. The EMMP has been developed to ensure that the potential impacts of the Project on the physical environment, flora and fauna are minimised and managed effectively. The EMMP outlines the roles and responsibilities of various parties involved in the Project, the monitoring methods and frequency, the reporting requirements, and the corrective actions to be taken in case of non-compliance or unforeseen circumstances.

On commencement of the construction contract, the Contractor is to ensure that the environmental control measures are adequate to minimise impact on the environment and validate any changes to the recommended mitigation measures. This is to be documented through the preparation of an EMMP Implementation Plan to be submitted for approval prior to commencement of physical works on the site. NParks is committed to undertaking the proposed Project in an environmentally sustainable manner and will take all necessary actions to ensure that the Contractor is in compliance with the final EMMP and all prevailing environmental regulations.

The environmental control measures recommended including mitigation, monitoring, management plans and procedures associated with the identified impacts have been presented and discussed, and it is concluded that these are sufficient to ensure the sound management of impacts throughout the development of BBNP, BBTP and BBHNP.

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