

PARTICULAR SPECIFICATION

APPENDIX BD

**ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN (EMMP)
FOR ENVIRONMENTAL IMPACT STUDY**

Contract CR2005
Provision of Services to Conduct Environmental
Impact Study

Appendix BD - Environmental Impact Study (Clementi Forest and Maju Forest) EMMP

Study Stage: Tender

Submitted by:
AECOM Singapore Pte Ltd

Submitted to:
Land Transport Authority

13. Proposed Environmental Monitoring and Management Plan

The proposed EMMP is prepared for environmental impacts of the construction, commissioning and operational phases associated with the Project in overall for comprehensiveness of the study as well as to provide an overall picture of the potential roles and responsibilities required during each phase of the Project. The coverage of the proposed EMMP involves the environmental parameters that were assessed, namely air quality, airborne noise, ground-borne vibration, hydrology and surface water quality, soil and groundwater, and biodiversity. The EMMP details how the key mitigation measures recommended from the impact assessment/study are to be implemented and specifies environmental monitoring measures to assess the effectiveness of the proposed mitigation measures.

- During construction phase, this document is intended to provide a broad framework for various players in the construction phase to develop a more contract-specific EMMP, as per their responsibilities in Section 13.4 in order to comply with LTA's SHE specifications and any contract-specific requirements.
- During commissioning phase, this document is intended to provide a broad framework for various players with similar roles and responsibilities from construction phase (see Section 13.4) to further compliment their environmental protection effort by developing and implementing contract-specific EMMP after the completion of all the major construction activities. This is also to ensure smooth transition of the Project before handing over to the Rail Operator in operational phase.
- During the operational phase, this document is intended to provide a brief understanding of the responsibilities of Rail Operator (see Section 13.5) and other relevant personnel who perform or ensure the implementation of minimum control measures as per the relevant legislations and the proposed mitigation measures based on the impact assessment/study findings.

This section outlines the objectives of the EMMP, the Project organisation, describes the roles and responsibilities relevant to implementation of the EMMP, and summarises the EMMP requirements for each discipline. A summary of the proposed EMMP of different phases, incorporated with the relevant minimum controls and key mitigation measures, is provided in Section 0.

13.1 EMMP Objectives

The EMMP details the implementation and deliverables of the key mitigation measures recommended from the impact assessment for each technical discipline. The EMMP progressively scrutinises construction, commissioning and operational activities as they ensue and applies flexible monitoring and management procedures to protect the Project's environmental values throughout the Project period. The objective of the EMMP is twofold:

- a) Environmental monitoring focuses on overseeing those impacts to the Project's environmental values from construction and commissioning phases are within the anticipated level and tackle unforeseen impacts that may arise; and
- b) It also tracks the effectiveness of the recommended mitigation measures to allow amendment or review of the mitigation measures to better address any issues faced during construction, commissioning and operational phases of the Project.

Environmental management employs a more active approach to ensure those impacts on flora and fauna are directly avoided through documentation, auditing and enforcement.

13.2 Project Organisation during Construction and Commissioning Phases

The proposed Project organization and lines of communication with respect to environmental protection works for construction and commissioning phases of this Project are presented in Figure 13-1. The roles and responsibilities of the various parties responsible for implementing the EMMP during the construction and commissioning phases are outlined in Section 13.4.

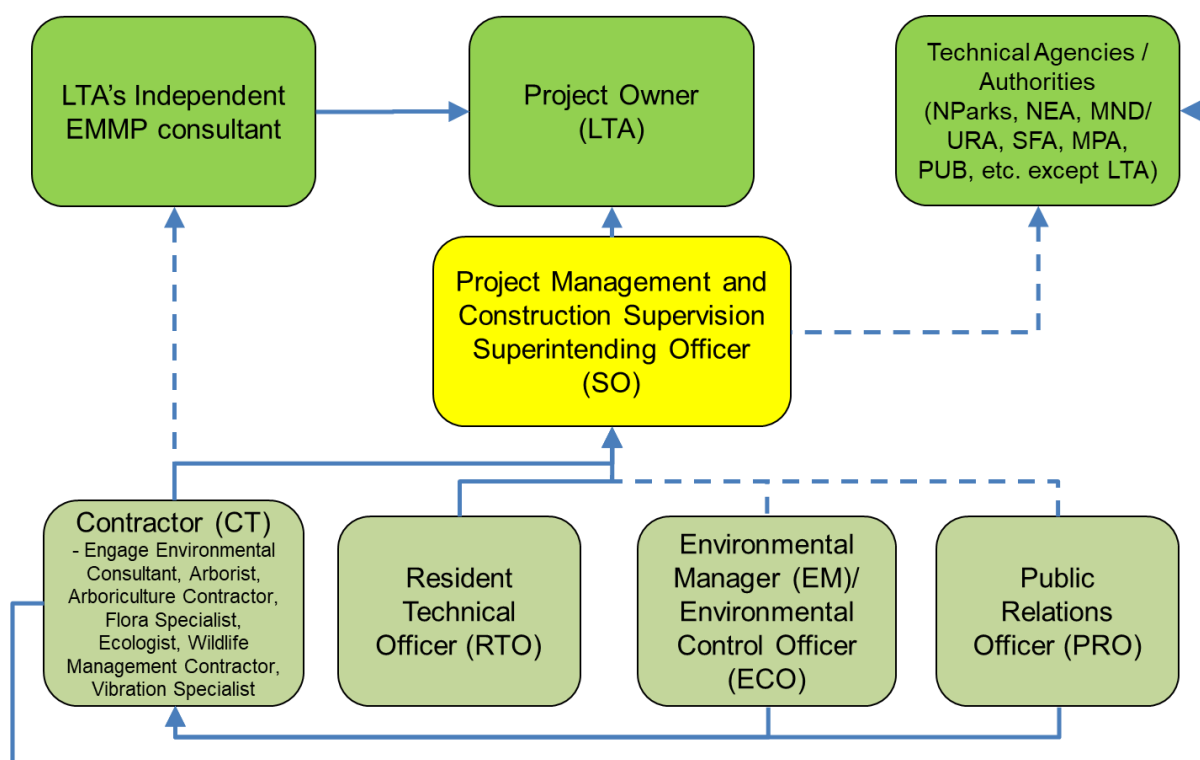


Figure 13-1 Project Organization and Lines of Communication during the Projects' Construction and Commissioning Phases

13.3 Project Organisation during Operational Phase

The proposed Project organization and lines of communication with respect to the general management and implementation of the recommended minimum control measures as well as key mitigation measures during operational phase of this Project are presented in Figure 13-2, forming a typical Environmental Management Committee or as part of the Environmental, Health and Safety (EHS) Committee for a particular organization/operation. The roles and responsibilities of the various parties involved in the operational phase are outlined in Section 13.5.

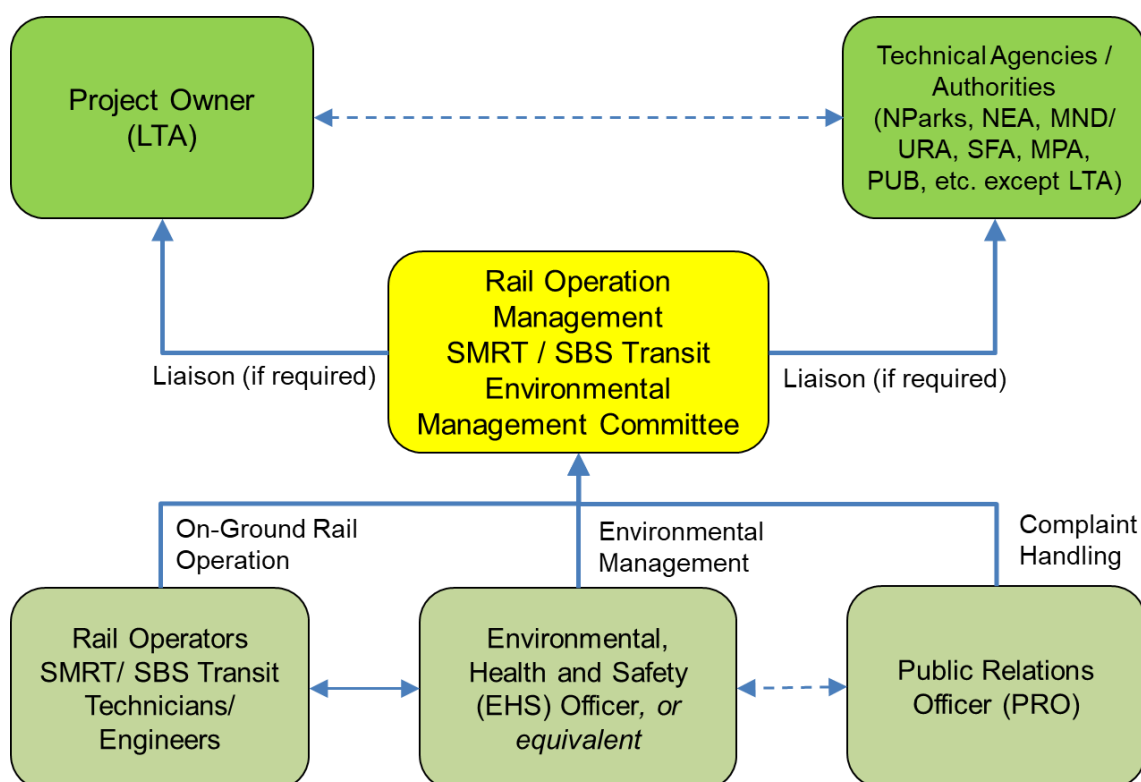


Figure 13-2 Project Organization and Lines of Communication during the Projects' Operational Phase

13.4 Roles and Responsibilities during Construction and Commissioning Phases

This section describes the roles and responsibilities of the EMMP members presented on the organisational chart for construction and commissioning phases in Section 13.2.

13.4.1 Technical Agencies

Technical Agencies constitute but are not limited to NParks, PUB, NEA, and URA. These Agencies shall assess and approve the detailed EMMP for the construction and commissioning phases prior to commencement of works and where required during the course of the relevant Project phases.

13.4.2 Project Owner (LTA) and Resident Technical Officer (RTO)

LTA, being the Project owner, oversees the construction and commissioning phases of the Project in accordance with the design. LTA, in conjunction with the Resident Technical Officer (RTO) (Contractor), are required to:

- Ensure resources are available to achieve the requirements of the EMMP;
- Provide leadership in the development and implementation of the EMMP;
- Ensure all environmental incidents and near misses are promptly investigated and reported;
- Resolve any non-compliance issues;
- Record, respond to, and action on any complaints from members of the public, if any, with inputs from the Technical Agencies, if required; and
- Reporting to the Technical Agencies regarding implementation of the EMMP.

13.4.3 Superintending Officer (SO)

The Superintending Officer is responsible for overseeing the construction works undertaken by various staff, Contractors and sub-contractors. The SO should ensure that the construction works are performed by the Contractors and personnel in accordance with the specification, contractual requirements, and EMMP. The SO should also:

- Communicate the requirements of this plan to all staffs, Contractors and sub-contractors
- Monitor all staffs, Contractor's and sub-contractor's compliance with contract specifications and regulatory requirements, including the implementation of the environmental mitigation and monitoring measures and ensure their effectiveness, and other aspects of the environmental audit program;
- Coordinate with the Project's EM/ECO to monitor and participate in the implementation of the environmental audit program, and ensure that the requirements in the environmental audit program are correctly followed;
- Implement measures to reduce impacts where emission/discharge levels are exceeded;
- Coordinate with the Project Owner and RTO for submission of environmental audit reports;
- Carry out any complaint investigations with PRO (see Section 13.4.4.8);
- Resolve any non-compliance issues; and
- Promote environmental awareness and responsibility and lead by example.

13.4.4 Contractor (CT)

The term "Contractor" refers to all construction Contractors and sub-contractors working onsite at any time, which also the "Occupier of Construction Site" as defined by NEA. In addition to reporting to the SO, the Contractor should:

- Work under the relevant contract scope, specifications, and other tender conditions;
- Ensure that the roles of Environmental Manager (EM), Environmental Control Officer (ECO), Certified Arborist, Arboriculture Contractor, Flora Specialist, Ecologist, Wildlife Management Contractor(s) are adequately resourced;

- Notify the Director-General of Public Health on the employment of ECO (also applicable for EM who shall also be an registered ECO in the context of this Project) by submitting the Notification on Employment of Environmental Control Officer (as per the format *in the NEA's Code of Practice of Environmental Control Officers*), as well as to notify in writing to the Director-General of Public Health and to employ another registered ECO/EM within 14 days of the termination of the employment of the originally appointed ECO/EM;
- Employ a temporary ECO or engage a registered Workplace Safety and Health Officer (WSHO) with valid ECO certificate obtained under NEA if both EM and ECO working on the construction site are on leave or absent for more than 5 days, and neither of them can take on the work responsibility of an ECO during the absence period;
- Endorse and submit the Site Environmental Control Programme prepared by the ECO/EM to the Director-General of Public Health at least two weeks before work commences on the construction site;
- Discuss about the Site Environmental Control Report with the EM/ECO within one week on receipt of the report, then countersign and stamp after finalization and implement the recommendations made by the ECO;
- Keep the Site Environmental Control Report available for inspection by the Director-General of Public Health or Public Health Officers when required, as well as to submit when required to so by the Director-General of Public Health;
- Participate in the required environmental site audits (via the SO) undertaken by a registered EM/ECO and undertake any corrective actions;
- Provide up-to-date information and advice to the RTO, SO, EM, ECO, Certified Arborist, Arboriculture Contractor, Flora Specialist, Ecologist, Wildlife Management Contractor(s) regarding any work activities which may contribute or continuously create adverse environmental conditions, or any changes to the work plan;
- Implement measures to reduce impacts where emission/discharge levels are exceeded;
- Prepare a detailed contract-specific EMMP, incorporating the relevant mitigation measures and monitoring works recommended in this study and seek technical Agencies' approval prior to the commencement of any works for the construction and commissioning phases of the Project. This detailed EMMP shall include, as a minimum, a Standard Operating Procedure (SOP) detailing:
 - Handling and storage of hazardous chemicals;
 - Biodiversity management plan;
 - Individual environmental management plans as detailed in the LTA's SHE Specifications (air, vector, waste, noise, water pollution management plans);
 - Monitoring plans (including but not limited to noise, air, waste, ecology and water pollution);
 - Environmental Impact Register;
 - Existing legislation and environmental best practices to be implemented; and
 - Contingency planning during emergency situations.

13.4.4.1 Environmental Personnel

According to LTA's SHE Specifications, the Contractor shall comply with all legislative safety, health and environmental (SHE) requirements as stipulated. SHE personnel refer to Workplace Safety and Health Officer (WSHO) registered with the Ministry of Manpower (MOM) and ECO registered with the NEA. After consultation with LTA, the Contractor shall engage the following environmental personnel during the construction and commissioning phases of this Project:

- Environmental Consultant, with strong and relevant experiences in developing and implementing EMMP for similar or larger construction Projects;
- Environmental Manager (EM), who is a NEA-registered ECO with strong and relevant experiences, to oversee/ lead/ guide environmental monitoring and auditing works on the construction site; and
- Environmental Control Officer (ECO), who shall assist the EM and is also registered with NEA, to perform and/or ensure implementation of EMMP, mitigation measures and minimum control measures on site.

13.4.4.1.1 Environmental Consultant

An environmental consultant shall be engaged by the Contractor to develop a contract-specific EMMP for implementation by all parties, including EM/ECO and relevant workers on site. The appointed environmental consultant may be required to re-establish baseline environmental conditions and perform the recommended environmental monitoring works throughout the construction and commissioning phases, as well as to provide environmental advisory services for the Contractor and to liaise with the authorities, stakeholders and/or the independent EMMP Consultant from LTA during external audit (see Section 13.12.1.2), when necessary.

13.4.4.1.2 Environmental Manager (EM)/ Environmental Control Officer (ECO)

General Introduction

The Environmental Control Officer (ECO) Scheme was launched by NEA on 1 April 2000 to advocate good environmental practices within construction sites. Under the Environmental Public Health Act (EPHA), a part-time ECO working at least 15hr/week is required for construction sites with contract sum of between \$10 million and \$50 million, whereas a full-time ECO working at least 40hr/week must be engaged by construction sites with contract sum exceeding \$50 million.

The main role of a registered ECO is to advise the Occupier of the construction site on what needs to be done, which include advising construction site's Contractors on environmental remediation measures, facilitating compliance with the environmental laws, carrying out site inspections and engagement of stakeholders for environmental lapses, as well as educating workers on maintaining good environmental health standards. NEA has also specified that the role of ECO(s) in general would comprise the following aspects:

- Disease-bearing insects and rodents;
- Proper disposal of construction waste/ marine clay;
- Noise, air and water pollution;
- Earth littering;
- Siltation of drains;
- Food hygiene in on-site canteens (if any);
- Proper maintenance of septic tank(s)/ holding tank(s), chemical/ portable toilet(s) and other sanitary facilities; and
- Any other environmental health matters.

The registered ECO(s) shall be employed by the Occupier of the construction site (the Contractor) but may not be in any way as an associated body of the Contractor, the SO, or the Project's SHE team.

For this Project

As mentioned, both EM and ECO are environmental control officers registered under NEA. In view of the scale and nature of this Project, during construction and commissioning phases, EM shall be the leading role and is expected to have prior experience in EMMP for Projects with biodiversity sensitivity to manage and oversee the overall EMMP implementation and act as the key liaison with Agencies and stakeholders on environmental-related matters when necessary; while the ECO can be the same person if possible, else a supporting role officer who is responsible for most of the implementation of EMMP and relevant environmental measures on ground.

Generally, a NEA-registered ECO (applicable for EM and/or ECO of this Project) shall comply with the latest NEA's [*Code of Practice for Environmental Control Officers*](#), where the duties include but not limited to:

- Prepare and submit a Site Environmental Control Programme based on the latest required format in Appendix 2 of the above-mentioned code of practice, within one month after the commencement of works on the construction site to NEA (after reviewed by the Project Owner LTA) via Form SG;
- Prepare and submit the Site Environmental Control Report(s) based on the latest required format in Appendix 3 of the above-mentioned code of practice, after the commencement of construction works, and at least once a month or any other frequency required by NEA and/or LTA throughout the construction and commissioning phases;
- Identify and attend to all environmental issues, inform the Occupier of the construction site accordingly, and recommend measures to rectify the irregularities;
- Assist the authorities to investigate environmental issues and outbreaks of infectious, vector-borne or food-borne diseases on the construction site; and

- Organise campaigns, training, toolbox briefings and other relevant courses to develop the capability of all relevant workers in implementing EMMP, as well as to raise their environmental and biodiversity awareness in maintaining good environmental performance on site.

Resources to implement the environmental monitoring program should be allocated time to fulfil the environmental audit/ inspection requirements during construction works. The EM/ECO shall work closely with other EMMP members to ensure environmental compliance of the construction sites, as well as to ensure proper and safe working condition of relevant construction facilities and equipment:

- Oversee and manage the implementation of minimum control measures, mitigation measures and EMMP on site;
- Coordinate with various parties with respect to EMMP, which include:
 - Liaise with the SO and/or WSHO regarding equipment, locations, and schedule of monitoring and auditing works; and
 - Coordinate among the Client, Contractor, and other personnel within the Biodiversity Team for the implementation of the EMMP measures for biodiversity.
- Formulate and implement the environmental monitoring and audit program as required in this document;
- Monitor compliance with conditions in the EMMP, relevant environmental protection, pollution prevention and control regulations and contract specifications;
- Analyse environmental monitoring data and audit findings, review the adequacy of implementation of mitigation measures, identify adverse environmental impacts, and liaise with the SO;
- Carry out weekly site audits/ inspections against the Contractor's site practices, equipment and work methodologies with respect to pollution control and environmental mitigation, and effect proactive actions to pre-empt problems in coordination with the SO;
- Report the results of the environmental monitoring works and audit program, and any required changes to meet the requirements of the EMMP and legal obligations to the SO in a timely manner; and
- Coordinate the investigation of biodiversity-related incidents;
- Provide solutions and address complaints related to environmental incompliances or related incidents, with cooperation from SO and/or WSHO; and
- Compile and submit the updated findings, along with completed remedial actions supported by photographs to LTA fortnightly in the form of an Environmental Performance Report (also known as Environmental Inspection Report).

13.4.4.2 Arborist

An Arborist certified by the International Society of Arboriculture (ISA) plays an important role as part of the biodiversity monitoring programme during both construction and commissioning phases of this Project. He/She shall possess previous work experience in developments of similar size or complexity who is able to demonstrate capability in monitoring and managing all matters related to the adequate and successful conservation of trees and flora within and adjacent to the contract boundary. A detailed description of biodiversity monitoring programme is provided in Section 13.6, where the key responsibilities of the Arborist are listed as follows:

Construction Phase

The key responsibilities of an ISA-certified Arborist during construction phase include but not limited to:

- Carry out tree mapping and assessment;
- Implement tree protection plans;
- Provide advice on tree transplanting;
- Review Contractor's method statements for site clearance, tree felling and setting up of tree protection zones (TPZ);
- Assess forest edge effects and its associated changes;
- Implement tree maintenance and care; and
- Carry out monthly tree inspection and reporting.

Commissioning Phase

The key responsibilities of an ISA-certified Arborist during commissioning phase include but not limited to:

- Implement tree maintenance and care; and
- Carry out monthly tree inspection and reporting.

13.4.4.3 Arboriculture Contractor

The Arboriculture Contractor should meet NParks' safety requirements for work at height and LTA's requirements for temporary works along roadsides. All arboriculture workers engaged by the Arboriculture Contractor to perform tree climbing and chainsaw work shall possess a valid basic tree climbing certification based upon demonstrated competence in the Workforce Skills Qualifications (WSQ) module conducted by Centre for Urban Greenery and Ecology (CUGE) or an equivalent WSQ-approved training organisation; and

The arboriculture crew deployed by the Arboriculture Contractor for the Contract shall possess the following valid competences:

- Operation of chainsaw for ground work (LS-MT-103E-1);
- Chainsaw safety and maintenance (LS-MT-102E-1);
- Perform formative pruning of young trees (LS-MT-114E-1);
- Provide Arboriculture support on site (LS-MT-116E-1);
- Workplace safety and health – operators (ES-WSH-101G-1);
- Respond to Emergency (LS-HM-208E-1);
- Perform advance rigging and climbing techniques (LS-HM-308S-1);
- Perform aerial tree access and aerial rescue skills (LS-HM-204S-1);
- Implement and apply appropriate risk and safety management to sector practices (LS- BP-301S-1);
- Prepare risk assessment report (LS-HM-406S-1); and
- Operate and work from an elevated work platform (CUGE-ARB-3501).

Construction Phase

The certified Arboriculture Contractor shall be responsible for pruning and maintenance of retained trees, as well as felling of trees during the construction phase of this Project.

Commissioning Phase

The certified Arboriculture Contractor shall be responsible for pruning and maintenance of retained and newly planted trees, as well as felling of trees (if required) during the commissioning phase of this Project.

13.4.4.4 Flora Specialist

For this Project, a Flora Specialist plays an important role in the implementation of flora-related EMMP measures (e.g. Flora Management Plans) as part of the biodiversity monitoring program during both construction and commissioning phases of this Project. He/She shall possess previous work experience in developments of similar size or complexity who is able to demonstrate capability in implementing flora management plans. A detailed description of biodiversity monitoring programme is provided in Section 13.6, where the key responsibilities of the Flora Specialist are listed as follows:

Construction Phase

The key responsibilities of a qualified Flora Specialist during construction phase include but not limited to:

- Review soil investigation locations and proposed site access to minimise excessive vegetation removal;
- Identify plant species (e.g., climbers, shrubs, epiphytes, ferns) of value that can be extracted for propagation and harvesting;
- Recommend weed and invasive species management if necessary;
- Review planting palette of reforestation works and ensure that the specifications for planting are met; and
- Carry out monthly flora inspection and reporting.

Commissioning Phase

The key responsibilities of a qualified Flora Specialist during commissioning phase include but not limited to:

- Recommend additional weed and invasive species management if necessary; and
- Carry out monthly flora inspection and reporting.

13.4.4.5 Ecologist

For this Project, an Ecologist plays an important role in the implementation of fauna-related EMMP measures as part of the biodiversity monitoring program during both construction and commissioning phases of this Project, who can also be known as a Fauna Specialist. He/She shall possess a degree (or equivalent) in ecology-related fields with experience in implementing fauna management plans. In addition, at least two (2) valid certifications of the following:

- Animal Management Professional Certification Programme (PCP) – Basic Module (CUGE-PCP-7006A)
- Animal Management PCP – Intermediate Elective Module – Mammals (CUGE-PCTP-7006C)
- Animal Management PCP – Intermediate Elective Module – Reptiles (CUGE-PCP-7006B)

A detailed description of biodiversity monitoring programme is provided in Section 13.6, where the key responsibilities of the Ecologist are listed as follows:

Construction Phase

The key responsibilities of a qualified Ecologist during construction phase include but not limited to:

- Carry out fauna monitoring surveys including terrestrial transect surveys, aquatic sampling and camera trapping;
- Implement fauna management during site clearance;
- Carry out pre-felling fauna inspections;
- Carry out monthly fauna inspection and reporting; and
- Facilitate the implementation of the fauna response plan.

Commissioning Phase

The key responsibilities of a qualified Ecologist during commissioning phase include but not limited to:

- Carry out fauna monitoring surveys including terrestrial transect surveys, aquatic sampling and camera trapping; and
- Carry out monthly fauna inspection and reporting.

13.4.4.6 Vibration Specialist

- Vibration Specialist, with strong and relevant experiences, to oversee/ lead/ guide vibration monitoring on the construction site, and to ensure it is carried out according to guidelines and standards;
- Vibration Specialist, who shall assist the ECO, to perform and/or ensure implementation of EMMP, mitigation measures and minimum control measures on site.

13.4.4.7 Wildlife Management Contractor

For this Project, the Wildlife Management Contractor (with at least one veterinary professional with experience within the team) would be responsible in carrying out animal rescue, trapping and transport of large fauna if any human-wildlife conflicts are encountered during construction and commissioning phases on site. The Wildlife Management Contractor shall be listed under NParks' public register of certified Wildlife Management Contractor and have experience carrying out animals rescue, trapping and transport of large fauna.

A detailed description of biodiversity monitoring programme is provided in Section 13.6, where the key responsibilities of the Wildlife Management Contractor are listed as follows:

Construction Phase

The key responsibilities of a qualified Wildlife Management Contractor during construction phase include but not limited to:

- Carry out fauna rescue and translocation in consultation with attending Ecologist and NParks; and

- Propose trapping of fauna in consultation with attending Ecologist and NParks to satisfy Section 10 of the Wildlife Act.

Commissioning Phase

The key responsibilities of a qualified Wildlife Management Contractor during commissioning phase include but not limited to:

- Carry out fauna rescue and translocation in consultation with NParks.

13.4.4.8 Public Relation Officer (PRO) for Complaint Handling

The Public Relation Officer (PRO) is responsible for handling complaints and managing feedback and investigative work. The PRO shall be supported by the Project Owner, RTO, SO, EM/ECO, Contractor representatives, and any other relevant parties.

During the construction and commissioning phases, upon receipt of complaints, the PRO should undertake the following procedures:

- Log the complaint and record the date when the complaint is received onto the complaint database and inform the Project Owner, SO, EM/ECO immediately;
- Investigate the complaint with the EM/ECO to determine its validity and assess whether the source of the problem is due to construction works;
- If a complaint is valid and due to construction works, liaise with the EM/ECO on the mitigation measures and seek agreement from SO;
- Review the current situation and the EM/ECO's and SO's implementation of the mitigation measures;
- Engage the EM/ECO to undertake additional monitoring and auditing to verify the complaint if necessary. Ensure that any valid reasons for complaints do not re-occur by revising the work methods, procedures, machines and/or equipment, etc.;
- Submit a complaint report (as well as the implementation of mitigation measures and the effectiveness of the mitigation measures as advised by the EM/ECO) to the Project Owner, RTO and the SO; and
- Log a record of the complaint, investigation, follow-up actions and the results in the environmental audit reports.

The EM/ECO and SO should provide all the necessary information and assistance to the PRO in order to complete the complaint investigation. Following the investigation, the Contractor should promptly undertake the mitigation measures. The PRO and SO should ensure that the measures have been appropriately implemented. The Contractor, RTO, and SO should also be responsible for the reporting of complaint investigation results and followed up actions to the Project Owner. The complaint investigation report and corrective action plan should be prepared and approved by LTA and/or other relevant Authorities within 24 hr upon receipt of complaints.

13.5 Roles and Responsibilities during Operational Phase

This section describes the roles and responsibilities of the EMMP members presented on the organisational chart for operational phase in Section 13.3.

13.5.1 Technical Agencies

Consultation and engagement with the technical Agencies (e.g. NParks, PUB, NEA, etc) may be required if there are any major environmental concerns affecting their property, land boundary and/or related to the respective scope of responsibilities, or when inputs from technical Agencies are necessary in addressing any major public complaints due to environmental incidents arising from the rail operation (if any) of this Project.

13.5.2 Project Owner (LTA)

The Land Transport Authority (LTA) is a statutory board in Singapore under the Ministry of Transport responsible for public transport in Singapore, which is also the Project owner for this Project.

During the operational phase, under LTA's New Rail Financing Framework (NRFF), LTA owns the rail operating assets (e.g. trains, signalling system) and other associated infrastructure (e.g. viaducts, tunnels, tracks). The role of LTA as the owner involves making decisions on building-up, replacement and upgrading of the rail operating assets and infrastructure, while the licensed rail operator (e.g. SMRT Trains, SBS Transit) is responsible for the operation and maintenance of those assets and infrastructure.

LTA oversees the rail operations and management of the rail operator during the operational phase. In terms of environmental management, the responsibility of LTA includes:

- Regulate the rail operation and maintenance through the stipulated Operating Performance Standard (OPS), Maintenance Performance Standards and ISO14001 Environmental Management System;
- Ensure resources and appropriate personnel are available to achieve the environmental requirements;
- Provide leadership in maintaining overall environmental performance;
- Ensure all environmental incidents and near misses are promptly investigated and reported by the rail operator;
- Resolve any environmental non-compliance issues with the assistance from the rail operator; and
- Record, respond to, and action any complaints from members of the public, if any, with inputs from the Technical Agencies, if required, and
- Liaise with the Technical Agencies regarding any relevant issues arising from the environmental incidents, or environmental reporting and submission (if any) by the rail operator.

13.5.3 Rail Operator

As mentioned in Section 13.5.2, the role of rail operator (e.g. SMRT Trains, SBS Transit) is to operate and maintain the rail operating assets and infrastructure of the owner (LTA) which is governed under the NREF regulatory framework.

The responsibilities of rail operator shall include:

- Operate and conduct maintenance by complying with LTA's Operating Performance Standard (OPS), Maintenance Performance Standards and ISO14001 Environmental Management System;
- Allocate sufficient resources and appropriate personnel in maintaining environmental, health and safety of the rail operation;
- Appoint and work with EHS officer or equivalent to ensure environmental, health and safety of rail operations;
- Form an Environmental Management Committee who manage the overall environmental performance and for the decision-making in resolving any environmental-related issues reported by the on-ground rail operators and/or the EHS Officer, which include:
 - Investigate any environmental incidents or near misses identified by the EHS Officer and the on-ground rail operators, and report promptly to LTA;
 - Record, respond to, and take action on any complaints from members of the public, if any, with inputs from the Technical Agencies, if required, and
 - Reporting to LTA and relevant Technical Agencies regarding environmental-related issues.

13.5.4 EHS Officer (or Equivalent)

In general, EHS Officer appointed by the rail operator is responsible for the overall environmental, health and safety during the operational phase of the Project. In terms of environmental management, the EHS Officer is required to:

- Conduct regular site inspections to ensure proper housekeeping as well as implementation of the minimum control measures and the proposed mitigation measures for operational phase in this report;
- Identify, record and report promptly any environmental non-compliance issues, incidents and near misses to the Environmental Management Committee; and
- Report the results of the environmental monitoring program, and any required changes, to meet the requirements of the EMMP to the rail operator and/or LTA in a timely manner.

13.5.5 Public Relation Officer (PRO) for Complaint Handling

The Public Relation Officer (PRO) is responsible for handling complaints and managing feedback and investigative work. The PRO shall be supported by the Project Owner, rail operator, EHS Officer and any other relevant parties.

During the operational phase, upon receipt of complaints, the PRO should undertake the following procedures:

- Log the complaint and record the date when the complaint is received onto the complaint database and inform the rail operator and EHS Officer immediately;
- Investigate the complaint with the rail operator's Environmental Management Committee and EHS Officer to determine its validity and assess whether the source of the problem is due to operational works;
- If a complaint is valid and due to operational works, liaise with the EHS Officer on the mitigation measures and seek agreement from the rail operator's Environmental Management Committee;
 - Review the current situation and the EHS Officer's implementation of the mitigation measures;
 - Engage the EHS Officer to undertake monitoring works for inspection purpose as well as to verify the complaint if necessary. Ensure that any valid reasons for complaints do not re-occur by revising the work methods, procedures, machines and/or equipment, etc.;
 - Submit a complaint report (as well as the implementation of mitigation measures and the effectiveness of the mitigation measures as advised by the EHS Officer) to the rail operator and/or LTA; and
 - Log a record of the complaint, investigation, follow-up actions and the results in the environmental inspection report.

The PRO should work with the rail operator's Environmental Management Committee and EHS Officer to gather all the necessary information and resources necessary to complete a complaint investigation. Following the investigation, the Project/ Operation Manager (who leads the Environmental Management Committee) and EHS Officer shall undertake appropriate mitigation measures. Follow-up is required by the PRO to ensure that the mitigation measures have been appropriately implemented. The complaint investigation report and corrective action plan should be prepared and approved by LTA and/or other relevant Authorities within 24 hr upon receipt of complaints.

13.6 Biodiversity EMMP Requirements

13.6.1 Construction Phase

At the construction phase, EMMP for both flora and fauna are essential in minimising and managing construction impacts.

13.6.1.1 Flora and Arboriculture Monitoring Programme

The flora and arboriculture monitoring aims to assess the impacts of construction to vegetation and habitat, such as tree health, unauthorised and/or excessive vegetation removal, edge effects, habitat degradation from soil erosion, and rubbish dumping. The programme should include the following:

Arboriculture Monitoring Programme should include the following works:

- Monitoring of the condition of trees at the new forest edge to determine the physiological health and structural stability of trees as edge effects can lead to die back of canopies, and branch and structural failures.
- Review of method statements of construction works in proximity to retained trees, if any, to determine if additional tree removal is required post-site clearance.
- Recommendation of solutions such as design changes, reduction of working space, reduction of TPZ area and reassessment of trees in cases of conflict with proposed works.
- Assessment of physiological health, vigour and structural stability of retained trees. Recommend additional mitigating measures if necessary.
- Assessment of the condition of retained trees, if any, to ensure that there has been no deterioration or mechanical damage and to determine if additional tree removal is required.
- Where a tree exhibits signs of stress, the Arborist should inspect the tree and advise on strategies to reduce further impacts and rehabilitation measures. Where monitoring indicates that drying out or edge impacts are occurring, remediation measures shall be undertaken. These measures may be temporary (such as carrying out watering when there is seven continuous days without rainfall). Long-term solutions shall be investigated and implemented.
- Inspection of the integrity of TPZs.
- Identification of excessive or unauthorised tree removal.

Flora Monitoring Programme should include the following works:

- Monthly flora inspections shall be conducted within the worksite boundary and in forested areas adjacent to the worksite up to 15 m from the hoarding.
- Identification of any unauthorized removal of flora within areas of conservation or beyond the demarcated Project worksite (Figure 13-3 Monitoring of Vegetation and Trees Along the Hoarding Line for Unauthorised Vegetation Clearance and Forest Edge Effects)
- Identification of direct/indirect impacts to sensitive vegetation and habitats. Such impacts include soil erosion and degradation that has resulted from construction activities, and unauthorized dumping of waste material, construction debris or oil/chemical leakage.
- Identification of forest edge effects and recommendation of mitigation measures where necessary.
- Assessment of the status of invasive flora species and weeds and recommendation to remove them where necessary.
- Inspection of areas cleared of weeds to detect any seedlings of invasive species.
- Monitoring of the health of all retained and planted flora, including identification of diseases and recommendations for treatment.



Figure 13-3 Monitoring of Vegetation and Trees Along the Hoarding Line for Unauthorised Vegetation Clearance and Forest Edge Effects

13.6.1.2 Flora and Arboriculture Management Programme

The flora and arboriculture management programme aims to manage all matters related to the adequate and successful conservation of trees and vegetation within and adjacent to the contract boundary (up to 15-m from the contract boundary). The programme should include the following works:

Arboriculture Management Programme should include the following works:

- Tree Mapping and Assessment
 - Trees within the worksite boundary, including any construction access roads, shall be mapped and assessed by the Arborist before work commencement.
 - Trees within the worksite boundary, including any construction access roads, shall be mapped and assessed by the Arborist. These specimens shall be tagged with a unique serial number.
 - The physiological health, presence of pests and diseases, and structural stability shall be assessed for all trees, single-stemmed palms and strangling Ficus species of ≥ 1.0 m girth or spread, respectively.

- Species of conservation significance—i.e., listed in Chong et al. (2009) as nationally Vulnerable, Endangered, Critically Endangered or Presumed Extinct (which indicates a rediscovery)—of ≥ 0.3 m girth or spread shall also be assessed. The locations, girth/spread, and height of these specimens shall also be recorded. These specimens shall be tagged with a unique serial number.
- The trees to be felled or retained shall be determined by the Arborist.
- A photographic report shall be provided for the trees affected by the proposed works.
- No trees shall be felled without prior approval from NParks.
- Tree Protection
 - Where there are trees to be retained within the worksite, specifications shall be formulated by the Arborist for the setting up of tree protection zones (TPZ) to meet NParks requirements (Appendix W).
- Sapling Harvesting
 - Viable saplings and conservation significant trees that are suitable for harvesting shall be identified by the Arborist. Saplings or trees suitable for transplanting should:
 - Exhibit good physiological health and vigour
 - Have no structural defects
 - Have good branch form
 - The root ball size to be extracted shall be based on the girth of the saplings or trees to be harvested as specified in Table 13-1.
 - Prior to transplanting, dead branches and climbers shall be cleared from the plant and canopy load and spread will be reduced where necessary, in consultation with the Arborist.
 - Manual trenching shall be carried out to determine the shape and size of root ball to be extracted. Where possible, feeder roots shall be retained without cutting.
 - The root ball shall be wrapped with cellophane sheet to reduce desiccation effects. When directed by the Flora specialist or Arborist, leaves of the canopy may also need to be enclosed and covered by cellophane or clear plastic bags.
 - The root ball shall be secured to the trunk to reduce risk of root ball disintegrating.
 - When handling/carrying the plant, care shall be taken not to damage any vegetative parts.
- Tree Transplanting
 - Where trees and vegetation are moved or translocated within the Project area, the Arborist shall review the method statement proposed by the tree transplanting Contractor and advise on additional recommendations necessary to ensure the tree's health during transplanting. The transplanting contract shall ensure in their best effort, intact and secured root balls at the point of extraction, during the lifting processes and during the installation at the receiving site. The transplant effort shall be documented for each individual tree to show intact root balls at all the stages mentioned. Transplanted trees shall be managed through adequate watering and monitoring of their health to ensure their long-term survival. Advice shall be sought from the Arborist if the tree exhibit signs of stress, e.g. peeling bark, withered leaves.
- Site Clearance and Tree Felling
 - The Contractor's method statements for site clearance, tree felling and setting up of TPZ shall be reviewed by the Arborist to ensure compliance to the specifications. The site clearance and tree removal method statements shall consider directional felling methods with a hinge and back cut. Trees shall not be removed by pushing with an excavator or other heavy machinery. Cranes shall be deployed to offset the tension of trunks in the direction of the drop. Interlocking canopy branches shall be pruned prior to tree felling.
 - In cases where design changes may affect additional trees or the retained trees, the Arborist shall work with the structural engineers and recommend solutions that will meet NParks guidelines.
 - Whenever reasonable and practicable, cleared vegetation at sloped areas shall be covered with mulch or with 100% biodegradable fauna-friendly ECBs to control erosion of exposed soil. Exposed ground shall be revegetated as soon as possible to stabilise surfaces and minimise re-entrainment of dust and potential for erosion of waste spoil to watercourses.

- Clearance activities on-site shall not occur during rainfall or when storm events are forecast to occur within the vicinity to protect forest edge from wind throw. Where forest edges are exposed to wind, temporary measures (e.g., additional hoarding) shall be discussed with the Arborist, and put in place to protect the forest edge during storm events.
- During site clearance, care will be taken when removing trees in riparian zones to reduce impacts to the bed and banks of waterways.
- Where practicable, saplings, seeds and seed banks will be retained within the soil profiles for use in forest restoration.
- Horticultural waste shall be removed on the same day. This is essential to reduce risk of fauna taking refuge within the cleared waste if left overnight.
- **Tree Maintenance and Care**
 - Where disease outbreaks are identified, the Arborist and/or Flora Specialist shall advise measures to manage them. Measures can include using selected insecticides/fungicides to control outbreaks; reduction of stressors (dust, water, etc.). The plant may be removed or quarantined if it poses a threat to surrounding individuals.
 - Where forest edges are exposed following site clearance and where impacts to vegetation are evident (e.g., vegetation shows signs of drying out), additional watering shall be carried out to improve moisture differentials around forest edges.
 - The use of herbicides, pesticide shall be minimised. If herbicides or pesticides are used within the Project area, techniques that limit spray or non-target spray drift shall be used. These techniques include but are not limited to: cut and paint techniques and drilling injection. All use of herbicides and pesticides shall be conducted in accordance with the relevant Material Safety Data Sheet (MSDS). Any incidents of off label use, spillage or damage to non-target species shall be reported and investigated.
 - When the site experiences seven continuous days without rainfall, the Contractor shall carry out additional watering of conserved trees within the TPZs and at the forest edge (up to 10 m) around the development boundary.
 - Post heavy rainfall, any snapped hanging branches that pose imminent hazards to workers within the site should be removed immediately

Table 13-1 Minimum Root Ball Diameter to Girth Requirements

Girth (m)	Minimum root ball diameter to extract (m)
<0.1	0.4
0.1–0.2	0.6
0.2–0.3	0.8
0.3–0.4	1.2
0.4–0.5	1.5
>0.5	To be determined by Arborist

Flora Management Programme should include the following works:

- **Verification and Review of Footprints for Hoarding, Access Roads and Soil Investigation Works**
 - After the worksite hoarding has been installed, the Flora Specialist shall conduct an inspection to verify that the footprint is as proposed, and that no excessive vegetation and tree removal has occurred as a result of deviations in the hoarding alignment.
 - The Flora Specialist shall review the proposed locations for the soil investigation works and the alignment of the construction access roads with the Client/Contractor. Feasible alternatives, if possible, shall be proposed to minimise vegetation and tree clearance.
- **Weed and Invasive Species Management**
 - Weeds and invasive species shall be cleared from the Project area progressively and shall be separated and transported to an appropriate disposal location. Transport shall occur within a covered vehicle to ensure seed/vegetative matter does not dislodge. All vegetative matter and seeds will be rendered inert at the disposal location through incineration at a licensed waste disposal facility. The Project area shall

be carefully cleared of all remaining vegetative matter from the weeds/invasive species. Herbicides may be used to render any stumps/root systems inert. The cleared area shall be inspected on a monthly basis to detect any seedlings of invasive species. These seedlings shall be killed using approved herbicides or removed by hand weeding. Any seedlings or vegetative matter that may sprout will be disposed of at a licensed waste management facility.

- Specific measures shall be undertaken to control and manage flora species within the Project area that have been identified to be invasive (i.e., *Spathodea campanulata*, *Cecropia pachystachya*, *Falcataria moluccana*). The Ecologist shall be consulted when managing *Falcataria moluccana* groves as tall trees may serve as nesting sites for birds of prey. The Ecologist shall also be consulted for other weed and invasive species that may also provide important foraging resources. Material imported into the Project area shall be checked for contamination from weeds/invasive species seeds/vegetative matter at source. This is particularly important for imported building materials, such as clay and soil. Source site shall be inspected to determine presence of weeds/invasive species. Where weeds or invasive species are identified, alternative supply sources or decontamination shall occur before the material is transported to site.
- **Reforestation Planting Palette and Plant Salvaging for Reforestation and Landscaping**
 - The planting palette including all flora and grasses used for reforestation and other landscape planting will be from native indigenous stock or non-native species that are not listed as weeds or invasive species or have a low seeding rate. Native indigenous stock can come from salvaged, transplanted and/or pre-grown specimens or potentially from project involving site clearance. However, when such Native indigenous stock is not available, it is also possible to obtain stock from neighbouring countries such as Malaysia.
 - All trees transplanted into the Project area shall have local provenance or will be from within the Johor region for all SRDB and IUCN listed species. Other species shall be obtained within the larger Sunda region. Due diligence shall be conducted on suppliers to ensure that the trees are obtained by legal means and are able to be exported/imported to Singapore. All imported trees shall be inspected and/or undergo quarantine if required to reduce the chance of transmission of weeds and soil pathogens.
 - The success of planting within landscape features shall be monitored. Where a planting strategy is not working, an alternative planting strategy shall be developed suitable for the location. Temporary measures shall be employed to reduce stress on planted individuals. The removal of sources of stress (such as dust) may also be required. If disease outbreaks are present, methods shall be used to control the outbreak or remove the diseased individual.
 - The flora specialist shall also identify other plant material, including ferns, epiphytes, orchids, shrubs, grasses, etc. that are of conservation value and work with NParks for the extraction of these plants by NParks to other sites.
 - The flora specialist shall formulate a salvaging protocol in consultation with NParks if salvaging of plant material is being carried out on site.

The flora specialists, arborists and the Arboriculture Contractor engaged should meet the expected qualifications as described in Section 13.4.4.4, Section 13.4.4.2 and Section 13.4.4.3 respectively.

Additionally, the Contractor should fulfil the following:

- The Contractor and the attending arborist shall complete the 'Verification of Tree Protection Checklist' prior to the start of site clearance (refer to Appendix W: Annex A).
- The Contractor shall instil discipline and raise awareness amongst all personnel on measures and mitigations to prevent damage to retained and protected trees throughout construction by including reminders on tree conservation guidelines within their daily toolbox briefings to workers and crane/excavator operators.

13.6.1.3 Fauna Monitoring Programme

Fauna monitoring surveys should comprise of transect surveys and site inspection surveys conducted together, at within and outside of hoarded areas. The programme should include the conducting of monthly diurnal and nocturnal fauna and site inspection surveys beginning one month prior to construction.

13.6.1.3.1 Faunistic Surveys

Faunistic surveys are recommended to be conducted along terrestrial sampling routes and aquatic sampling points undertaken during the baseline studies (Figure 13-4 and Figure 13-5). This will include diurnal and nocturnal surveys, and terrestrial transect will have to be conducted in reverse direction on alternate months. All fauna encountered shall be identified to species, or the lowest taxonomic level possible. The locations of all fauna

sightings shall be recorded using a handheld GPS. Important behavioural observations (e.g., displaying, guarding, mating, ovipositing) and plant species that the fauna was observed to be feeding, laying eggs, or nesting on, shall be recorded.

Subsequently, camera trap monitoring will also be installed and maintained for the purpose of monitoring impacts to fauna species within the study site during construction phase. Camera traps will be situated as closely as possible to those deployed during construction monitoring. In the event camera trap location falls within worksite, monitoring location would be removed. The camera traps will be deployed at approximately 20–30 cm above ground. They should be operational 24 hr a day and programmed to record a 10-s footage per trigger with a 10-s quiet period following each trigger. Camera trap maintenance and data retrieval should be carried out at least once a month.

All methodology for the faunistic surveys should closely follow that implemented for this impact study as summarized in Table 13-2, so as to ensure that the data collected can be used to compare against the baseline data. Comparison of species presence can be made with the baseline studies, where appropriate, to provide an indication of the changes in fauna diversity. Details of the surveys should be determined in consultation with NParks and should take into account construction phases, final construction footprint, final development hoarding plan, and baseline studies.

Surveys should target the following fauna groups detailed in Table 13-2.

Table 13-2 Summary of Survey Methods for Each Faunal Group

Faunal Group	Survey Timing (h)	Description
Odonates	0900–1600	<ul style="list-style-type: none"> Diurnal visual encounter surveys along terrestrial sampling routes and aquatic sampling points.
Butterflies	0900–1600	<ul style="list-style-type: none"> Diurnal visual encounter surveys along the terrestrial sampling routes.
Freshwater Decapod Crustaceans And Fish	0900–1600	<ul style="list-style-type: none"> Diurnal visual encounter surveys along terrestrial sampling routes and aquatic sampling points.
Herpetofauna (Amphibians And Reptiles)	0700–1600, 2000–0000	<ul style="list-style-type: none"> Diurnal and nocturnal visual encounter surveys along terrestrial sampling routes and aquatic sampling points.
Birds	0700–1000, 2000–0000	<ul style="list-style-type: none"> Diurnal and nocturnal visual and auditory encounter surveys along the terrestrial sampling routes
Non-Volant Mammals	0700–1000, 2000–0000	<ul style="list-style-type: none"> Diurnal and nocturnal visual and auditory encounter surveys along terrestrial sampling routes 18 terrestrial camera traps (i.e. 6 locations in Maju Forest and 12 in Clementi Forest) deployed across the Study Areas
Bats	2000–0000	<ul style="list-style-type: none"> Acoustic recording along terrestrial sampling

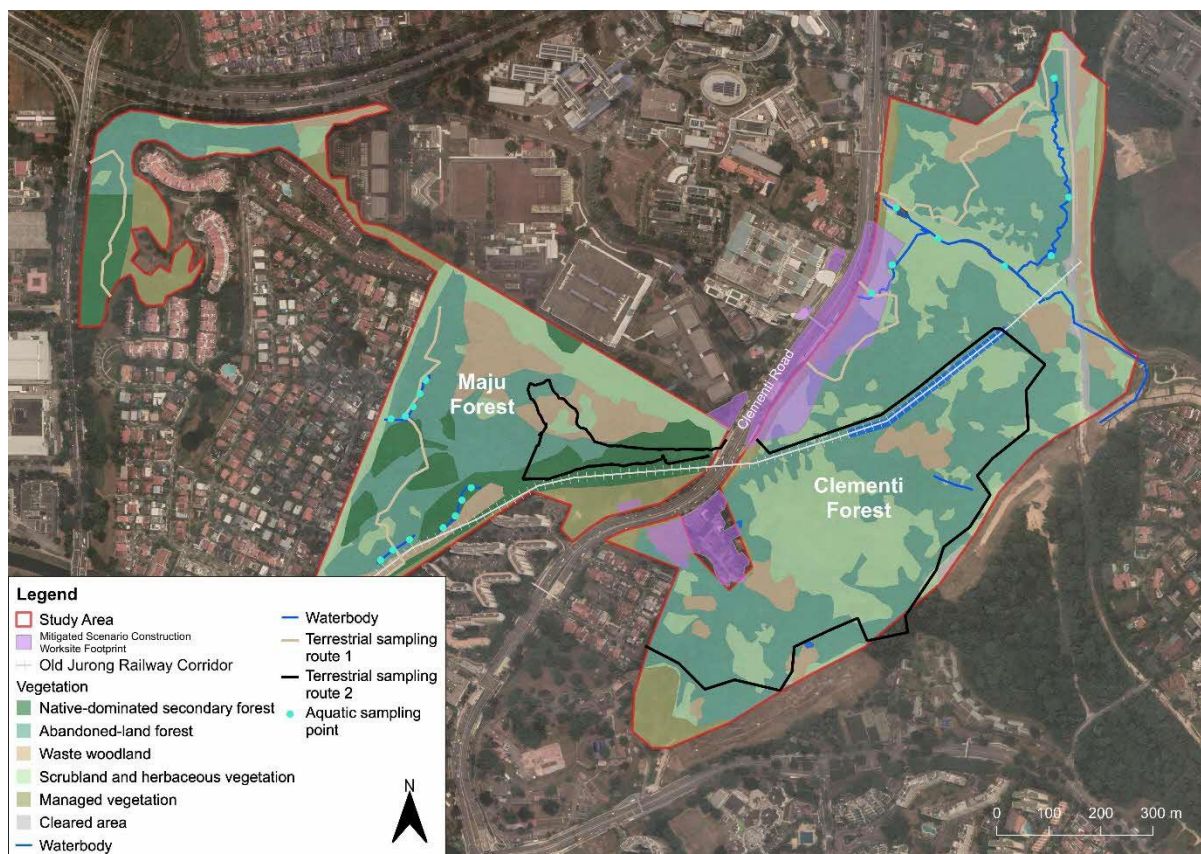


Figure 13-4 Terrestrial Sampling Routes and Aquatic Sampling Points at Maju Forest and Clementi Forest

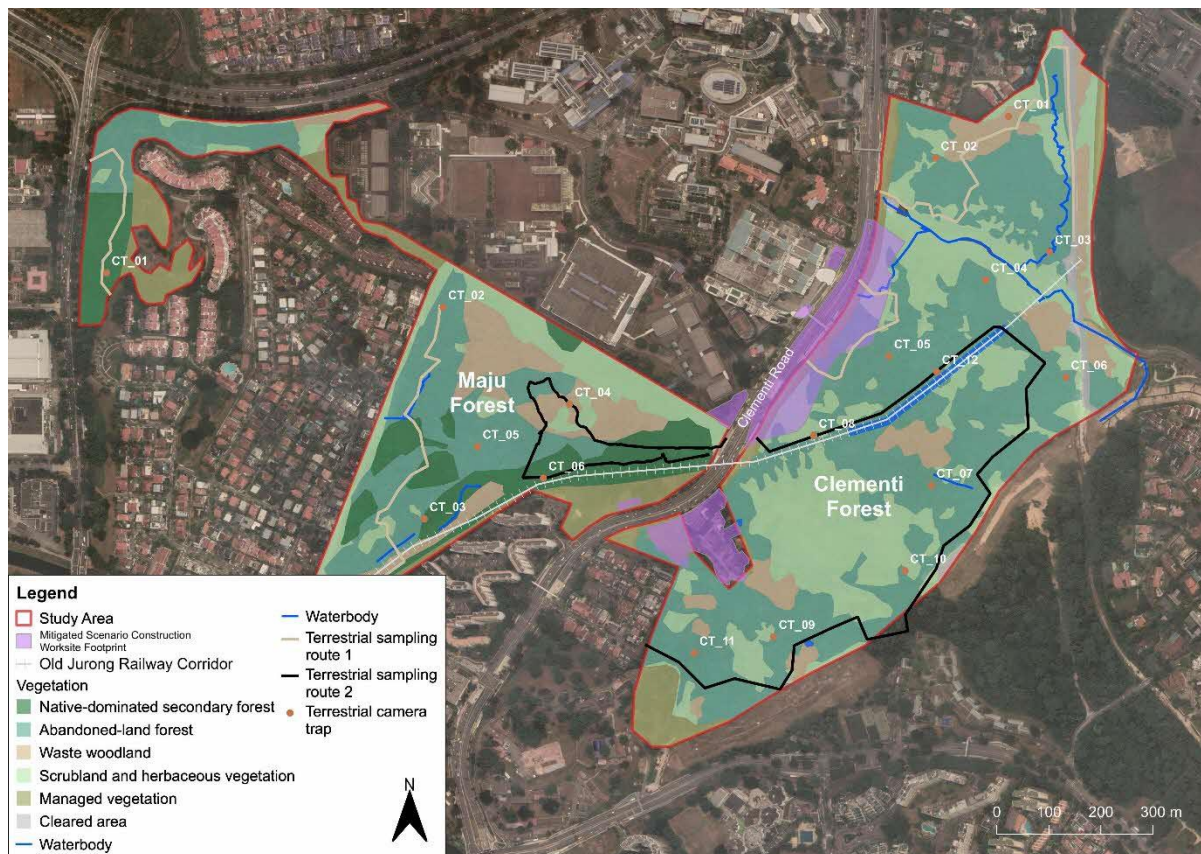


Figure 13-5 Locations of Terrestrial Camera Traps in Maju Forest and Clementi Forest

13.6.1.3.2 *Site Inspections*

Monthly fauna inspections shall be conducted by the Ecologist within the worksite boundary. The following shall be noted during the inspections (Figure 13-6):

- Visual inspection of sensitive habitats in the vicinity (e.g., streams, forests) to determine if the construction has damaged or affected them.
- Presence of trapped/injured/dead fauna.
- Potential fauna entrapments (e.g., ECBs, TPZs, pits, drains, ponds, trenches, tanks).
- Gaps in hoarding that may allow entry of ground-dwelling fauna.
- Improperly disposed/stored food and food packaging.
- Degradation of adjacent sensitive habitats (e.g., streams, forest).
- Daily roadkill surveys shall be conducted by the ECO along roads adjacent to the worksite, up to 500 m from the worksite boundary. A roadkill and investigation register shall be maintained. Appropriate mitigation measures shall be implemented where necessary.
- Reporting and documentation of all findings and recommendations
- Visual inspection of sensitive habitats in the vicinity (e.g., streams, forests) to determine if the construction has damaged or affected them
- Presence of trapped/injured/dead fauna
- Potential fauna entrapments (e.g., ECBs, TPZs, pits, drains, ponds, trenches, tanks)
- Gaps in hoarding that may allow entry of ground-dwelling fauna
- Improperly disposed/stored food and food packaging
- Degradation of adjacent sensitive habitats (e.g., streams, forest)
- Daily roadkill surveys shall be conducted by the ECO along roads adjacent to the worksite, up to 500 m from the worksite boundary. A roadkill and investigation register shall be maintained. Appropriate mitigation measures shall be implemented where necessary.
- Reporting and documentation of all findings and recommendations.



Figure 13-6 Photographs Showing Monthly Fauna Monitoring and Inspection On-Site

13.6.1.4 Fauna Management Programme

Fauna management will consist of managing fauna within and around all designated work areas. It consists of pre-site clearance inspections and continued biodiversity awareness training for the site team, tree felling inspections, and fauna response plan in event of animal encounters. The objectives of fauna management are as follows:

- Minimise negative impacts to fauna, particularly to species of conservation interest;
- Inspect hoarded areas for any compromises that may allow smaller-sized animals to enter;
- Prevent human-wildlife conflicts;
- Monitor presence of trapped/injured/dead fauna inside hoarded areas;
- Monitor and compare presence of targeted fauna groups within and outside of hoarded areas; and
- During each survey, fill out Fauna Inspection Form (Appendix V).

13.6.1.4.1 Biodiversity Awareness Training

The Ecologist shall conduct toolbox briefings on biodiversity awareness to inform site personnel of but not limited to the following:

- Ecological value of the site and its surrounding habitats
- Types of fauna present
- Biodiversity protection strategies
- Site personnel's responsibilities towards biodiversity
- How to respond to fauna encounters
- No feeding of wildlife
- Prevention of roadkill
- Inspection of trees before felling

All site personnel shall undergo biodiversity awareness training prior to commencing work at on-site, and regularly (every six months) throughout the duration of the construction. Documentation of such trainings and briefings shall be maintained.

13.6.1.4.2 Fauna Management Pre-Site Clearance

- The objective of fauna management pre-site clearance is to remove target fauna from the worksite before construction works begin to prevent fauna entrapment, injury and mortality, whilst minimising contact between human and wildlife.
- Target fauna species include ground-dwelling mammals such as the Wild Pig (*Sus scrofa*) and Sunda Pangolin (*Manis javanica*), as well as animals that may be implicated in human-wildlife conflicts (e.g., snakes) during passive wildlife shepherding.
- Sapling harvesting, if necessary, should be carried out prior to site clearance.
- Hoarding Installation
 - Hoarding installation shall be completed by the Contractor, leaving a 2–6-m wide gaps as the wildlife exit point. The wildlife exit point shall be located away from roads. The suitability of the exact location of the exit point shall be confirmed on-site by the Ecologist to ensure that shepherded fauna can exit into a forested area with ample cover to minimise stress and the possibility of roadkill.
 - The hoarding shall be at least 2.4-m high, with the surface facing the worksite coloured in white so that it is visually apparent to fauna.
 - The sequence of the hoarding installation shall be reviewed by the Ecologist to ensure that disturbance generated by the hoarding installation activities does not cause fauna to venture onto adjacent roads.
 - After hoarding installation is completed, the Ecologist shall inspect the hoarding to ensure its integrity and ability to prevent fauna entry/exit.
- Pre-site Clearance Camera Trap Monitoring
 - Camera traps shall be deployed within the hoarded worksite at a density of approximately one camera trap per 1 ha over a period of at least seven days prior to site clearance. Additional camera traps may be needed on request from NParks or Ecologist.
 - The camera traps shall be approximately evenly spaced throughout the worksite and targeted at strategic locations with signs of fauna use (e.g., clearings, burrows, nests).
 - The camera traps and the data shall be retrieved one to two days before the day site clearance is slated to commence to determine the species that are likely to be encountered during the site clearance.
 - Prior to site clearance, site clearance personnel shall be briefed by the Ecologist on species that are likely to be encountered during site clearance to prepare them for efficient response during encounters.
- Pre-site Clearance Fauna Inspection
 - Prior to site clearance, the Ecologist shall conduct a fauna inspection to identify active animal nests, hollows, other nesting structures, and any animals that may potentially get trapped/injured or die during site clearance (e.g., snakes, Sunda pangolin, bamboo bats). Animals that may be implicated in human-wildlife conflict (e.g., snakes) shall also be identified.
 - Refer to Figure 13-7 for a sample of pre-felling inspection protocol. Refer to Appendix X for Pre-felling Inspection Form.
 - The validity of the inspection shall be no more than seven days.

- Where fauna is found to be present on vegetation to be cleared, the affected vegetation shall be marked with coloured tags/tape. The fauna shall be allowed to leave on their own prior to vegetation clearance. Where eggs, chicks, or young fauna are found in nests, they shall be allowed to fledge or leave the nests on their own prior to vegetation clearance. The Ecologist shall conduct subsequent checks to ascertain that the fauna has left prior to vegetation clearance.
- Where it is not possible or ideal to allow the fauna to leave on its own (e.g., a stranded Sunda pangolin that is unable to move away on its own, a venomous snake that is feasible to catch) relocation shall be considered and implemented by certified Wildlife Management Contractors, in consultation with NParks and in accordance with the Fauna Response Plan.
- Where the Ecologist deems there is a risk of injury/death to fauna even though there were no immediately apparent findings during the inspection (e.g., nest in good condition but fauna activity not observed/visible), the Ecologist shall be present on-site during the removal of the affected vegetation to facilitate the implementation of the Fauna Response Plan where necessary.
- Elevating equipment shall be deployed where necessary and feasible to inspect nests, hollows and other nesting structures.
- Ecologist shall submit an inspection report indicating the date of the inspection, tree tag number (and/or location coordinates if untagged), observations, recommended mitigation measures, and photographic evidence within 24 h of the inspection.
- Where bamboo clusters are to be removed, the following steps shall be carried out:
- The Ecologist shall determine if the affected clusters are potential roosting sites for bamboo bats (*Tylonycteris* spp.).
 - If determined to be a potential roosting site, the Ecologist shall carry out a bamboo bat roost emergence survey to determine the presence of bamboo bats. The roost emergence survey shall be carried out at least once for each bamboo cluster. The surveys shall occur between 1830–2100 h, during which two to three Ecologists shall be stationed around each bamboo cluster to observe for bamboo bat activity, and to identify slits in the bamboo stems that are used as roosts. Torches shall be used to aid in the detection. Stems bearing active slits shall be marked, and the number of bats residing within each slit shall be documented.
 - Bat detectors shall be deployed to detect the ultrasonic echolocation calls to aid in species identification.
 - If bamboo bats are determined to be present in the affected bamboo clusters, they should be rescued and released. Prior to the removal of the bamboo clusters, the Ecologist shall seal the slits of identified roosts with mesh and tape if feasible, and the section of the bamboo stem bearing the roost shall be cut with a chainsaw or hand saw and lowered in a controlled manner, ensuring that the section remains intact. The bamboo bats shall be held in the extracted bamboo stems if they are still intact. If not, the bamboo bats shall be vacated into individual cloth bags.
 - The remaining stems of the bamboo cluster shall be cut stem by stem manually (e.g., chainsaw, hand saw, parang) where feasible and deemed safe to do so. Where manual cutting is not feasible, a grabber excavator may be used to remove the stems bit by bit from the base of the cluster. The stems shall be kept as intact as possible during felling. Each felled stem shall be inspected immediately by the Ecologist for holes those are possibly entrances to roosts of the bamboo bats. All bamboo bats found occupying the bamboo stems shall be held within the bamboo stems if they are still intact. Mesh and tape shall be used to seal the holes of the roosts. If bamboo stems are too damaged to be sealed, the bamboo bats shall be vacated into individual cloth bags.
 - If bamboo bats are not determined to be present during the roost emergence survey, the Ecologist may also recommend for the Ecologist to be present during the removal of the bamboo cluster to inspect each stem for roosting bamboo bats.
 - After the bamboo clusters and felled stems have been completely removed from the worksite or destroyed, any rescued bamboo bats shall be released on the spot and tracked visually until out of sight. If the felling of a bamboo cluster cannot be completed by the end of the day (i.e., 1800 h), any rescued bats shall also be released.
 - Should trapped/injured/dead bats be encountered, the Fauna Response Plan shall be activated.
 - Bat handling shall be performed by experienced personnel properly trained in bat handling techniques.

- Passive wildlife shepherding involves directional site clearance within the hoarded worksite towards a forested wildlife refuge area (Figure 13-8). The disturbance generated by site clearance activities is expected to encourage target fauna to move out of the worksite on their own.
 - Where feasible, site clearance shall be scheduled to avoid the peak bird breeding season (March to July)
 - A camera trap shall be placed outside of the wildlife exit point throughout the duration of site clearance to monitor entry/exit of target fauna.
 - Site clearance shall begin furthest from the exit point and gradually move towards the exit point to flush fauna out of the worksite.
 - The wildlife exit point shall be opened by the Contractor before the start of site clearance works each day and closed at the end of each workday and during breaks to prevent fauna from returning to the worksite.
 - Horticultural waste shall be removed on the same day to prevent fauna from using it as shelter.

13.6.1.4.3 Fauna Management Post-Site Clearance

- After site clearance is completed, the Ecologist shall conduct a visual inspection of the cleared worksite for target fauna.
- If there are no trapped fauna, the wildlife exit point shall be sealed and the camera trap at the wildlife exit point shall be removed.
- If there are trapped fauna, the Ecologist shall formulate species-specific methods to remove them in consultation with NParks and in accordance with the Fauna Response Plan.

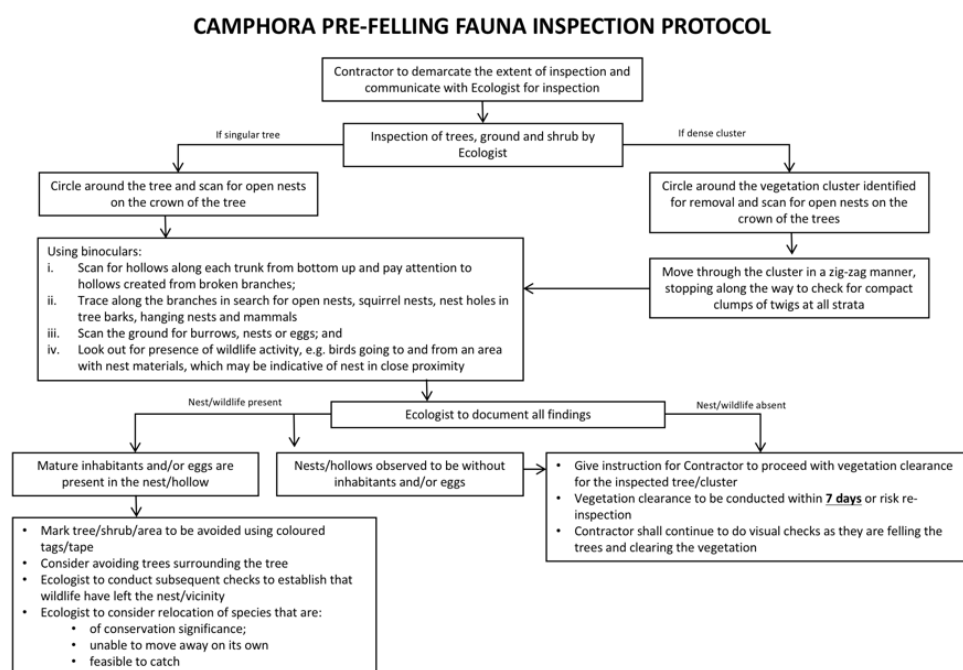


Figure 13-7 Pre-felling Inspection Protocol.

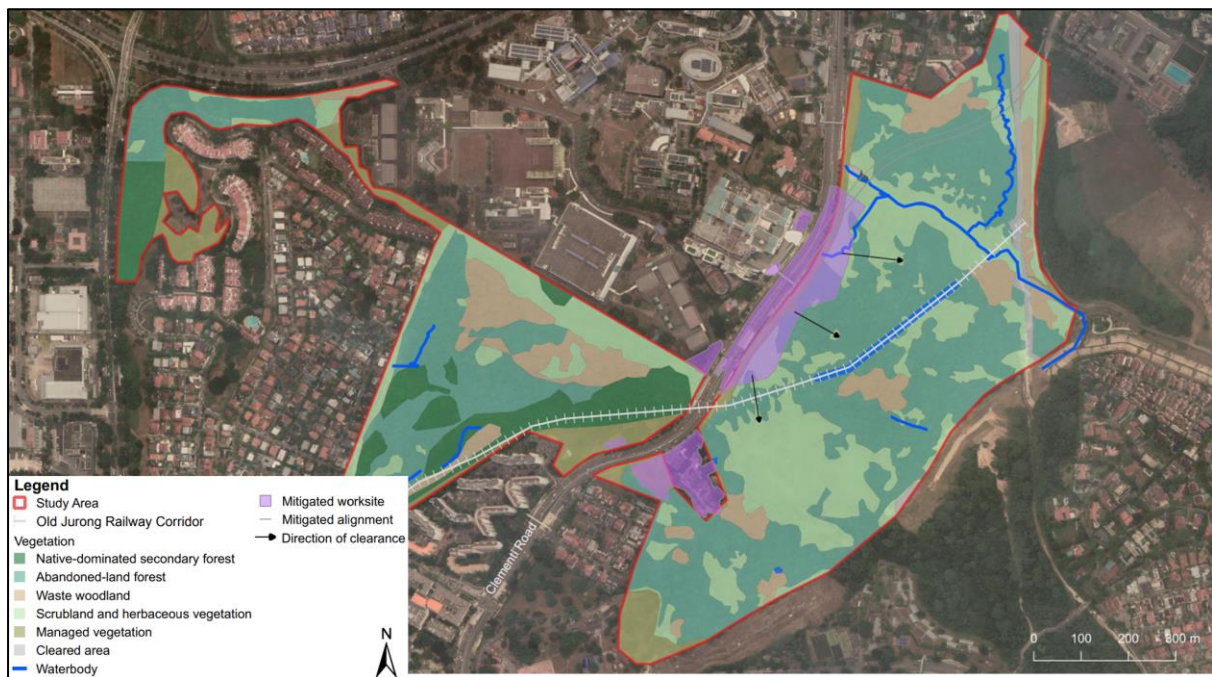


Figure 13-8 Direction of Clearing for Passive Wildlife Shepherding

13.6.1.4.4 Fauna Response and Rescue Plan

The Fauna Response and Rescue Plan should be enacted when a trapped/injured/dead/dangerous animal is encountered around or within the worksite. The objective of the wildlife response plan is to minimise animal injury and mortality by responding appropriately to the different scenarios in Figure 13-9. This should be emphasized during the toolbox briefings. All wildlife encounters are to be documented within 24 h using the Wildlife Incident Form (Appendix U).

Where species of conservation significance are affected by the development, relocation works should be planned (e.g., bamboo bats). where fauna is trapped on-site, options should be explored to remove them from site (e.g., partitioning worksite, use of one-way exit door) (Figure 13-10).

In scenarios where certain animal groups are encountered around or within the worksite, external specialists may be contacted to handle the animal. These scenarios are shown below:

- For encounters with snakes that require relocation/handling, a snake specialist should be contacted
- For animal carcasses that require disposal, an animal carcass disposal service should be contacted
- For injured animals that require medical attention, a veterinarian should be contacted

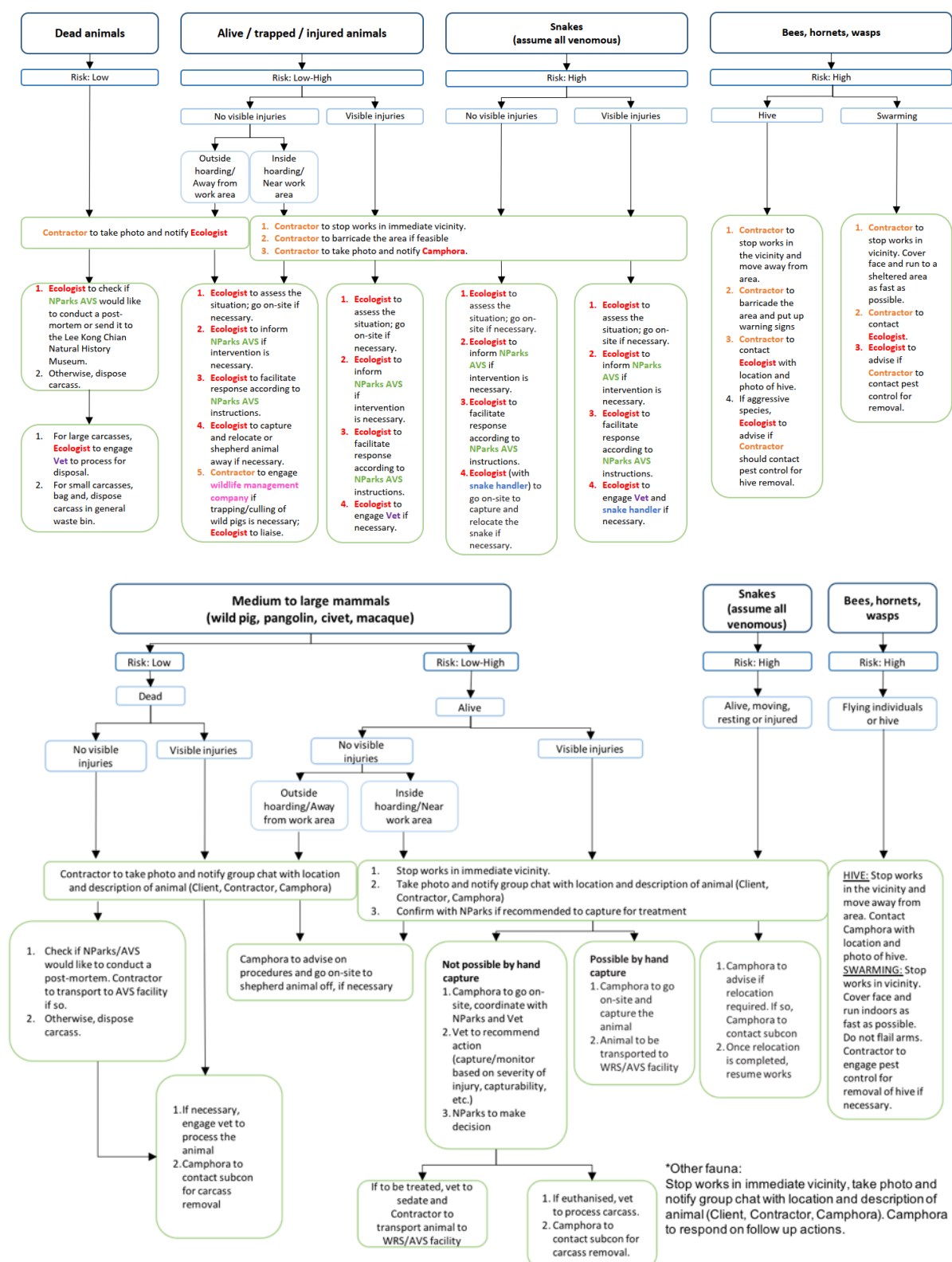


Figure 13-9 Flowchart of the Wildlife Response Plan



Figure 13-10 Example of One-Way Flap Door to Allow Fauna to Exit Independently

13.6.1.4.5 Light Management

Night-time works should be avoided to prevent disturbance to nocturnal fauna. It is recommended to restrict working hours to 0700–1900h. Other light management measures include:

- The Contractor shall submit a site lighting plan (detailing the type of lights, specifications, numbers, locations, and direction) for all anticipated night works as part of the contract-specific EMMP.
- All lighting shall be directed away from adjacent forested areas. Upward and directional lighting into unintended areas shall be avoided.
- Where lighting is required to be installed for safety and security purposes, regulatory requirements shall be followed.
- Reduce the duration of nocturnal lighting sources by using a timer or movement-based sensor system to turn off lights.
- Lights that have a high UV component shall be avoided to reduce impacts on insects.
- Broad spectrum lights shall be avoided.
- Provide mitigation measures such as covers and shields where possible.
- The Ecologist shall conduct regular checks to ensure that lights are positioned as proposed.
- The lux levels in adjacent forested areas should be monitored. A baseline should be established at least one month before the start of any works, including pre-site clearance works. There should be at least eight light monitors, four 5 m away from worksite and four 30 m away from worksite. Locations to be decided in consultation with NParks prior to start of any works. Data collected as baseline should be used as a comparison during construction phase to ensure that light levels do not exceed those that recorded in the baseline study.

13.6.1.4.6 Other General Fauna Management Measures

Besides, the Contractor shall be responsible in implementing the other general fauna management measures which include:

- The Contractor shall visually inspect the worksite for wildlife prior to the start of construction activities each day.
- The Contractor shall maintain the integrity of the worksite hoarding and repair any damages/breaches on a timely basis.
- Upon encountering trapped/injured/dead/dangerous fauna, the Contractor shall respond in accordance with the Fauna Response Plan.
- The Contractor shall not touch or handle any fauna unless instructed to do so.
- The Contractor shall implement all mitigation measures recommended by the Arborist, Flora Specialist, and Ecologist, as far as practicable.

- The Contractor shall ensure that all personnel and external visitors limit their movements and activities (including non-work activities such as resting and eating) to within the worksite boundary. There shall be strictly no movements into adjacent forested areas.
- Graphical representations of but not limited to the following shall be posted around the worksite:
 - No feeding of wildlife
 - No fishing
 - No littering
 - No food or drinks (outside designated eating areas)
 - No cutting of trees or plants
 - No smoking (outside designated smoking areas)
- The Contractor shall deploy only 100% biodegradable ECBs.
- The Contractor shall provide designated sheltered eating areas that are wildlife-proof.
- The Contractor shall provide fully covered food storage areas that are wildlife-proof.
- The Contractor shall ensure that all pits, drains, ponds, trenches, tanks that are potential fauna entrapments are suitably covered (e.g., using plywood, mesh, tarpaulin) to prevent fauna from falling in.
- The Contractor shall trim overhanging vegetation above the worksite hoarding to prevent arboreal fauna from entering the worksite.
- Areas not used should be returned to earth ground and replanted if possible. Planting scheme should be as similar to forest composition to adjacent forest, if not as native as possible. Other than minimising edge effects, it can serve as a natural barrier to light, noise and dust to reduce disturbance. As a general guide, 400 trees should be replanted for every hectare to be reinstated.

13.6.2 Commissioning Phase

At the commissioning phase, arboricultural services and management of flora and fauna are typically not expected. However, regular flora and fauna monitoring for at least six months should still be considered and conducted during the commissioning phase. This is to review the effectiveness of mitigation measures proposed during design phase and rectify biodiversity problems that arise due to operational works.

13.6.2.1 Flora Monitoring Programme

The flora monitoring aims to assess the impacts of operational works to surrounding vegetation and/or adjacent forest, and rectify issues when identified. The programme should include the following:

- Assess impact of operational on the physiological health and structural stability of vegetation and trees at proximity to the development;
- Determine whether there has been excessive and unauthorised removal of vegetation and trees beyond the development boundary;
- Monitor and assess potential edge effects (e.g., predictable failures, accelerated growth of climbers on canopy, change in species composition at the edge) within vegetation adjacent to the development;
- Determine if there was unauthorised dumping of rubbish (e.g., food materials), construction debris and materials, oil/chemical leakage that may contaminate soil watercourses, from post-construction water bodies post-construction.

13.6.2.2 Fauna Monitoring Programme

The fauna monitoring aims to assess the impacts of operational works to fauna residing within adjacent forest, and rectify issues when identified. The programme should include faunistic surveys. Faunistic surveys are recommended to be conducted along terrestrial sampling routes and aquatic sampling points, and should target the following fauna groups: odonates (dragonflies and damselflies), fish, decapoda, butterflies, herpetofauna (amphibians and reptiles), birds, and mammals. Comparison of species presence can be made with the baseline studies (Figure 13-4 and Figure 13-5), where appropriate, to provide an indication of the changes in fauna diversity.

The methodology for the faunistic surveys should closely follow that implemented for this EIS, so as to ensure that the data collected can be used to compare against the baseline data and data from construction monitoring (Table 13-2).

13.6.3 Operational Phase

At the operational phase, the Rail Operator shall ensure minimum controls stated in Section 13.3.3 are adhered to. In addition, as a practice, disturbance should be kept to a minimum.

13.7 Hydrology and Surface Water EMMP Requirements

13.7.1 Construction Phase

13.7.1.1 Monitoring Before Commencement of Site Clearance

One (1) time monitoring for hydrology and surface water quality should be conducted before the construction commencement as a baseline reference for the EMMP.

Prior construction, the hydrological conditions of drainage system within construction worksite and at immediate vicinity should be monitored and inspected especially during heavy storm event to ensure no flooding. For surface water quality, the baseline monitoring parameters should follow Table 13-4. All the discharge points from construction worksites should follow NEA's Allowable Limits for Trade Effluent Discharge to Sewer/Watercourse/Controlled Watercourse. Meanwhile, the water quality of sensitive streams (i.e. D/S1 and D/S22 shown in Figure 13-11, should also be recorded and compared with the water quality criteria for aquatic life as listed in Table 13-3 to make sure the aquatic condition will not be impacted by the construction activities.

Table 13-3 Water Quality Guidelines and Criteria

Parameter	NEA Trade Effluent Discharge Limits ¹	International Water Quality Criteria for Aquatic Life ²
pH	6 - 9	6.5 - 9
Temperature (°C)	45	-
Conductivity (µS/cm)	-	-
Total Dissolved Solids, TDS (mg/L)	1000	1000
Dissolved Oxygen, DO (mg/L)	-	> 4.0
Turbidity (NTU)	-	50
Total Suspended Solids, TSS (mg/L)	30 SDA: 50 ⁶	50
Biological Oxygen Demand, BOD ₅ (mg/L) ³	≤ 20	3
Chemical Oxygen Demand, COD (mg/L)	≤ 60	25
Total Phosphorous, TP (mg/L)	-	Eutrophic limit: 0.075 mg/L
Orthophosphate, PO ₄ -P (mg/L)	0.65 (equivalent to 2 as PO ₄)	0.033 (equivalent to 0.1 as PO ₄)
Total Nitrogen, TN (mg/L)	-	Eutrophic limit: 1.5 mg/L
Nitrate, NO ₃ -N (mg/L)	4.52 (equivalent to 20 as NO ₃)	10 (equivalent to 44 as NO ₃)
Ammoniacal Nitrogen (NH ₄ -N)	-	0.5
Total Organic Carbon (TOC)	-	-
Total Alkalinity	-	-
Oil & Grease - Total (mg/L)	1	0.14
Oil & Grease - Hydrocarbon (mg/L)	-	-
Lead, Pb (mg/L)	0.1	Acute LOEL ⁵ : 82 Chronic LOEL ⁵ : 3.2
Zinc, Zn (mg/L)	0.5	0.0085
Mercury, Hg (mg/L)	0.001	0.00016
Enterococcus (cfu/100mL) ⁴	-	-

Note:

1. NEA Trade Effluent Discharge Limits for discharge into a controlled watercourse.
2. The sources of international water quality criteria for aquatic life include United Nations Economic Commission for Europe [R-2], United States Environmental Protection Agency [R-3], Australian & New Zealand [R-4], Canada [R-5], Philippines [R-1], and Malaysia [R-6].
3. BOD₅ is the amount of dissolved oxygen needed by aerobic biological organisms to break down organic material per litre of sample during 5 days of incubation at 20 °C.
4. Enterococcus counts should follow the Singapore's Water Quality Guidelines for Recreational Beaches and Fresh Water Bodies (i.e. ≤ 200 cfu/100mL)

Parameter	NEA Trade Effluent Discharge Limits ¹	International Water Quality Criteria for Aquatic Life ²
5. LOEL – Lowest Observed Effect Level		
6. The limit value is for TSS discharge into storm water drainage system (i.e. ECM discharge) which referred from Sewerage and Drainage (Surface Water Drainage) Regulations.		

13.7.1.2 Monitoring Throughout Construction Period

In order to ensure that procedures are followed appropriately, the construction phase of the Project should be accompanied by an EMMP.

Water quality monitoring is essential as discharge of excess contaminants, especially pH, nutrients and heavy metals, may lead to severe consequences (e.g. algae blooms). Discharges via detention ponds/tanks will take place during the construction phase, therefore monitoring of detention pond/tank discharge waters was recommended to be undertaken to complement surface water quality to assure compliance with the relevant standards. In addition, due to the ecological importance of streams such as D/S1 and D/S22 as shown in Figure 13-11, it was also recommended to monitor the water quality throughout the construction period to ensure minor construction impacts on the water quality. For all discharge points from construction worksites, it is recommended to monitor water quality following Singapore NEA's Allowable Limits for Trade Effluent Discharge to Sewer/Watercourse/Controlled Watercourse. Meanwhile, the water quality of sensitive natural streams should also be recorded and compared with the water quality criteria for aquatic life as listed in Table 13-3 to make sure the aquatic condition will not be impacted by the construction activities.

Table 13-4 Recommended Monitoring Program during Construction Phase (Surface Water Quality)

Test	Parameters	Monitoring Recommendation and Frequency
In-situ	Temperature	<ul style="list-style-type: none">Online real time monitoring for turbidity at the discharge point location at all the construction sites throughout the construction period.Monthly monitoring for temperature, pH, conductivity, turbidity, TDS and DO at all the discharge point locations at the construction sites throughout the construction period.Monthly monitoring for all the in-situ parameters at the sensitive streams including D/S1 and D/S22 throughout the construction period
	pH	
	Conductivity	
	Total Dissolved Solids (TDS)	
	Turbidity	
	Dissolved Oxygen (DO)	
Ex-situ	Total Suspended Solids (TSS)	<ul style="list-style-type: none">Monthly monitoring for all the ex-situ parameters at the discharge point if discharging into public drains during the construction periodMonthly monitoring for all the ex-situ parameters at the sensitive streams including D/S1 and D/S22 throughout the construction period
	Biochemical Oxygen Demand (BOD ₅)	
	Chemical Oxygen Demand (COD)	
	Total Nitrogen (TN)	
	Nitrate (NO ₃ -N)	
	Ammoniacal Nitrogen (NH ₄ -N)	
	Total Organic Carbon (TOC)	
	Total Alkalinity	
	Total Phosphorus (TP)	
	Orthophosphate (PO ₄ -P)	
	Oil & Grease (Total)	
	Oil & Grease (Hydrocarbon)	
	Lead (Pb)	
	Zinc (Zn)	
	Mercury (Hg)	
	Enterococcus	

Note: In addition to the above monitoring list, Contractor is to ensure that the discharge also complies to NEA's allowable limit for trade effluent discharge - in particular the limits for heavy metals (e.g. through monthly testing).

Beside the water quality monitoring, hydrological conditions of drainage system within construction site and at immediate vicinity should also be closely monitored during construction phase. Before draining to public drains or watercourses, surface runoff from the construction site should be drained to the treatment system to be filtered and to reduce peak runoff based on ECM Guidebook. The hoarding and perimeter drains of construction site should be inspected daily to ensure no surface runoff flowing out from the site untreated and no clogging which would affect

the flow capacity of the drains/streams. During heavy storm event, site inspection should be carried out to ensure no flooding. The discharge of pumped dewatered groundwater or other wastewaters to sensitive aquatic habitats shall be prohibited (e.g. natural streams within Clementi Forest and Maju Forest).

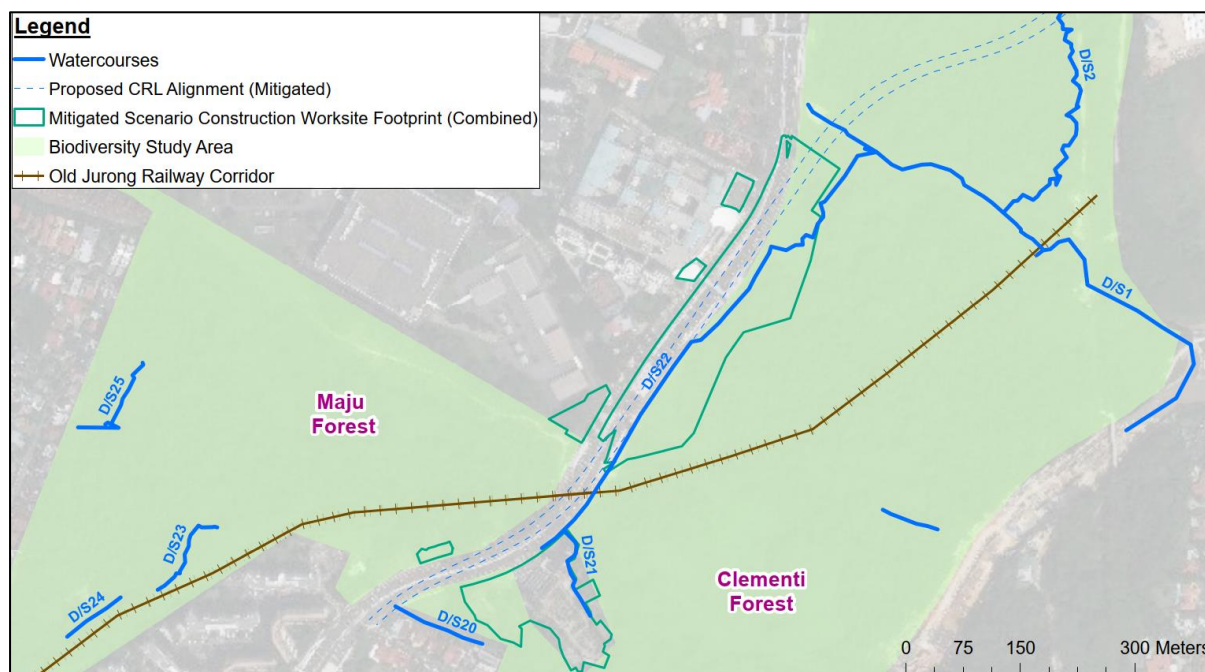


Figure 13-11 Watercourses at Clementi Forest and Maju Forest

13.7.2 Commissioning Phase

The commissioning phase of the Project should be accompanied by an EMMP to ensure the proposed development will have minor impact on the surrounding watercourses. Water quality monitoring is essential as discharge of excess contaminants, especially pH and suspended solids may lead to severe consequences (e.g. water with less clearance) due to the commissioning activities. Hence, due to the ecological importance of streams D/S1 and D/S22, it was recommended to monitor their water quality during the first three (3) months of commissioning phase to ensure minor impacts on their water quality. For main outlets/drains (if any) of the Project site, it is recommended to monitor water quality following Singapore NEA's Allowable Limits for Trade Effluent Discharge to Sewer/Watercourse/Controlled Watercourse. Meanwhile, the water quality of sensitive streams (i.e. D/S1 and D/S22) should also be recorded and compared with the water quality criteria for aquatic life as listed in Table 13-3 to make sure the aquatic condition will not be impact by the commissioning activities.

Table 13-5 Recommended Monitoring Program during Commissioning Phase (Surface Water Quality)

Test	Parameters	Monitoring Recommendation and Frequency
In-situ	Temperature	Monthly monitoring for all the in-situ parameters at the main outlets/drains (if any) of the Project site, as well as sensitive streams (i.e. D/S1 and D/S22) in the Clementi Forest during the first three (3) months of commissioning phase.
	pH	
	Conductivity	
	Total Dissolved Solids (TDS)	
	Turbidity	
	Dissolved Oxygen (DO)	
Ex-situ	Total Suspended Solids (TSS)	Monthly monitoring for all the ex-situ parameters at the main outlets/drains (if any) of the Project site, as well as sensitive streams (i.e. D/S1 and D/S22) in the Clementi Forest during the first three (3) months of commissioning phase.
	Biochemical Oxygen Demand (BOD ₅)	
	Chemical Oxygen Demand (COD)	
	Total Nitrogen (TN)	
	Nitrate (NO ₃ -N)	
	Ammoniacal Nitrogen (NH ₄ -N)	
	Total Organic Carbon (TOC)	
	Total Alkalinity	
	Total Phosphorus (TP)	
	Orthophosphate (PO ₄ -P)	
	<i>Enterococcus</i>	

For the hydrology monitoring during commissioning phase, drainage system within the site and at immediate vicinity should be inspected especially during heavy storm event to ensure no flooding. Routine audit on the site should be carried out during the first three (3) months of commissioning phase.

13.7.3 Operational Phase

During operational phase, hydrology and water quality monitoring and audit is not required.

In general, the Rail Operator shall ensure the implementation of minimum control measures according to the relevant legislations (e.g. PUB Code of Practice on Surface Water Drainage, Singapore Sewerage and Drainage (Trade Effluent) Regulations, SS 593: 2013 – Code of Practice for Pollution Control (COPPC), Environmental Protection and Management Act and its associated regulations etc., as listed in Section 14); as well as the proposed mitigation measures where the key ones are summarised in Section 13.13.2. General housekeeping and environmental management measures shall be applied.

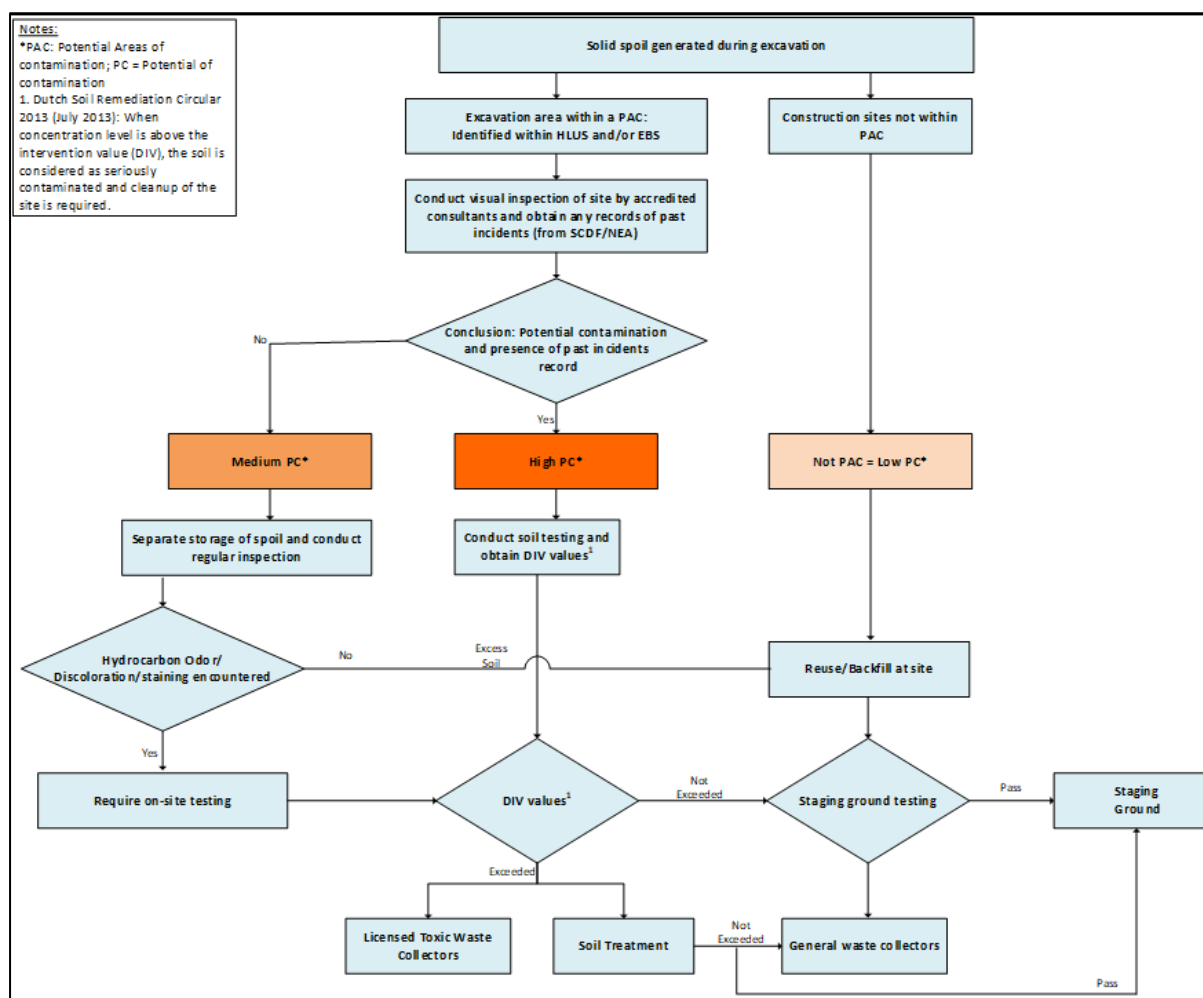
13.8 Soil and Groundwater EMMP Requirements

13.8.1 Construction Phase

A summary of the recommended monitoring for soil and groundwater during the construction phase is provided in the table below.

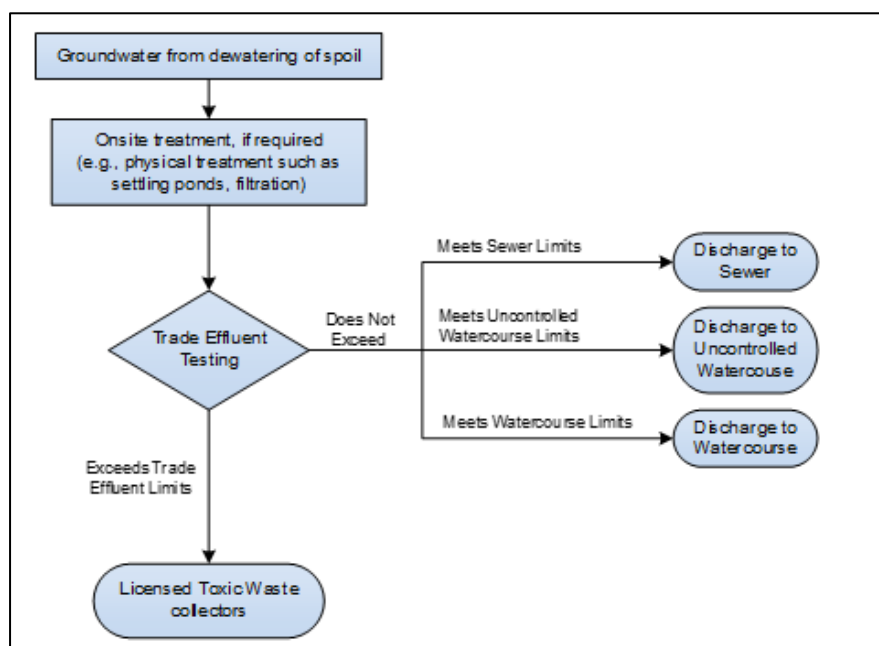
Table 13-6 Recommended Monitoring Program during Construction Phase (Soil and Groundwater)

Location	Parameters	Frequency and Duration
Within the development boundary	Groundwater level	<ul style="list-style-type: none"> Continuous monitoring of groundwater level throughout the lifetime of the construction phase as per the instrumentation and monitoring plan developed by the Qualified Professional (QP). Visual monitoring of spoil generated by the TBM to be conducted daily. Refer to Figure 13-12 and Figure 13-13 for procedures for screening and handling of suspected contaminated soils and groundwaters. Records on chemical waste from the waste generator should be properly kept and records produced when requested. Inspection of hazardous chemical/substances storage condition weekly during construction phase. Routine environmental audit by independent EMMP consultant during construction phase.
At locations within the Project site where excavated soil and extracted groundwater are generated and stored	Improper Management of Excavated Soil and Extracted Groundwater	
At locations within the Project site where toxic chemical waste is generated/stored	Toxic Chemical Waste Generation	
At locations within the Project site where hazardous chemicals/substances are used/stored	Improper Handling of Hazardous Chemical/Substances	



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

Figure 13-12 Screening and Disposal of Excavated Soils



Note: DIVs for groundwater consider risks to human health and local ecosystems, whichever is more sensitive. When assessing risk to human health, a typical Dutch residential land use setting is considered which includes exposure via potable consumption of groundwater and consumption of home-grown produce which are not common exposure scenarios for Singapore.

Figure 13-13 Disposal of the Groundwater Generated Through Dewatering or Inflow Into Excavations

13.8.2 Commissioning Phase

A summary of the recommended monitoring for soil and groundwater during commissioning phase is provided below in Table 13-7.

Table 13-7 Recommended Monitoring Program during Commissioning Phase (Soil and Groundwater)

Location	Parameters	Frequency and Duration
At locations within the Project site where toxic chemical waste is generated/stored	Toxic Chemical Waste Generation	Monthly monitoring records of the amount and type of toxic chemical waste generated during the first three (3) months of commissioning phase.
At locations within the Project site where hazardous chemicals/substances are used/stored	Improper Handling of Hazardous Chemical/Substances	Monthly inspection of hazardous chemical/substances storage conditions during the first three (3) months of commissioning phase.

13.8.3 Operational Phase

During operational phase of this Project, soil and groundwater monitoring and audit are not required.

It is assumed that the Rail Operator shall ensure the successful implementation of minimum control measures (examples shown in the Section 13.3.3). As the impact on soil and groundwater during the operational phase of this Project is assessed to be minor, no additional soil and groundwater mitigation measures are required in commissioning and operational phases.

13.9 Air Quality EMMP Requirements

13.9.1 Construction Phase

As noted in the mitigation measures (Section 13.13), dust monitoring shall be undertaken during the construction phase. Dust deposition monitoring is recommended due to the potential of High consequence dust impact conducted within the ecologically sensitive receptors during construction phase. Based on a review of sensitive receptors around the construction worksite areas, a continuous monitoring program as per Table 13-8 is proposed to be conducted during project construction. The Contractor is also recommended to conduct air quality monitoring of PM₁₀ and PM_{2.5} for 1 week prior to site clearance for the re-establishment of latest baseline conditions around the Project area.

Table 13-8 Recommended Monitoring Program during Construction Phase (Air Quality)

Location	Parameters	Frequency and Duration	Triggers
Monitoring at the following location: <ul style="list-style-type: none"> Clementi Forest Maju Forest 	PM ₁₀ and PM _{2.5}	Continuous monitoring of PM ₁₀ and PM _{2.5} for 1 week prior to site clearance averaged over 1-day period	-
	Dust Deposition in mg/m ² /day	Continuous monitoring of dust deposition during construction phase averaged over 4-week period	Investigation and corrective actions to be taken, when <ol style="list-style-type: none"> Any of the following documentation are found inadequate / missing: Air Pollution Control Plan; Compliance certificate of an Off-Road Diesel engine; or Monitoring Log. If the monitored PM₁₀ and PM_{2.5} exceed Singapore long term air quality targets. If the dust deposition monitored exceeds 200 mg/m²/day averaged over 4-week If complaints are received due to project activities.

Location	Parameters	Frequency and Duration	Triggers
			5. If visual non-compliance to any of the minimum control or mitigation measures are observed on-site.

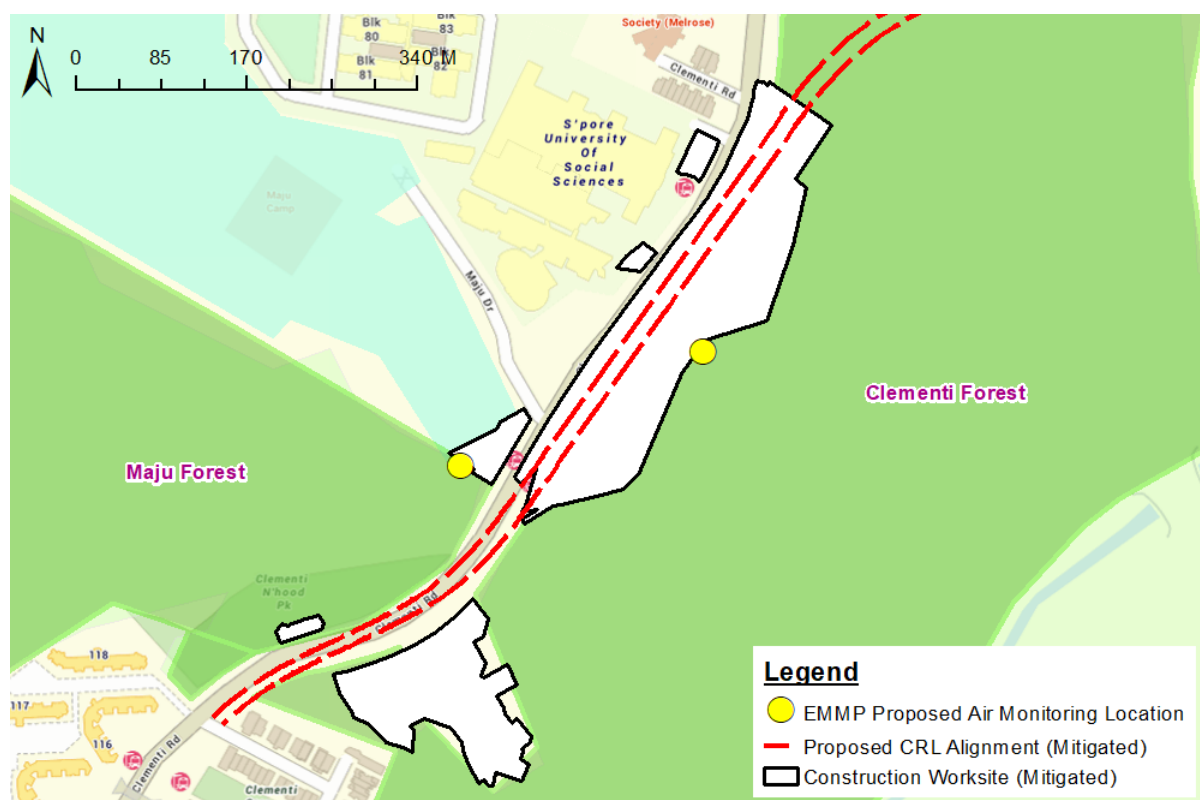


Figure 13-14 Proposed EMMP Air Monitoring Location at Clementi Forest and Maju Forest.

13.9.2 Commissioning Phase

During commissioning phase, ambient air quality monitoring may not be required.

13.9.3 Operational Phase

During operational phase, ambient air quality monitoring may not be required.

General housekeeping and environmental management measures shall be applied.

13.10 Airborne Noise EMMP Requirements

13.10.1 Construction Phase

The proposed noise monitoring locations and monitoring program as per Table 13-9 are presented in Figure 13-15, along with the noise barriers recommended as mitigation measures. Other key minimum control and key mitigation measures are summarised in Section 0.

Table 13-9 Recommended Monitoring Program during Construction Phase (Airborne Noise)

Location (see Figure 13-15)	Parameters	Frequency and Duration
Maju Forest One (1) monitoring locations within Maju Forest and closet to construction worksite	$L_{Aeq}(12 \text{ hour})$, $L_{Aeq}(1 \text{ hour})$, and $L_{Aeq}(5 \text{ min})$	<ul style="list-style-type: none"> Prior to site clearance: To conduct one-time (i.e. 1-week period) airborne noise monitoring at this location to re-establish the baseline noise levels for reference/comparison purposes before any construction works commence.

Location (see Figure 13-15)	Parameters	Frequency and Duration
		<ul style="list-style-type: none"> • Throughout construction period: Continuous monitoring at this location for the entire duration of construction.
Clementi Forest: Two (2) monitoring location within Clementi Forest and closest to northern and southern part of construction worksite		<ul style="list-style-type: none"> • Prior to site clearance: To conduct one-time (i.e, 1 week period) at these locations to re-establish the baseline noise levels for reference/ comparison purposes before any construction works commence. • Throughout construction period: Continuous monitoring at this location for the entire duration of construction.

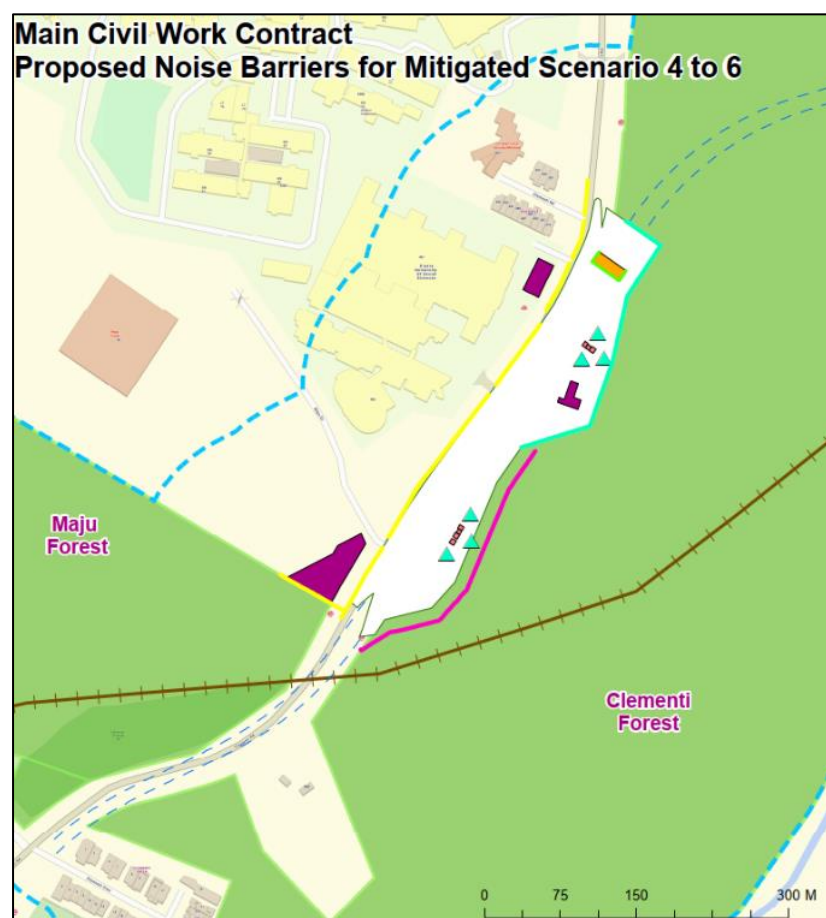


Figure 13-15 Proposed Noise Monitoring Locations with Construction Noise Barriers

13.10.2 Commissioning Phase

During commissioning phase, continuous airborne noise monitoring (L_{eq} 5min and L_{eq} 1 hour) shall be conducted for the three (3) monitoring locations in Maju Forest and Clementi Forest (as per Figure 13-15) for three (3) months of the commissioning phase.

Apart from that, six (6) additional airborne noise monitoring (L_{eq} 15min) will be required at the east, north and south of the boundary of ventilation shaft building at station for one (1) day (24 hours) within the commissioning phase, to monitor the potential airborne noise impact arising from the air conditioning and mechanical ventilation (ACMV) equipment which will be operating during commissioning phase. This indicates a total of nine (9) airborne noise monitoring locations during commissioning phase.

The airborne noise level monitored shall comply with the *NEA's Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Building*, however, noise criteria for biodiversity shall follow a "no worse off than baseline criteria" shall be complied. The current set of Project-specific noise criteria based on baseline noise monitoring in Year 2020 is provided in Table 13-10 below for reference and/or basis of comparison if there is no further update hereafter.

Table 13-10 Project-Specific Noise Criteria for Commissioning Phase (Baseline Measured in Year 2020)

No.	Types of Affected Receptors	L _{Aeq} (15 min), dB		
		7am-7pm	7pm-11pm	11pm-7am
Maju Forest	Ecologically sensitive receptors	48	49	42
Clementi Forest (Southern)		48	49	42
Clementi Forest (Northern)		66	66	60

***Notes:**

1. Ecological receptor noise impact to be assessed against the baseline noise level as the noise criterion.

2. If there are any noise monitoring works being conducted hereafter, i.e. during actual pre-construction phase (i.e. before actual site clearance) and/or pre-commissioning phase, this Project-specific noise criteria (no worse off than baseline approach) shall be updated accordingly and be complied on site.

13.10.3 Operational Phase

During operational phase, airborne noise monitoring and audit are not required. General housekeeping and environmental management measures shall be applied.

In general, the Rail Operator shall ensure the implementation of minimum control measures according to the relevant legislations (i.e. *NEA's Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Building* and *Technical Guideline for Land Traffic Noise Impact Assessment*), as well as the proposed mitigation measures where the key ones are summarised in Section 13.13.3. If there are any noise monitoring works to be carried out at Maju Forest and Clementi Forest during operational phase in future, the same no worse-off than baseline noise criteria (see Section 13.10.2) shall be complied.

13.11 Ground-borne Vibration EMMP Requirements

This section details ground-borne vibration EMMP requirements during construction, commissioning and operational phases.

13.11.1 Construction Phase

During pre-construction and construction phase, vibration monitoring is not required. During the construction phase, the Contractor shall control construction vibration levels using the best available techniques (BAT). The Contractor shall ensure that the vibration levels for any construction activities at Maju Forest and Clementi Forest (excluding the worksite area) do not exceed Peak Particle Velocity, PPV, 8 mm/s.

Additional requirements are required during rock breaking and excavation stage (Stage 2) and tunnel boring (Stage 2) planned for the worksites at Maju and Clementi Forest as outlined in Section 13.11.1.1 below.

13.11.1.1 EMMP for Structural Integrity of Burrows

The Contractor shall control construction vibration levels using the best available techniques (BAT). The construction activities include tunnel boring and rock breaking and excavation during Stage 2. The Contractor shall ensure that the vibration levels for any construction activities at Maju Forest and Clementi Forest (excluding the worksite area) do not exceed Peak Particle Velocity, PPV, 8 mm/s.

A ground-borne vibration monitoring program will need to be implemented before commencement of construction works (for 1 week period) and throughout rock breaking and excavation, piling and tunnel boring activities during construction phase, please refer to Table 13-11.

Table 13-11 Recommended Monitoring Program during Construction Phase (Ground-borne Vibration)

Location (see Figure 13-16)	Parameters	Frequency and Duration
Clementi and Maju Forest: One (1) monitoring location each at Clementi and Maju Forest	Peak Particle Velocity, PPV, mm/s	<ul style="list-style-type: none"> • Prior to site clearance: To conduct one-time (i.e. 1-week period) continuous vibration monitoring (Triaxial with 3G remote communication) at these locations to re-establish the baseline vibration levels for reference/comparison purposes before any construction works commence. • During construction phase: Continuous monitoring at this location during rock breaking and excavation, piling and tunnel boring activities.

Additionally, an Ecologist and Environmental Officer shall be present to survey for burrows before any construction activities. If burrows are detected within the Biodiversity Study Areas, camera traps should be deployed to assess fauna activity. If there are no burrows or fauna activity detected, construction works can continue.

13.11.1.2 EMMP for Behavioural Impacts of Ecologically Sensitive Species

During rock breaking and excavation stage (Stage 2) and tunnel boring (Stage 2), the Ecologist shall monitor for any fauna behaviour (e.g. dashing onto the road) resulting in road-kill incidents for at least thirty (30) minutes after the event. In addition, there shall be Ecologists present to observe fauna movements during these construction activities. Suppose fauna is seen trying to dash onto the road. In that case, construction activities will be immediately suspended, and mitigation measures should be applied to prevent such events from happening in the future.

At Maju and Clementi Forest, before the construction activities commence, a 220 m long temporary barrier (e.g. water-filled barrier of 1 m height) shall also be set up at specific locations along Clementi Road for pipe jacking (Advance Works). The Client has confirmed on 31st May 2022 that Brookvale Drive will still be under construction during Advance Works. Hence, existing hoardings will be present to replace water barriers during this stage. Where there are no hoardings from Brookvale Drive leading to Clementi Road, water barriers have to be implemented. More water barriers will have to be added along Clementi Road at Stage 2 when rock breaking and excavation, and tunnel boring begin. At this stage, the temporary barrier should have a total length of 480 m. In addition, 635 m of the permanent BRC fences along Brookvale Drive from a residential project must also be covered with canvas sheets. At Advance Works and Stage 2, hoardings must be included at the worksites, and canvas sheets must be added onto existing railings (220 m long) along Clementi Road to cover holes on the railings. These potentially mitigate roadkills due to the impacted fauna trying to dash onto a road during construction. The temporary barriers are shown in Figure 13-16.

Lastly, no night work should be conducted after 7 pm for all non-safety critical activities since the site is next to the sensitive receptors.



Figure 13-16 Proposed Barriers During Construction Activities

13.11.2 Commissioning Phase

During the commissioning phase, vibration monitoring is not required. General housekeeping and maintenance shall be applied.

13.11.3 Operational Phase

During the operational phase, vibration monitoring is not required. General housekeeping and maintenance shall be applied.

13.12 Environmental Audit

13.12.1 Construction Phase

13.12.1.1 Internal Site Inspection/Audit by EM/ECO

Site surveillance provides a direct means to assess and ensure the Project's environmental protection and pollution control measures comply with the contract specifications and the EMMP. The EM/ECO should inspect the construction activities regularly and routinely to ensure that the appropriate environmental protection and pollution control mitigation measures are properly and timely implemented, based on the EMMP's recommendations. With well-defined pollution control and impact mitigation measures outlined, and a well-established efficient remedial action reporting system, the site inspection is an effective "tool" to ensure acceptable environmental performance at the construction site.

After consultation with Project's SO, the EM/ECO should prepare a procedure for the site inspections, deficiencies, remedial action, and reporting requirements. This documentation shall be agreed upon by the RTO and Contractor representative, and approved by the Project Owner within 21 days of the commencement of the construction contract.

Weekly site inspections should be carried out by the EM/ECO to ensure the environmental, health and safety measures are correctly implemented in all the work areas during the construction phase. The EM/ECO shall submit an Environmental Performance/Inspection Report covering the onsite environmental situation, pollution control and mitigation measures to LTA fortnightly. Offsite environmental situations, which may be affected by onsite activities (directly or indirectly), should also be reviewed.

13.12.1.2 External Environmental Audit by Independent EMMP Consultant

A third party independent EMMP consultant shall be engaged to perform routine environmental audit/ verification checks of the EMMP implementation by the Contractor (for all assessed environmental parameters in ecological perspectives) throughout the construction period. The routine audit includes but not limited to reviewing relevant documents prepared by Contractor's EMMP consultant, providing ad-hoc advice, assisting in resolving complaints

with the Contractor, etc. largely for ecological perspective as LTA in house staff and project staff shall be able to resolve issues related to human impacts.

The external environmental audit exercise would also include the documentation review of on-site monitoring records against the proposed measures and findings in the approved site specific EMMP. This is to ensure proper implementation of minimum control measures, mitigation measures and EMMP proposed in this report, as well as to identify and/or resolve potential environmental noncompliances and potential gaps with the findings in report, if any observed during the audit.

13.12.2 Commissioning Phase

It is suggested that the Contractor engage an independent EMMP consultant to perform routine environmental audit parallel to the biodiversity monitoring works. This is to inspect the effectiveness of biodiversity monitoring works and other on-site environmental implementations during the commissioning phase before handing it over to the rail operator.

13.12.3 Operational Phase

An environmental audit by an independent EMMP consultant may not be required during the operational phase of this Project. The EHS Officer and the rail operator shall manage the overall environmental performance and ensure the implementation of minimum control measures and mitigation measures proposed in this Report.

13.13 Summary of Proposed EMMP

The framework for the proposed EMMP is detailed below; however, it is essential to note that this is not an exhaustive list of potential impacts, monitoring requirements, and triggers. This EMMP is intended to be a living document and should be reviewed thoroughly by the Client/ Project Owner/ rail operator and the Contractor (CT) before implementation. Development of the following inputs that have not been addressed in this Report by the CT and/or rail operator is also required, including but not limited to:

- Stakeholder Communications Plan;
- Tree Protection Specifications;
- Sapling Harvesting Specifications;
- Tree Transplanting, Maintenance and Care Recommendations (if any);
- Fauna Management Plan;
- Air Pollution Control Plan;
- Noise Management Plan;
- Erosion Control Plan;
- Waste Management Plan;
- Vector Pollution Control Plan
- Site log for all monitoring activities and complaints;
- Construction Logistics Plan;
- Standard Operating Procedures;
- Emergency Response Plan;
- Inventory of wastewater streams;
- Training protocols for staff, where appropriate; and
- Maintenance and Audit Schedules.

13.13.1 Construction Phase

The EMMP for construction phase of the Project is described in Table 13-12.

Table 13-12 Proposed Environmental Monitoring and Management Plan for the Construction Phase

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{1,2}
General	Exclusion of the evaluation of specific environmental impacts where detailed design is not available for review at the time of writing this Report	<ul style="list-style-type: none"> This EIS was conducted based on a preliminary worksite design. The current worksite design excludes any inputs regarding locations of piezometers, utilities/ road diversion areas, and site elements (e.g. workers dormitory, detention tank, site office etc.). If this is available at a later stage, the contractor shall update the findings of this EIS. 	N/A	N/A	N/A	N/A	CT	N/A
Biodiversity	Minimisation of construction impacts to flora/vegetation	<ul style="list-style-type: none"> Mark out site boundary. Trees that are to be retained within worksite would require an arborist to clearly mark out Tree Protection Zones where no works are allowed. The Tree Protection Zones should be set up in accordance with NParks guidelines 	<ul style="list-style-type: none"> Identification of locations, species and quantity of transplant candidates that are affected by construction 	Flora and Arboriculture	Within development boundary	Prior to site clearance	CT, EM/ECO, Flora Specialist	N/A
			<ul style="list-style-type: none"> Inspection of integrity of TPZ hoarding Assessment of tree physiological health and vigour Determination of presence of mechanical damage to trees that may impair stability Review of method statements of construction works in proximity to retained trees Identification of excessive or unauthorised tree removal Identification of trees that require management and maintenance such as tree care and pruning Determination of any unauthorised removal of flora within areas of conservation (if any) or beyond the demarcated worksite Identification of areas with soil erosion and degradation that have resulted from construction activities Determination of unauthorised dumping of waste material, construction debris or oil/chemical leakage that may contaminate the soil and waterbodies, and/or be detrimental to the vegetation Identification of areas that are responding poorly due to the development impacts. 		Within development boundary and 15m beyond hoarding line	Monthly for duration of construction	CT, EM/ECO, Flora Specialist, Arborist	
	Minimisation of construction impacts to fauna	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Areas not used should be returned to earth ground and replanted if possible. Planting scheme should be as similar to forest composition to adjacent forest, if not as native as possible. Other than minimising edge effects, it can serve as a natural barrier to light, noise and dust to reduce disturbance. As a general guide, 400 trees should be replanted for every hectare to be reinstated. 	Fauna	Within development boundary	Post-construction	CT, EM/ECO, Ecologist	N/A
			<ul style="list-style-type: none"> Implementation of directional clearing 		Within development boundary	Prior to site clearance	CT, EM/ECO, Ecologist	

¹ Resident Technical Officer (RTO) and Site Officers (SO, WSHO and ECO) check the project site for construction progress and implementation of environmental mitigation measures.

² If there is trigger then all the mitigation and management measures should be audited in detail for compliance and corrective action must be taken in liaison with the Project Owner.

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{1,2}
		actively used such as bird nests, tree hollows and burrows.	<ul style="list-style-type: none"> Inspection for presence of trapped/injured/dead fauna, potential fauna entrapments and gaps in site hoarding 					
		<ul style="list-style-type: none"> Follow the measures for physical parameters from the rest of the table. 	<p>Toolbox briefings on biodiversity awareness</p> <ul style="list-style-type: none"> Assessment of habitat quality (e.g., water quality, excessive vegetation removal, light management strategies) Implementation of only 100% biodegradable ECBs Establish a comprehensive waste management system and submit a contract-specific Waste Management Plan which details the types of waste generated, location and types of waste management facilities, frequency of disposal, as well as information of waste management contractors. This will act as the guidance for workers to ensure proper implementation of waste management and disposal on site, where the practices shall include but not limited to: <ul style="list-style-type: none"> Strictly prohibit illegal disposal of construction wastes into streams and storm water channels or other waterbodies Strictly prohibit littering of food waste and food packaging Provide sufficient fully covered food waste bins that are secured in a manner that is wildlife-proof Clear all food waste from the worksite at least once a day If fauna is found to be active around waste disposal areas, the Contractor shall implement measures to reduce the source of the attractant in consultation with the Ecologist Implementation of proper vector management strategies, where the hierarchy of vector control for construction worksites near the Biodiversity Study Area shall be as follows: <ol style="list-style-type: none"> no thermal fogging to prevent unintended impacts to invertebrate fauna nearby; no chemical insecticides, pesticides and rodenticides shall be used for pest control; no sticky traps shall be used for pest control. 		Within development boundary	Monthly for duration of construction	CT, EM/ECO, Ecologist	
		NA	<ul style="list-style-type: none"> Conduct biodiversity survey to monitor construction impacts on fauna activity and presence 		Adjacent to development boundary	Monthly for duration of construction	CT, EM/ECO	When fauna is encountered within development boundary
		NA	<ul style="list-style-type: none"> Recording of number of number of occurrences of human-wildlife conflict 		Within development boundary	Daily monitoring and record-keeping	CT, EM/ECO	N/A

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{1,2}
Hydrology and Surface Water Quality	<ul style="list-style-type: none"> Solid & Toxic Waste Generation Liquid Effluent and Stormwater Runoff Generation Improper Management of Chemical Substances 	<p>Key Minimum Controls</p> <p>a. Solid & Toxic Waste Generation</p> <ul style="list-style-type: none"> Effective ECM and monitoring implemented as recommended in the Code of Practice on Surface Water Drainage to ensure that discharge into the stormwater drainage system does not contain TSS in concentrations greater than the prescribed limits under the Sewerage and Drainage (Surface Water Drainage) Regulations; Implementation of CCTV including SIDS at the public drain to monitor the surface runoff discharges from the sites as per the Public Utilities Board of Singapore's (PUB) circular on Preventing Muddy Waters from the Construction Sites (October 2015); and All wastes will be disposed only in the designated waste disposal facilities and appropriately separated, i.e. by trained workers to properly sort and label the different types of waste (reusable and recyclable waste, toxic and non-toxic waste, etc.). <p>b. Liquid Effluent Generation and Stormwater Runoff</p> <ul style="list-style-type: none"> A full inventory of all anticipated wastewater streams and volumes should be finalised before the onset of the construction works; No unmanaged discharge of wastewater stream permitted; Reduce, reuse, and recycle hierarchy principle to be applied to wastewater on-site; Hazardous wastewater, such as oily water, thinners, solvents, or paints, are to be stored and removed for treatment and disposal off-site by an approved Waste Management Contractor. Hazardous liquids to be handled as Hazardous Waste; Adequate drainage, cut-off drains, sump pit, road kerb, piping and toe wall shall be designed for channelling of construction process wastewater streams (e.g. concrete batching, wash water, etc.) and stormwater runoff separately through detailed design for capture and treatment in the detention ponds. Where applicable (e.g. in the vicinity of liquid storage or refuelling areas), this infrastructure shall include oil-water separators to capture inadvertent spills or leaked oils or greases; The wastewater from tunnelling activities should be stored and treated on-site and disposed to public sewer based on PUB Sewerage and Drainage (Trade Effluent) Regulations; The treated effluent from bentonite slurry treatment system/plant should be treated on-site prior disposal to PUB's sewerage system based on PUB Sewerage and Drainage (Trade Effluent) Regulations; The discharge of pumped dewatered groundwater or other wastewaters to sensitive aquatic habitats shall be prohibited (e.g. natural streams within Clementi Forest and Maju Forest); Tunnel washing effluent should be discharged to a retention tank that manually collected by operator assigned private wastewater collector to be transferred to wastewater treatment plant; 	N/A	All water quality parameters identified in Table 13-4. And any flooding issues should be recorded and inspected.	Before every discharge outlet and at the sensitive streams (i.e. D/S1 and D/S22).	One time monitoring prior to site clearance	CT, EM/ECO	Investigation and corrective actions to be taken there is a significant drawdown of groundwater level.
			<ul style="list-style-type: none"> Conserve D/S1, no construction/blockage on top of it or in its vicinity, and with no disturbance on its water quality and hydrology (i.e. 30m buffer from both embankments of the stream). Flow diversion of D/S22 and discharge water to the main natural stream D/S1. The diversion must follow PUB's Code of Practice on Surface Water Drainage. The diverted flow shall be treated to meet NEA Trade Effluent Discharge Limits. 	All water quality parameters identified in Table 13-4. And any flooding issues should be recorded and inspected.	Before every discharge outlet and at the sensitive streams (i.e. D/S1 and D/S22).	<ul style="list-style-type: none"> Permanent TSS monitor installed at every discharge outlet; Implementation of CCTV including a SIDS at every discharge outlet to monitor the surface runoff discharges from the sites; Monthly water quality monitoring for all discharge locations during construction phase; Monthly water quality monitoring for the sensitive streams with high ecological importance including D/S1 and D/S22 throughout the construction period; Intensity of the laboratory analysis will be increased (e.g. fortnightly, weekly) if in-situ measurements and/or monthly laboratory results indicate deterioration in the water quality. Intensified monitoring will be carried out until in-situ measurements and/or laboratory results indicate 'normality'/consistency with earlier monitored conditions; and Daily inspection on perimeter drains to ensure no surface runoff flowing out from the site untreated done by the site officer with routine audit done by independent EMMP consultant. 	CT, EM/ECO	Investigation and corrective actions to be taken, when: <ul style="list-style-type: none"> The following documentation are found inadequate/missing: <ul style="list-style-type: none"> ECM Plan; Monitoring Log; Training Log; Audit Reports; If the monitored parameters exceed applicable values of NEA Trade Effluent Discharge Limits at discharge point (refer to Table 13-3); If the monitored parameters exceed applicable values of Water Quality Criteria for Aquatic Life at natural stream (refer to Table 13-3); If any flooding or clogging issues observed; If complaints are received due to project activities; and If visual non-compliance to any of the minimum control or mitigation measures are observed on-site.

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{1,2}
		<ul style="list-style-type: none"> • Appropriate disposal of any waste listed in the Environmental Public Health (General Waste Collection) Regulations by licensed waste operator/collector; • Runoff within, upstream of, and adjacent to the worksite shall be effectively drained away without causing flooding in the vicinity; • Appropriate permits for discharge to be obtained from relevant authority prior to discharge. No trade effluent other than that of a nature or type approved by NEA Director-General shall be discharged into any watercourse or land; • Regular and dedicated procedures for the management of stormwater collection, settling, testing and eventual discharge of 'clean' water to surface waters. This should also include associated measures required to prevent high sediment concentration stormwater drainage to surface waters; and • Geotechnical aspect of site's slope stability (such as Earth Retaining and Stabilising structures (ERSS) to be included in detailed design engineering for the construction stage. <p>c. Improper Management of Chemical Substances</p> <ul style="list-style-type: none"> • Development of SOP for safe handling, transfer and storage of toxic waste; housekeeping checks once a day to ensure all toxic waste is cleared from site; • Appropriate tests to ascertain the presence/absence of contamination of the excavated earth and sand; • Appropriate fully sheltered storage area with storage volume to be 110% of the largest volume of chemical substances to be stored (kerb up and enclosed on at least 3 sides, covered and with adequate ventilation) for hazardous substances; • Appropriate construction material for toxic waste storage containers with leak detection tests conducted periodically; • Provision of secondary containment for all toxic waste stored in bulk as per the requirements in the COPPC/SS593; • Preparation of an emergency response plan, training of the emergency response team (ERT) to be competent in the response mechanism and provision of response kits for any spillages; • Consignment notification/tracking system and transport emergency response plan for transport of toxic waste; • Appropriate disposal of toxic waste as per required in the Environmental Public Health (Toxic Industrial Waste) Regulations by licensed waste operator/collector. 						
Soil and Groundwater	Decreased groundwater baseflow feeding into the streams	<p>Minimum Controls:</p> <ul style="list-style-type: none"> ▪ Install piezometers to monitor the changes in groundwater level in compliance with Building Control Regulations 2003 as part of its instrumentation and monitoring plan to be endorsed by the Qualified Professional (QP); and 	<ul style="list-style-type: none"> ▪ Not Applicable. 	Groundwater Level	Actual monitoring location to be decided by QP.	To continuously monitor the groundwater level throughout the lifetime of the construction phase.	CT, EM/ECO	Investigation and corrective actions to be taken there is a significant drawdown of groundwater level.

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{1,2}
	Improper Management and Disposal of Excavated Soil and Groundwater	<ul style="list-style-type: none"> • Proper Earth Retaining Stabilising Structures (ERSS) should be selected and designed to limit groundwater settlement. • Identify all types of solid waste (e.g. tunnelling waste) and implement comprehensive waste management system at the site in order to ensure proper disposal and prevent pollution to the environment. This contractor should conduct a construction risk assessment and prepare a comprehensive construction health, safety and environment plan. If health impacts to workers are foreseen due to the handling of such waste, necessary precautionary measures as per the safety data sheets (SDS) including personal protective equipment should be implemented on site. • Use approved materials, of the same or better quality as the surrounding area, for backfilling works. All backfilled material shall be free of debris, and of good material soil. • Handle and dispose excavated soil following the procedure shown in Figure 13-12. This flow chart explains how to handle excavated soils, and identify potential areas of contamination as well as potential of contamination (POC) in excavated soils. If the POC soils are tested for exceedance in DIVs, the soils can be disposed of to toxic waste collectors or undergo soil treatment. If contaminated soils were sent for treatment to an acceptable standard such as the DIV, the treated soil can be disposed in the staging ground or through a general waste collector, depending on the level of the contaminants during the staging ground testing. • Upon receipt of results on the tested parameters (chemicals, heavy metals) exceeding the regulatory limits, the construction contractor should further assess the potential inhalation and dermal contact impacts of the exceeded parameters to the site workers exposed to areas where soil and/or groundwater contamination is identified. The risk assessment should be conducted before the commencement of construction activities and the findings incorporated into the contractors' construction risk assessment and health, safety and environment plan. If health impacts to workers are foreseen, necessary precautionary measures, as per the respective chemical SDS, should be implemented on site. • A site management plan should include plans of safe handling, transfer and storage of excavated soils following the procedure in Figure 13-12 • Discharge of extracted groundwater shall be to an area approved for such disposal by the NEA and the proposed location as identified in Figure 13-12 and following the process set out in Figure 13-13. Based on the results of the soil and groundwater baseline study, the detected concentrations in groundwater do not exceed the DIVs. However, it is recommended that the construction Contractor to be vigilant of site conditions and extracted groundwater to be tested at regular intervals, especially for extracted groundwater 		Records on waste generated and hazardous chemicals used at the construction site should be properly kept and records produced when requested.	<ul style="list-style-type: none"> • At locations where excavated soil and extracted groundwater are generated and stored. • At locations where toxic chemical wastes are generated and stored. • At locations where hazardous chemicals/substances are used and stored. 	<ul style="list-style-type: none"> • Monitoring records of the amount and type of toxic chemical waste generated, once a week • Inspection of hazardous chemical /substances storage conditions, once a week. • Routine environmental audit by independent EMMP consultant during construction phase. 	CT, EM/ECO	<p>Investigation and corrective actions to be taken, when:</p> <ul style="list-style-type: none"> • There are no/ poor records of toxic chemical waste amount and type; and • There is evidence of poor handling/ storage of toxic chemical waste and hazardous chemical.

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{1,2}
		<p>with oily sheens or noticeable odour. If a contaminant concentration in excess of the DIV is detected, the Contractor shall assess the potential inhalation and dermal impacts of the chemical identified and assess potential health and safety considerations for exposure to groundwater before commencement of construction activities. Such contaminated wastewater may need to be disposed of to a licenced toxic waste collector.</p> <ul style="list-style-type: none">Contractor will need to seek approval from relevant authorities (e.g., PUB & NEA) as per NEA's Trade Effluent Discharge Limits if the treated groundwater will be disposed to controlled watercourse. If such discharges are not approved, the trade effluent will be stored, treated, or recycled on site and finally disposed of. The extracted groundwater to be discharged should be tested in regular intervals, especially if oily sheens or odour are observed.Bentonite slurry used in the TBM will be pumped into the slurry treatment plant for recycling, cleaning and removal of native cut material. Treatment methodologies in the slurry treatment plant will include de-sanding (e.g., cyclones) and filtration. Handling and disposal of spoils for disposal after the treatment shall follow the procedure in Figure 13-12.						
	Toxic Chemical Waste Generation during Construction Phase	<p>Minimum Controls:</p> <ul style="list-style-type: none">Identify all types of toxic chemical waste and implement comprehensive waste management system at the site in order to ensure proper disposal and prevent pollution to the environment. This contractor should conduct a construction risk assessment and prepare a comprehensive construction health, safety and environment plan. If health impacts to workers are foreseen due to the handling of such waste, necessary precautionary measures as per the safety data sheets (SDS) including personal protective equipment should be implemented on site;Inspect all equipment prior to entering the site for fuel/hydraulic lines, leaking tanks, and other potential faulty parts that could potentially cause contamination to soil or groundwater;Dispose all construction debris (under category C&D) at the gazetted Government dumping grounds or at such other sites or locations as directed by NEA;Store generated toxic chemical waste under shelter within concrete bund walls or in storage containers with good ventilation. Spill trays shall be provided for all waste containers. Spill trays shall be regularly maintained to prevent rain from washing out the pollutive substances;Note that the Earth Control Measures (ECM) is for the containment and treatment of silty discharge due to the impact of rainwater. ECM is not meant for the treatment of wastewater due to construction activities (such as pipe-jacking and bore-piling works) which shall be treated to comply with the requirements under prevailing legislation; and						

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{1,2}
	Improper Handling of Hazardous Chemicals/Substances during Construction Phase	<ul style="list-style-type: none"> The wastewater from tunnelling activities should be stored and removed for treatment and disposal off-site by an approved Waste Management Contractor. <p>Minimum Controls:</p> <ul style="list-style-type: none"> Remove any hazardous substance or chemical if there are safer alternatives; Ensure all hazardous substance and chemical containers are labelled its movement is recorded and returned to the designated storage areas when not in use; Assess the SDS of all the hazardous substances and chemicals prior to its entry to site for its suitability in terms of SHE hazards and consider safer alternatives; Ensure no trade effluent other than that of a nature or type approved by NEA Director-General shall be discharged into any watercourse or land; Ensure all activities involving repair, servicing, engine overhaul works, etc. shall be carried out on an area which is appropriately contained (e.g. concreted area and with proper containment/sumps) and all wastes are channelled for appropriate treatment or disposal to meet the regulations; Store chemicals stored under shelter within concrete bund walls or in storage containers with good ventilation. Spill trays shall be provided for all drums, plants and machinery and potential pollutive substances used on site. Spill trays shall be regularly maintained to prevent rain from washing out the pollutive substances; and 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. 						
Air Quality	Air quality impact from dust nuisance from the construction activities and gaseous emissions from the construction equipment and vehicles	<ul style="list-style-type: none"> The construction footprint shall be hoarded on all sides; No demolition of permanent structure is expected as part of the project; and Road construction or expansion shall be completed first and paved where possible before the construction of other development commences. Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable) for local access roads in all construction sites. Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits. 	<p>General mitigation measures to be implemented throughout construction period.</p> <p>Communications:</p> <ul style="list-style-type: none"> Develop and implement a stakeholder communications plan that includes community engagement before work commences on site. Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager. Develop and implement an Air Pollution Control Plan (APCP) <p>Site Management:</p> <ul style="list-style-type: none"> Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken. Make the complaints log available to the local authority when asked. Record any exceptional incidents# that cause dust and/or air emissions, either on-site or off-site, and the action taken to resolve the situation in the log book. 	Dust deposition in mg/m ² /day	<ul style="list-style-type: none"> Clementi Forest Maju Forest 	<ul style="list-style-type: none"> Prior to site clearance: Conduct one-time air quality monitoring of PM₁₀ and PM_{2.5} for 1 week at Clementi Forest and Maju Forest, for the establishment of baseline Throughout construction period: Continuous dust deposition monitoring, averaged over 4-week period Routine environmental audit by independent EMMP Consultant during construction phase. 	CT, EM/ECO	<p>Investigation and corrective actions to be taken, when</p> <ol style="list-style-type: none"> Any of the following documentation are found inadequate / missing: Air Pollution Control Plan; Compliance certificate of an Off-Road Diesel engine; or Monitoring Log. If the monitored PM₁₀ and PM_{2.5} exceed Singapore long term air quality targets. If the dust deposition monitored exceeds 200 mg/m²/day averaged over 4-week If complaints are received due to project activities. If visual non-compliance to any of the minimum control or mitigation measures are observed on-site.

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{1,2}
			<ul style="list-style-type: none"> • Hold liaison meetings with other high risk construction sites within 500m of the site boundary, if any, to ensure plans are co-ordinated and dust and particulate matter emissions are minimised. <p>Monitoring:</p> <ul style="list-style-type: none"> • Undertake regular (daily frequency recommended) on-site and off-site inspections and record results. The log should be made available to the NEA or other Government Agencies if required. Inspections should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary. Cleaning should be provided if necessary. • Carry out regular site inspections to monitor and record compliance with the Air Pollution Control Plan. • Increase the frequency of site inspections during prolonged dry or windy conditions. • Conduct monitoring for dust deposition at suitable locations (refer to Section 10 for details) <p>Preparing and maintaining the site:</p> <ul style="list-style-type: none"> • Plan site layout so that machinery and dust causing activities are located away from receptors, where possible. • Erect hoarding around dusty activities and at the site boundary wherever possible. Boundary screens should be at least as high as any stockpiles or dust emission sources on site. • Fully enclose specific activities where there is a known high potential for dust production and the site will be active for an extensive period of time. • Keep site fencing, barriers, and scaffolding clean by cleaning regularly using wet methods (dry methods may give rise to fugitive dust). • Remove materials that have the potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site, stockpiled material should be covered, seeded, fenced or enclosed to prevent fugitive dust formation. <p>Operating vehicle/machinery and sustainable travel:</p> <ul style="list-style-type: none"> • Impose and signpost a maximum-speed-limit of 25 km/hr on paved or surfaced haul roads and 15 km/hr on unpaved haul roads and work areas within the worksite, as well as local access roads leading to the worksite. • Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials. • Ensure all vehicles and engine powered equipment comply with the legislative requirements of Singapore • Ensure all vehicles and equipment switch off their engines when stationary – i.e. no idling 					

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{1,2}
			<p>vehicles or engines. Clear signs shall be erected at site entrance to inform all visitors.</p> <ul style="list-style-type: none">Where practicable, avoid the use of diesel- or petrol-powered generators and use mains electricity or battery powered equipment <p>Construction:</p> <ul style="list-style-type: none">Only use cutting, grinding or sawing equipment fitted with, or in conjunction with, suitable dust suppression techniques such as water sprays or local extraction e.g. local exhaust ventilation system.Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.Use enclosed chutes and conveyors and covered skips wherever possible.Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.A stringent “Clean as you go” Policy should be implemented on site to ensure no loose dry material is left exposed when not in use. Equipment should be readily available on site to clean and dry spillages, and cleaning should be conducted as soon as reasonably practicable after the event using wet cleaning methods. <p>Waste Management:</p> <ul style="list-style-type: none">Avoid burning of waste or other materials <p>MITIGATION MEASURES FOR EARTHWORKS</p> <ul style="list-style-type: none">Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.Use Hessian, mulches or soil tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.Only remove the cover in small areas during work and not all at once. <p>MITIGATION MEASURES FOR CONSTRUCTION</p> <ul style="list-style-type: none">Avoid scabbling (roughening of concrete surfaces) if possible.Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust. <p>MITIGATION MEASURES FOR TRACKOUT</p>					

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{1,2}
			<ul style="list-style-type: none"> • Use water-assisted dust sweeper(s) on the access and affected local roads, to remove, as necessary, any material tracked out of the site. This may require the sweeper being continuously in use. • Avoid dry sweeping of large areas. • Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport. • Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable. • Record all inspections of haul routes and any subsequent action in a site log book. • Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned. • Site access gates to be located at least 10m from receptors where possible 					
Airborne Noise	Noise from construction machines and equipment, especially rotational and vibratory equipment (e.g. dozers, cranes, excavators, trailers, generators, etc.)	<p>Minimum Controls:</p> <ul style="list-style-type: none"> • Construction prohibition period should be followed, as per fourth schedule of Environment Protection and Management regulation; • Prepare a Construction Noise Management Plan, to establish baseline monitoring prior to site clearance, plan for monitoring during the construction phase, and procedure for complaint handling; • The Contractor shall review the equipment to be used on site and erect localised noise barriers prior to undertaking high noise generating work; • Machines (such as trucks) that may be in intermittent use shall be shut down between work periods or shall be throttled down to a minimum; • Only well-maintained plants shall be utilised on-site and plants shall be serviced regularly during the entire construction period; • The number of PMEs shall be reduced as far as practicable when construction works are carried out at areas close to the noise sensitive receivers; • Silencers or mufflers on construction equipment shall be utilised and shall be properly maintained during the construction programme; • Behavioural practices including no shouting, no loud stereos/ radios on site, no dropping of materials from height, no throwing of metal items shall be ensured; • Construction respite: Restrict high noise generating drilling activities only in continuous blocks, not 	<p>MITIGATION MEASURES FOR GENERAL CONSTRUCTION NOISE CONTROL:</p> <ul style="list-style-type: none"> • Control of noise sources at the source from construction site – Analyse construction inventory list and check equipment causing high noise levels. The equipment with lower noise level shall be prioritised. • Where controlling noise sources at the source is not feasible, acoustic enclosures or sheds are to be introduced to mitigate noise at the source. Typical acoustic enclosure covers the machine as fully as possible (with or without ventilation where applicable) to provide sound insulation. <p>MITIGATION MEASURES FOR CONSTRUCTION NOISE:</p> <p>Noise Barrier of minimum STC 20 are proposed to be erected at all the locations presented in Figure 13-15 in order to mitigate the construction noise to the noise sensitive receptors. These locations are;</p> <p>For Main civil work,</p> <ul style="list-style-type: none"> • 12 m high noise barrier at the west construction boundary of Main construction work worksite fronting noise sensitive receptors, 	Leq 12hours, Leq 1hour and Leq 5mins	<p>One (1) location at Maju Forest boundary and closest to construction worksite</p> <p>(see Figure 13-15)</p> <p>Two (2) locations within Clementi Forest and closest to northern and southern part of construction worksite</p> <p>(see Figure 13-15)</p>	<p><u>Before commencement of any construction works (including site clearance)</u></p> <ul style="list-style-type: none"> • One-time airborne noise monitoring for 1 week at this location, for establishment of latest baseline. <p><u>During Construction Phase</u></p> <ul style="list-style-type: none"> • Continuous monitoring at this location for the entire duration of construction. <p><u>Before commencement of any construction works (including site clearance)</u></p> <ul style="list-style-type: none"> • One-time airborne noise monitoring for 1 week at these locations, for establishment of latest baseline. <p><u>During Construction Phase</u></p> <ul style="list-style-type: none"> • Continuous monitoring at this location for the entire duration of construction. 	CT, EM/ECO	<p>Investigation and corrective actions to be taken, when:</p> <ol style="list-style-type: none"> 1. Any of the following documentation are found inadequate / missing: <ul style="list-style-type: none"> • Construction Noise Management Plan; • Monitoring Log. 2. If the monitored parameters exceed applicable values of EPM regulations. 3. If complaints are received due to project activities. 4. If visual non-compliance to any of the minimum control or mitigation measures are observed on-site. 5. If there are any cracks / leaks present on the noise barrier erected.

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{1,2}
		<p>exceeding 3 hours each, with a minimum respite period of one hour between each block, if possible;</p> <ul style="list-style-type: none"> Periodic noise monitoring by an independent third party, to establish compliance with requirements and to advise on equipment causing concern, and additional potential mitigation measures; Plan the layout of the site by considering using materials and other large structural equipment as noise barriers; Plant known to emit noise strongly in one direction shall, wherever possible, be orientated so that the noise is directed away from the nearby NSRs; and Material stockpiles and other structures shall be effectively utilised, wherever practicable, in screening noise from on-site construction activities. The optimisation of worksite to be situated away from the Biodiversity Study Area as far as practicable. Acoustic sheds should be provided at the locations of the noise generating activity such as operation of hand-held breaker. All construction works should be conducted within the daytime period. TBM works are to be conducted in the daytime as much as possible. 	<ul style="list-style-type: none"> Use the existing 6 m high noise barrier from the south-east construction boundary of Advance work) and 12m high noise barrier from the north-east construction boundary of Advance work worksite, LTA's standard TBM enclosure (one facade opening at northern side) 15m high at boundary of launch shaft. Above-ground works not critical for safety reasons to be restricted to weekdays (avoiding works on Sunday and Public holidays) No night works after 7pm for all non-safety critical activities since the site is next to Biodiversity Study Area Portable noise barrier were highly recommended close to the noisy equipment/ activities For noisy machinery such as the Secant Pile Auger - that typically operate for long period, the soundproof baffles can be mounted directly on the machine around the engine cowl. 		For all monitoring locations	<ul style="list-style-type: none"> Records on noise levels from construction sites should be properly kept and produced when requested. 		
Ground-borne Vibration	Ground-borne vibration from construction machines and equipment (e.g. vibratory roller, hydraulic hammer/rock breaker, pipe jacking), rock breaking and excavation and tunnel boring machine.	<ul style="list-style-type: none"> Equipment Selection and Maintenance. Associated with the piling during the construction of the viaducts, facility buildings, cut and cover tunnel, at-grade ramp, plus the operation of the TBM. Works Scheduling and Respite Periods. Community Consultation. It is recommended that the surrounding community be notified before commencing any piling and TBM related works, as a matter of good community relations. 	<ul style="list-style-type: none"> Optimise the worksite for smallest footprint within this area. Schedule rock breaking and excavation activities during day time. Restrict high amplitude vibratory compactors, pipe jacking, rock breaking and tunnel boring to below vibration threshold of PPV, 8 mm/s. Use of tri-axle trucks to reduce truck trips on the road. No night works should be conducted after 7pm for all non-safety critical activities. Temporary barriers (i.e. water barriers of 1 m height) should be implemented along Brookvale Drive and Clementi Road as seen in Figure 13-16. Canvas sheets should also be used to cover the holes on the existing railings along Brookvale Drive and Clementi Forest. Hoardings must be ensured at the worksites and at the existing construction beside Maju Forest. The Contractor shall control construction vibration levels using best available techniques (BAT) for tunnel boring and rock breaking and excavation at Stage 2. The Contractor shall ensure that the vibration levels for any construction activities at Maju Forest and Clementi Forest (excluding the worksite area) do not exceed PPV, 8 mm/s. Ecologist and Environmental Officer to identify burrows before the start of construction and monitoring burrow collapse during construction activities; 	PPV, mm/s	<p>One (1) location each at Maju Forest and Clementi Forest boundary and closest to construction worksite</p> <p>(see Figure 13-16)</p>	<p><u>Before commencement of any construction works (including site clearance)</u></p> <ul style="list-style-type: none"> One-time vibration monitoring for 1 week at this location, for establishment of latest baseline. <p><u>During Construction Phase</u></p> <ul style="list-style-type: none"> Continuous monitoring at this location during rock breaking and excavation, piling and tunnel boring activities. In the event of a valid complaint, until the complaint has been resolved. Routine environmental audit by independent EMMP Consultant during construction phase. 	CT, EM/ECO	<p>Investigation and corrective actions to be taken, when:</p> <ol style="list-style-type: none"> If the monitored parameters exceed applicable limits. If complaints are received due to project activities. If visual non-compliance to any of the minimum control or mitigation measures are observed on-site.

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{1,2}
			<ul style="list-style-type: none"> During rock breaking and excavation stage (Stage 2) and tunnel boring (Stage 2) construction activities, Ecologist shall monitor for any fauna behaviour (e.g. dashing onto road) resulting in road-kill incidents, for at least thirty (30) minutes after the event. If fauna is seen trying to dash onto the road, construction activities will be immediately suspended, and mitigation measures should be applied to prevent such event from happening in the future. 					

13.13.2 Commissioning Phase

The EMMP for commissioning phase of the Project is summarised in the following table. The key minimum control measures and key mitigation measures from the operational phase (see respective sections of Section 13) are generally applicable where relevant.

Table 13-13 Proposed Environmental Monitoring and Management Plan for the Commissioning Phase

Environmental Parameter	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{3,4}
Biodiversity	Flora and Arboriculture	<ul style="list-style-type: none"> Softscape of operational boundary. Conduct flora surveys in adjacent forest to development boundary. 	Monthly for duration of at least 6 months	CT, Floral Specialist, Arborist	NA
	Fauna	<ul style="list-style-type: none"> Conduct fauna surveys in adjacent forest to development boundary. Conduct ground-borne and airborne noise monitoring to monitor behaviour of fauna to impacts in tandem with biodiversity camera traps for fauna monitoring (refer to details of noise and vibration monitoring as part of the additional faunistic survey programme in Section 13.6.1.3). 		CT, Ecologist	NA
Hydrology and Surface Water Quality	All parameters identified in Table 13-5. And any flooding issues should be recorded and inspected.	At the main outlets/drains of the Project site, as well as the sensitive streams in the vicinity of proposed Project (i.e. D/S1 and D/S22) during the first three (3) months of commissioning phase	Monthly inspection for the water quality and hydrology, especially during heavy storm event for hydrological conditions during first three (3) months of commissioning phase	CT, EM/ECO	Investigation and corrective actions to be taken, when: <ul style="list-style-type: none"> If the monitored parameters of all discharge points exceed applicable values of NEA Trade Effluent Discharge Limits at discharge point (refer to Table 13-3); If the monitored parameters of natural streams exceed applicable values of Water Quality Criteria for Aquatic Life at natural stream (refer to Table 13-3); If any flooding issues observed; If complaints are received due to Project activities; and If visual non-compliance to any of the minimum control or mitigation measures are observed on-site.
Soil and Groundwater	<ul style="list-style-type: none"> Records on waste generated and hazardous chemicals used at the Project site should be properly kept and records produced when requested. 	<ul style="list-style-type: none"> At locations where toxic chemical waste are generated and store. At locations where hazardous chemicals/substances are used and stored. 	<ul style="list-style-type: none"> Monthly monitoring records of the amount and type of toxic chemical waste generated during first three (3) months of the commissioning phase Monthly inspection of hazardous chemical/substances storage conditions during first three (3) months of the commissioning phase 	CT, EM/ECO	Investigation and corrective actions to be taken, when: <ul style="list-style-type: none"> There are no/poor records of toxic chemical waste amount and type; and There is evidence of poor handling/storage of toxic chemical waste and hazardous chemical.

³ Resident Technical Officer (RTO) and Site Officers (SO, WSHO and ECO) check the project site for construction progress and implementation of environmental mitigation measures.

⁴ If there is trigger then all the mitigation and management measures should be audited in detail for compliance and corrective action must be taken in liaison with the Project Owner.

Environmental Parameter	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{3,4}
Airborne Noise	Leq 5min and Leq 1 hour	<ul style="list-style-type: none">Three (3) noise monitoring locations at boundary of Maju Forest and Clementi Forest (see Figure 13-15)	<ul style="list-style-type: none">Continuous monitoring for three (3) months of the commissioning phase	CT, EM/ECO	<p>Investigation and corrective actions to be taken, when:</p> <ul style="list-style-type: none">If complaints are received due to Project activities.If visual non-compliance to any of the minimum control or mitigation measures are observed on-site.
	Leq15 min	<ul style="list-style-type: none">Six (6) noise monitoring locations at the east, north and south boundary of ventilation shaft building (see Figure 13-15)	<ul style="list-style-type: none">Continuous monitoring for one (1) day (24 hours) within the commissioning phase, as per <i>NEA's Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Building</i>		
Ground-borne Vibration	PPV, mm/s	N/A	N/A	N/A	N/A

13.13.3 Operational Phase

The EMMP for operational phase of the project is described in Table 13-14.

Table 13-14 Proposed Environmental Monitoring and Management Plan for the Operational Phase

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Responsibility
Biodiversity	Minimisation of operational impacts to flora/vegetation	<ul style="list-style-type: none"> Identify of areas that are responding poorly due to operational activities Ensure that post-construction planting is responding well to development surrounding Ensure integrity of adjacent forest (if any) Identify signs of edge effects on new forest edge of adjacent forest (if any) Assessment of habitat quality (e.g., water quality, excessive vegetation removal) 	<ul style="list-style-type: none"> Flora and Arboriculture Ensure integrity of adjacent forest (if any) Identify signs of edge effects on new forest edge of adjacent forest (if any) 	Softscape of operational boundary Adjacent forest to development boundary
	Minimisation of operational impacts to fauna	<ul style="list-style-type: none"> Inspection for presence of trapped/injured/dead fauna, potential fauna entrapments and gaps in site hoarding Recording of number of occurrences of human-wildlife conflict Conduct biodiversity survey to monitor construction impacts on fauna activity and presence 	<ul style="list-style-type: none"> Fauna 	Adjacent forest to development boundary
Hydrology and Surface Water Quality	Stormwater Runoff Generation	<p>a. Stormwater Quality:</p> <ul style="list-style-type: none"> Adequate drainage, piping and/or channelling of stormwater runoff to be assured through detailed design [such as Active, Beautiful, Clean Water (ABC) Water Design approach] for capture and treatment before discharge into surface water; Regular and dedicated procedures for the inspection and maintenance of stormwater collection, storage, and treatment infrastructure, such as pipes, oil water separation, silt screens, etc.; and Regular and dedicated procedures for the management of stormwater collection, settling, testing and eventual discharge of 'clean' water to surface waters. This should also include associated measures required to prevent high sediment concentration stormwater drainage to surface waters. <p>b. Hydrology:</p> <ul style="list-style-type: none"> Potential increase of peak-flow due to the change in the land use at the new developments can be mitigated by providing detention ponds/tanks within the <u>Study Area</u>. Detention tanks can capture stormwater during heavy storm events to reduce the peak runoff. Stored water can then be discharged back to the system after the storm event. As required by PUB, the storage system needs to be in place to reduce the peak flow at the operational phase to be the same or less than that of the existing condition; Active, Beautiful, Clean Water (ABC) Water Design approach can be considered to reduce the peak-flow as well; and Geotechnical aspect of the site's slope stability (such as ERSS) shall be included in detailed design engineering for the operational stage. 	<ul style="list-style-type: none"> Redesign and reduce proposed footprint areas. Divert D/S22 permanently and discharge water to the natural stream D/S1. Area reinstatement with greenery provision to reduce the runoff coefficient which will help to reduce the peak-flow and reduce flood risk at downstream area. 	Rail Operator/ EHS Officer
Soil and Groundwater	Generation of small quantities of toxic chemical waste (used fluorescent bulbs, used lead-batteries, used maintenance chemical containers i.e. thinner, paints, lubricants, etc.)	<ul style="list-style-type: none"> Store all toxic chemical waste at designated sheltered area provided with access-controlled entrance and concrete bund walls or in storage containers with good ventilation. Spill trays shall be provided for all chemical drums, plants and machinery and potential pollutive substances used on site. Spill trays shall be regularly maintained to prevent rain from washing out the pollutive substances. Dispose all toxic waste chemicals off-site to licensed TIW collectors for treatment. 	Not Applicable	Rail Operator/ EHS Officer
	Improper handling of hazardous chemical/ substances	<ul style="list-style-type: none"> Store all hazardous substances/chemicals at designated sheltered area provided with access-controlled entrance and concrete bund walls or in storage containers with good ventilation. Spill trays shall be provided for all chemical drums, plants and machinery and potential pollutive substances used on site. Spill trays shall be regularly maintained to prevent rain from washing out the pollutive substances. Ensure that all hazardous chemicals/substances are labelled its movement is recorded and returned to the designated storage areas when not in use. Ensure all activities including repair, servicing, engine overhaul works, etc. involving the use of hazardous chemicals/substances are carried out on an area which is appropriately contained (e.g. concreted area and with proper containment/sumps). Provide emergency spill kits on site in the event of any chemical spillages. The emergency response team shall also be competent in the use of these spill kits. Ensure no trade effluent other than that of a nature or type approved by NEA Director-General are discharged into any watercourse or land. 		

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Responsibility
Airborne Noise	Noise from facility building operation	<p>Minimum controls for ACMV noise:</p> <p>Minimum controls should be applied at the detailed design stage of the development by the appointed M&E consultants. An appointed Noise consultant should validate the noise in accordance with NEA's Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Building.</p> <ul style="list-style-type: none"> • Use low air-conditioning and mechanical ventilation system equipment; • Ensure that any exhaust outlet or intake from the mechanical ventilation system is designed to be adequately set back as far as possible from the boundary line of the development; • Acoustic treatment for equipment to meet noise level limit at site boundary where necessary; • AC system to be designed with the AHU units placed at appropriate locations as set back from the boundary line of the development as possible; and • Acoustic enclosures for outdoor equipment. <p>Minimum controls for traffic noise:</p> <p>Due to the lack of information at this juncture of reporting, assessment, minimum controls and mitigation will be provided by the appointed Noise Consultant during the prelim design stage and in accordance with Technical Guideline for Land Traffic Noise Impact Assessment</p>	<ul style="list-style-type: none"> • Noise attenuators and other BAT and BEP noise control measures shall be utilised • Traffic noise at the drop-off points and parking areas shall be mitigated with low speed postings, humps and signage 	Rail Operator/ EHS Officer
Ground-borne Vibration	Ground-borne Vibration from the operation of trains	<ul style="list-style-type: none"> • Train, track and tunnel design; • Maintenance of vertical track alignment at the relevant longitudinal wavelengths; • Maintenance of roughness of the railhead and wheel thread at the relevant longitudinal and circumferential wavelengths; • Maintenance of resilient elements of track construction, e.g. rail pads, sleeper pads and ballast mats; and • Maintenance of rail joints, switches and crossings. 	<ul style="list-style-type: none"> • General maintenance of the railway track and minimising of wheel defects. 	Rail Operator

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