

PARTICULAR SPECIFICATION

APPENDIX BE

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

Contract CR2005
Provision of Services to Conduct Environmental
Impact Study

Appendix BE - Project Environmental 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 (EMMP)

The proposed EMMP is prepared for environmental impacts of the construction phase associated with the Project and that were assessed in this Project Environmental Study (PES), namely air quality, airborne noise, ground-borne noise and vibration, and surface water quality, soil and groundwater, and vectors. The EMMP details how the key mitigation measures recommended from the impact assessment are to be implemented and specifies environmental monitoring measures to assess the effectiveness of the proposed mitigation measures.

During the construction phase, this document is also 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 13.3 to comply with Land Transport Authority's (LTA) Safety, Health and Environment (SHE) specifications and any contract-specific requirements from the study.

Since the Project evolves, the EMMP is an adaptive document meant to be amended where necessary. Copies of the EMMP must always be kept onsite for reference.

This section outlines the objectives of the EMMP, and the Project organisation describes the roles and responsibilities relevant to the implementation of the EMMP and summarises the EMMP requirements for each discipline.

13.1 EMMP Objectives

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

- a) Environmental monitoring focuses on overseeing those impacts to the Project's environmental values from construction phase 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 phase of the Project.

Environmental management employs a more active approach to ensure the identified environmental impacts on sensitive receptors are directly avoided through documentation, auditing and enforcement.

13.2 Project Organisation

The proposed Project organisation and lines of communication with respect to environmental protection works are presented in Figure 13-1. The roles and responsibilities of the various parties responsible for implementing the EMMP during the construction phase are outlined below.

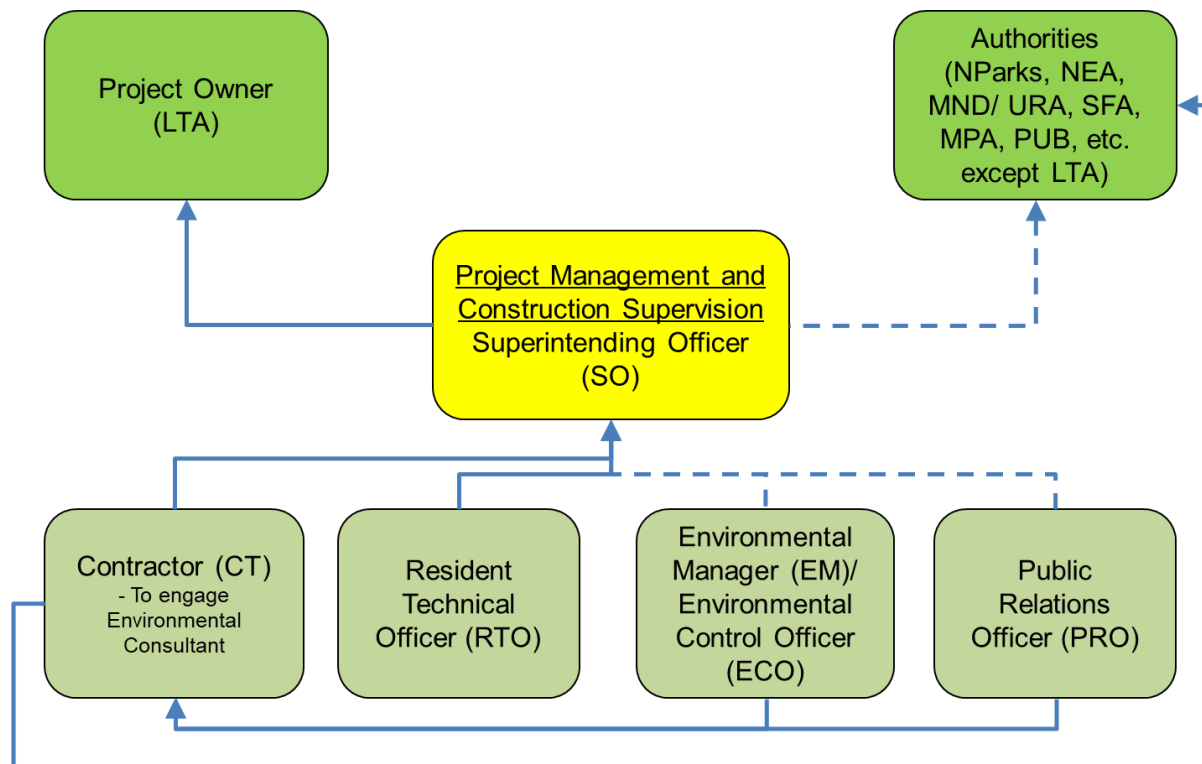


Figure 13-1 Project Organisation and Lines of Communication

13.3 Roles and Responsibilities during Construction Phase

This section describes the roles and responsibilities of the EMMP members presented on the organisational chart for construction phase of this Project.

13.3.1 Technical Agencies

Technical agencies constitute but are not limited to National Parks Board (NParks), Public Utilities Board (PUB), National Environment Agency (NEA), and Urban Redevelopment Authority (URA). These agencies shall assess and approve the detailed EMMP for the construction phase prior to commencement of works and where required during the course of the relevant Project phases.

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

LTA, being the Project owner oversees the construction phase 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.

13.3.3 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 13.3.6);
- Resolve any non-compliance issues; and
- Promote environmental awareness and responsibility and lead by example.

13.3.4 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) and/or Environmental Control Officer (ECO) 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 of Appendix 5 in the 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 EM/ECO 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 finalisation 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 and ECO 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 and seek technical agencies' approval prior to the commencement of any works for the construction phase 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.

13.3.5 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 phase 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.

13.3.5.1 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 phase, 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 13.10.1.2), when necessary.

13.3.5.2 Environmental Manager (EM) and Environment 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 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 onsite 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 phase, EM shall be the leading role with more qualified experience (especially for Projects with biodiversity sensitivity) to manage and oversee the overall EMMP implementation and

acting as the key liaison with agencies and stakeholders on environmental-related matters when necessary; while the ECO will be the supporting role to be responsible for most of the implementation of EMMP and relevant environmental measures on ground.

Generally, a NEA-registered ECO (applicable for EM and 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 phase;
- 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 courses, toolbox briefings and other relevant courses to develop the capability of all relevant workers in implementing EMMP, as well as to raise their environmental awareness in maintaining good environmental performance on site.

Resources to implement the environmental monitoring program should be allocated time to fulfil the environmental audit 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 relevant personnel for the implementation of the EMMP measures for biodiversity.
- Formulate and implement the environmental monitoring and audit program;
- 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
- Provide solutions and address complaints related to environmental incompliance 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).

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

- Log the complaint and record the date when the complaint is received onto the complaint database and inform the Project Owner, SO, 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 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.

13.4 Air Quality EMMP Requirements

As part of the recommended mitigation measures (see summary of key measures in Section 13.11), routine dust monitoring shall be undertaken during the construction phase. Based on a review of human sensitive receptors around the construction worksite areas, a continuous monitoring program as per Table 13-1 is proposed to be conducted during Project excavation and other major construction works. 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 13-1 Recommended Monitoring Program during Construction Phase (Air Quality)

Location	Parameters	Frequency and Duration	Triggers
Monitoring at the following locations as per Figure 13-2: <ul style="list-style-type: none"> • Singapore University of Social Sciences (SUSS) • 19 Clementi Crescent 	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	-
	PM ₁₀ and PM _{2.5}	Continuous monitoring of the mentioned parameters during excavation and other major construction works	Investigation and corrective actions to be taken, when <ol style="list-style-type: none"> 1. Any of the following documentation are found inadequate / missing: Air Pollution Control Plan; Compliance certificate of an Off-Road Diesel engine; or Monitoring Log. 2. If the monitored parameters exceed Singapore long term air quality targets. 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 onsite.

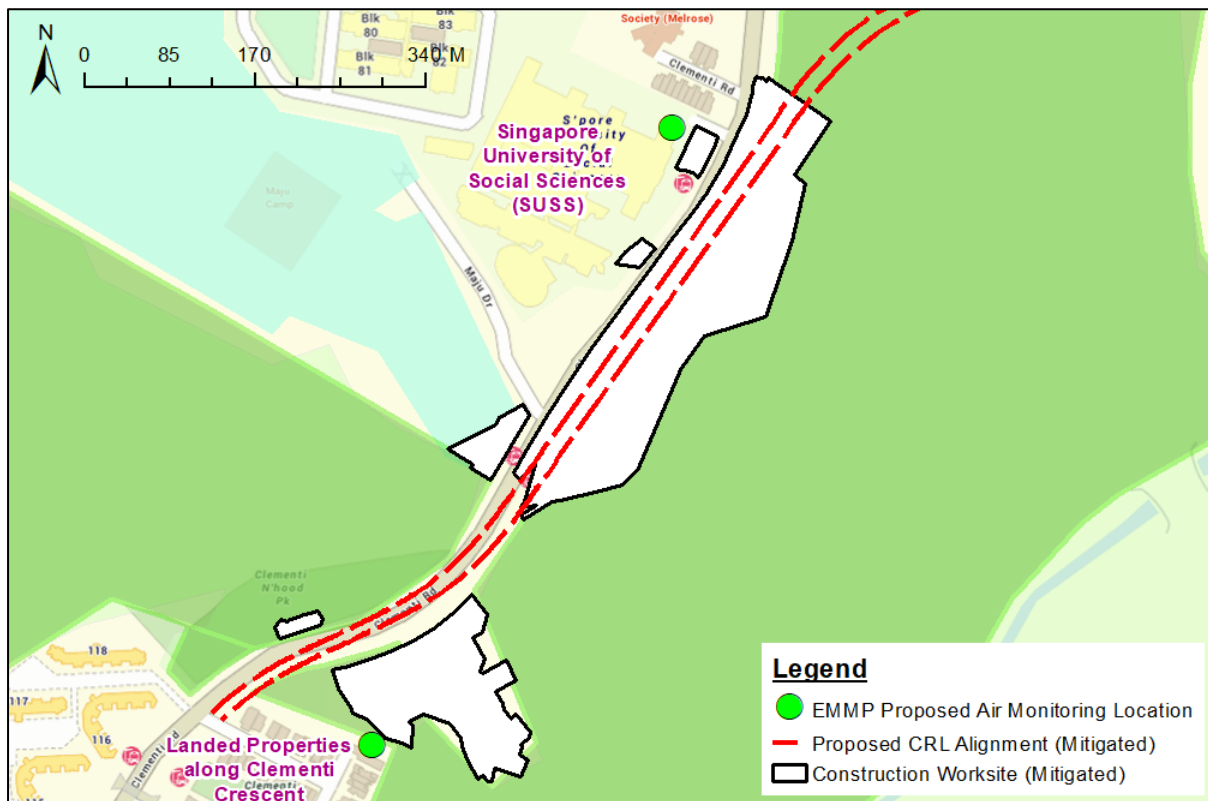


Figure 13-2 Proposed Air Monitoring Location Prior to Site Clearance and During Construction Period

13.5 Airborne Noise EMMP Requirements

The development listed below are recommended for noise monitoring due to the proximity and sensitivity of the airborne noise receptor to the construction worksite.

Table 13-2 Recommended Monitoring Program (Airborne Noise)

Location	Parameters	Frequency and Duration
Singapore University of Social Sciences	$L_{Aeq}(12 \text{ hour})$, $L_{Aeq}(1 \text{ hour})$, and $L_{Aeq}(5 \text{ min})$	At all proposed locations: <ul style="list-style-type: none"> To conduct baseline noise monitoring for one week of the afore mentioned parameters before the commencement of any construction works including site clearance. To conduct continuous monitoring of the afore mentioned parameters throughout construction period.
479 Clementi Road		

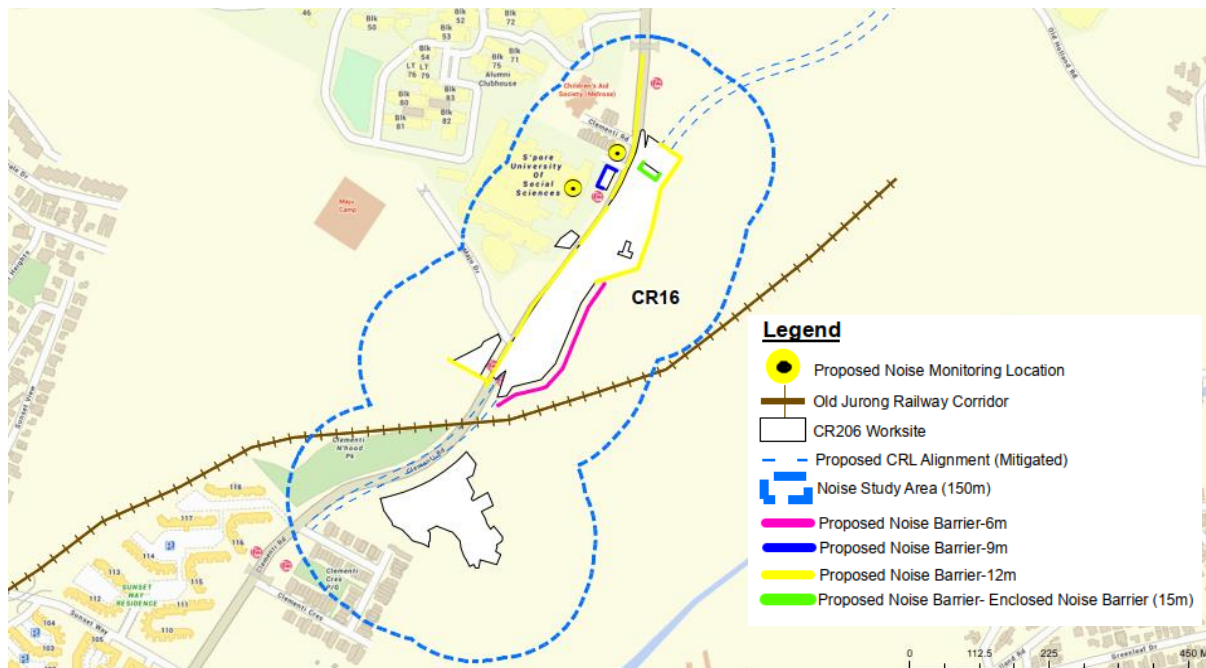


Figure 13-3 Proposed Noise Monitoring Location with Construction Noise Barriers

13.6 Ground-borne Vibration EMMP Requirements

During the construction phase, the Contractor will control construction vibration levels using the best available techniques (BAT). The Contractor will ensure that the vibration levels for any construction activities at the sensitive receptors (excluding the worksite area) do not exceed Peak Particle Velocity, PPV, 15 mm/s, to avoid cosmetic damage. No night work should be conducted after 7 pm for all non-safety critical activities since the site is next to the sensitive receptors.

Routine ground-borne vibration monitoring shall be undertaken during the construction phase. Based on a review of sensitive receptors around the construction worksite areas, a continuous monitoring program is proposed to be conducted during project construction. The proposed monitoring locations are shown in Table 13-3 and Figure 13-4.

Table 13-3 Recommended Monitoring Program (Vibration)

Location	Parameters	Frequency and Duration
1 Clementi Crescent, Clementi Green	Vibration Velocity PPV	Continuous during piling and tunnel boring activities
SIM Headquarters	Vibration Velocity PPV	Continuous during piling and tunnel boring activities
479 Clementi Road, Rosedale	Vibration Velocity PPV	Continuous during piling and tunnel boring activities
Singapore University of Social Sciences (SUSS)	Vibration Velocity PPV	Continuous during piling and tunnel boring activities



Figure 13-4 Recommended Ground-borne Vibration Monitoring Locations

13.7 Surface Water Quality EMMP Requirements

Monitoring Before Commencement of Site Clearance

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

For surface water quality, the baseline monitoring parameters should follow Table 13-4. All the discharge points from construction worksites and watercourses (as shown in Figure 13-5) should follow NEA's Allowable Limits for Trade Effluent Discharge to Watercourse/Controlled Watercourse.

Monitoring Throughout Construction Period

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

Water quality monitoring is essential as discharge of excess contaminants, especially pH, suspended solids, etc., 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 ponds/tanks discharge waters is recommended to be undertaken to complement surface water quality to assure compliance with the relevant standards. For all discharge points from construction worksites and watercourses (as shown in Figure 13-5), it is recommended to monitor water quality following Singapore NEA's Allowable Limits for Trade Effluent Discharge to Watercourse/Controlled Watercourse.

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

Test	Parameter	Monitoring Recommendation and Frequency
In-situ	Temperature	
	pH	
	Turbidity	

Test	Parameter	Monitoring Recommendation and Frequency
	Dissolved Oxygen (DO)	<ul style="list-style-type: none"> Online real time monitoring for turbidity at the discharge point locations throughout the construction period. Monthly monitoring for temperature, pH and DO at all the discharge points at the construction sites throughout the construction period.
Ex-situ	Biochemical Oxygen Demand (BOD ₅)	<ul style="list-style-type: none"> Monthly monitoring for all the ex-situ parameters at the discharge points if discharging into public drains during the construction period.
	Total Suspended Solids (TSS)	
	Nitrate (NO ₃ -N)	
	Orthophosphate (PO ₄ -P)	
	Oil & Grease (Total)	
	Oil & Grease (Hydrocarbon)	
	Lead (Pb)	
	Zinc (Zn)	
	Mercury (Hg)	

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)

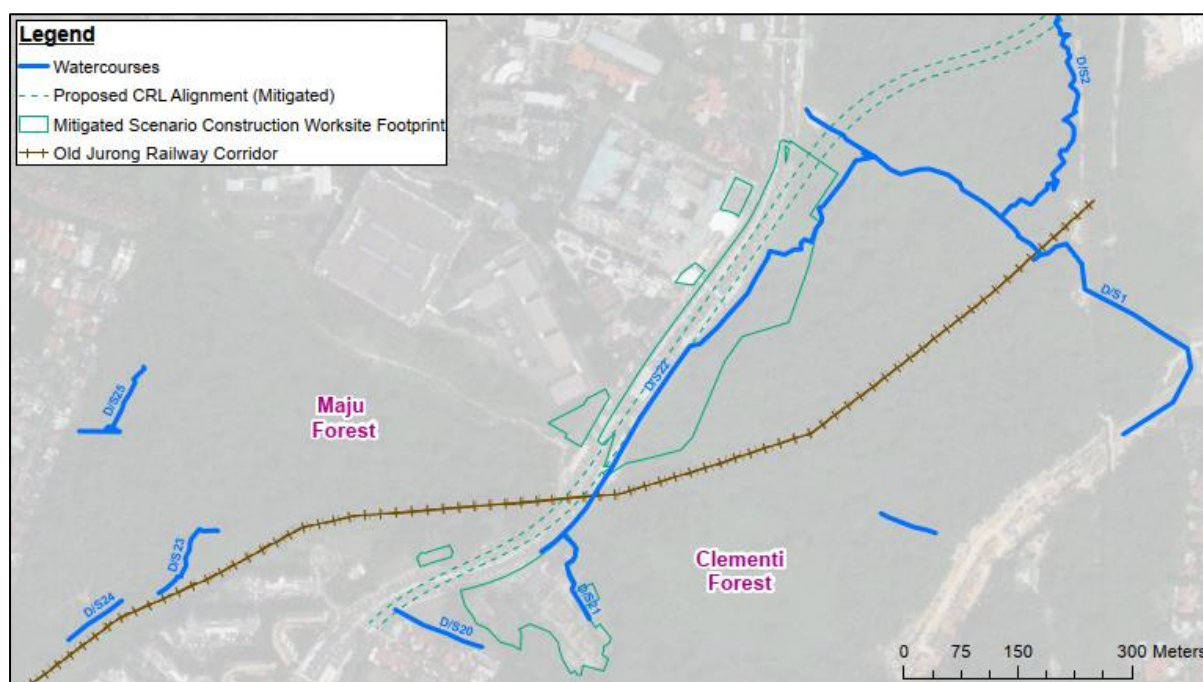


Figure 13-5 Watercourses at Clementi Forest and Maju Forest

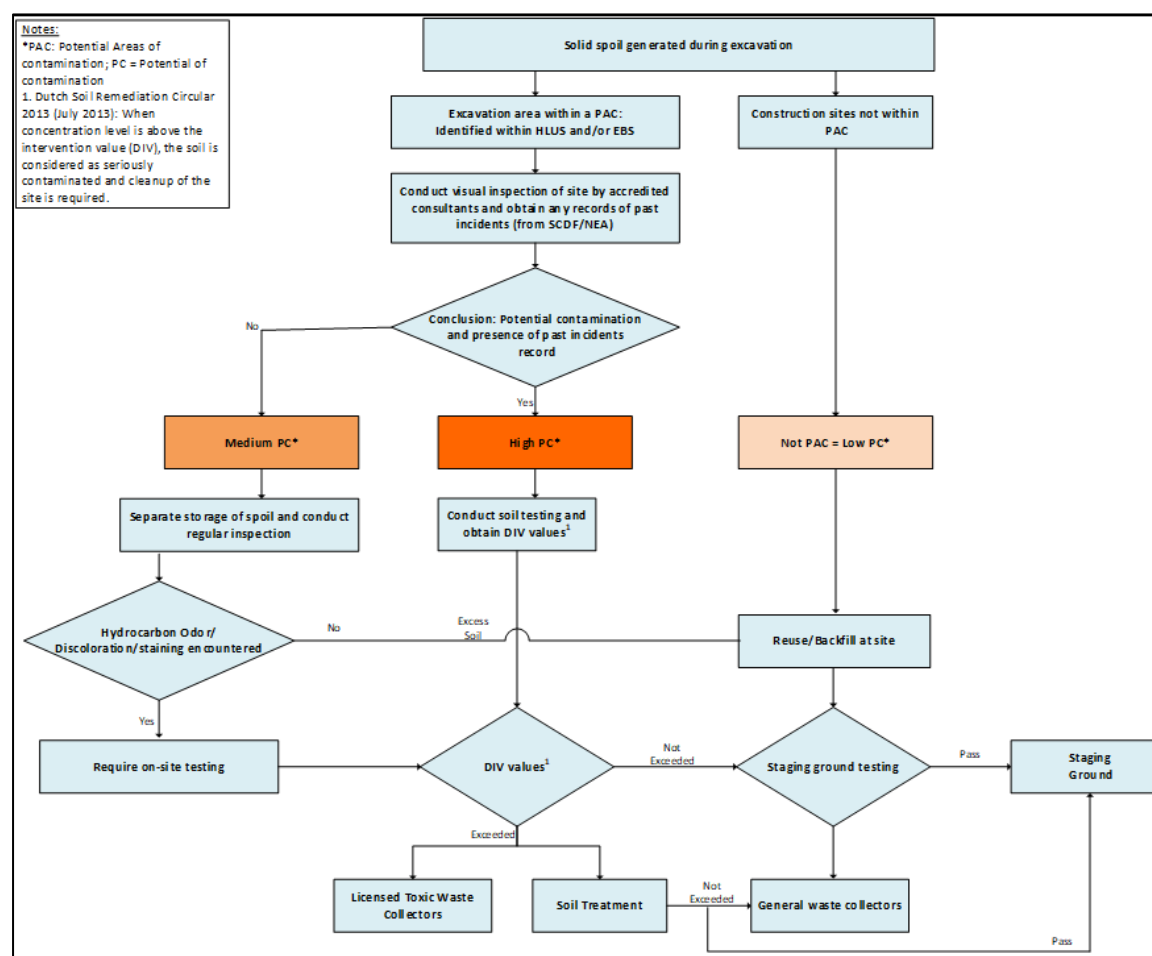
13.8 Soil and Groundwater Quality EMMP Requirements

A summary of the recommended monitoring for soil and groundwater is provided below in Table 13-5.

Table 13-5 Recommended Monitoring Program (Soil and Groundwater Quality)

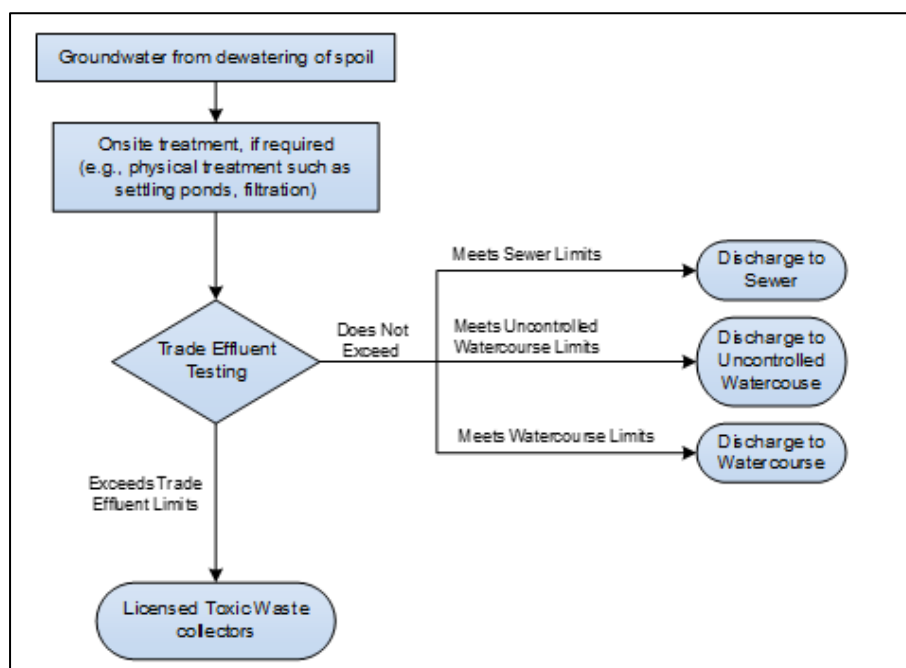
Location	Parameters	Frequency and Duration
At locations withing the Project site where excavated soil and extracted groundwater are generated and stored	Improper Management of Excavated Soil and Extracted Groundwater	<ul style="list-style-type: none"> Visual monitoring of spoil generated by the TBM to be conducted daily. Refer to the Figure 13-6 and Figure 13-7 of suspected contaminated soils and groundwater.

Location	Parameters	Frequency and Duration
At locations within the Project site where toxic chemical waste is generated/stored	Toxic Chemical Waste Generation	<ul style="list-style-type: none"> 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
At locations within the Project site where hazardous chemicals/substances are used/stored	Improper Handling of Hazardous Chemical/Substances	<ul style="list-style-type: none"> Routine environmental audit during construction phase.



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 13-6 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 13-7 Disposal of the Groundwater Generated Through Dewatering or Inflow into Excavations

13.9 Vectors EMMP Requirements

In order to ensure that procedures are closely followed, the construction phase of Projects should be accompanied by a vector monitoring program. This vector monitoring program is dedicated for the construction worksites of this Project only. Areas outside of the Project boundary is not within the Project's authority and minimum control measures shall be carried out by each household or its housing/ school/ building/ public committee and other relevant party according to the stipulated legislations and guidelines.

All construction worksites were identified to be the potential sources of vector impact due to accumulation of stagnant water, poor housekeeping and improper waste handling, transfer and storage of waste onsite. Vector-breeding may lead to severe consequences such as the spread of virulent diseases (e.g. dengue fever) both to the workers onsite and to other people near the worksite.

Aligning with LTA's Guidebook in Vector Control at LTA Sites and LTA's SHE Specifications, the Contractor shall submit a site-specific Vector Control Plan upon contract award, which encompassing the following elements:

- **Pre-existing Conditions:** To conduct a pre-construction survey and establish vector baseline based on the *LTA's Procedure for Pre-Construction Vector Baseline Survey*, which purpose is to identify high-risk areas for vectors-breeding and eliminate pre-existing vector issues before starting work.
- **Zoning Method (see example in Figure 13-8):** To divide the construction site into a maximum of three (3) zones for vector control and surveillance activities which to be conducted at least one (1) zone per day, where each zone will be combed at least twice a week.
- **Dengue Contingency Plan:** To develop response plan based on "*LTA Dengue Contingency Plan*" in case that any person found on site is discovered to be a carrier of vector-borne disease, and when outbreak of dengue or mosquito breeding ground is detected on site.

For the implementation of Vector Control Plan, the Contractor shall provide competent personnel on site as follows:

- **A registered ECO** who undergone relevant trainings (e.g. Joint ITE-NEA Certificate in Pest Management for ECO or equivalent) shall be appointed by the Contractor to assist in investigating vector-borne disease on site as part of the ECO's responsibilities stated in NEA's Code of Practice for Environmental Control Officers (ECO).
- **An in-house pest control team** with competent personnel who have undergone relevant trainings (e.g. ITE-NEA Certificate in Control for in-house pest control team or equivalent) shall be formed to carry out vector control and surveillance at least once a week. The in-house pest control team shall be able to

identify potential vector-breeding grounds and propose measures to prevent propagation of vectors on site.

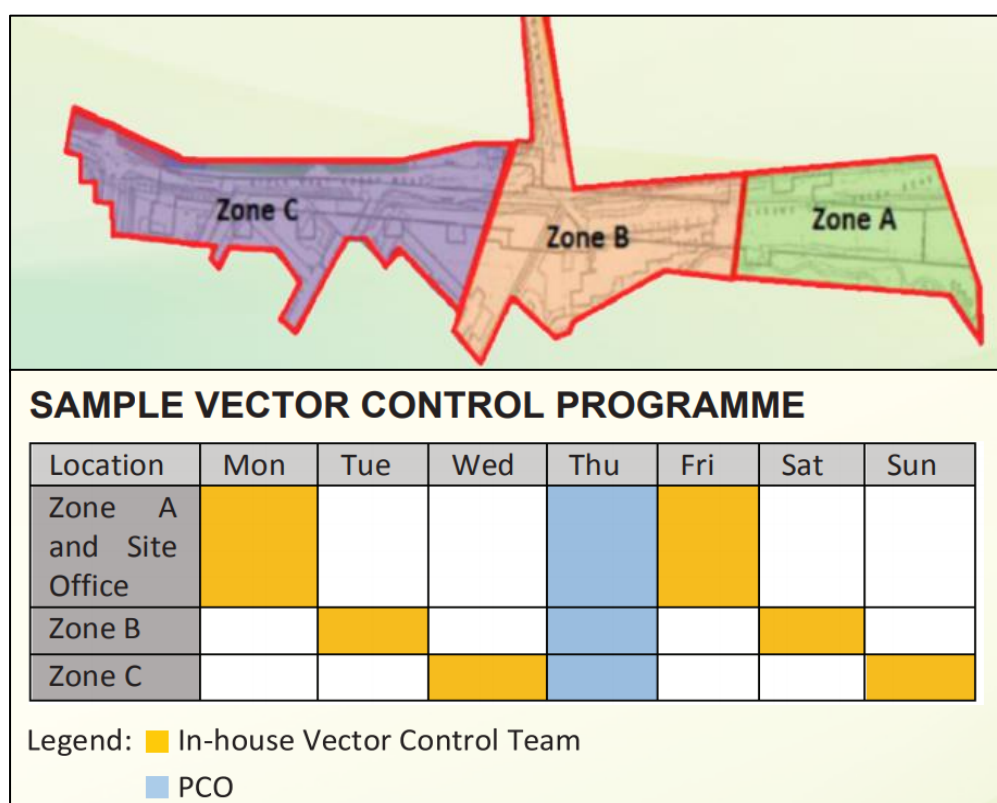
- **An external NEA-licensed PCO** (Pest Control Operator) shall be engaged to supplement the weekly in-house vector control and surveillance routine.

Noted as one of the minimum control measures on site, Gravitraps will normally be employed to prevent mosquito breeding. The in-house pest control team shall develop a vector control program (see example in Figure 13-8) to conduct a daily routine of "Search and Destroy"¹ activities at each zone, as well as to monitor and maintain Gravitraps using the Zoning Method.

The recommended monitoring program for vectors is summarised in Table 13-6 below.

Table 13-6 Recommended Monitoring Program (Vectors)

Location	Parameters	Frequency and Duration
<p>Contractor to define vector zones (see example in Figure 13-8) as per LTA's SHE specifications, for all the construction worksites (including storage and resting areas) as listed below:</p> <ul style="list-style-type: none"> • Stage 1 Worksites: <ul style="list-style-type: none"> - Cleared Site in Clementi Forest (B1); - Worksite at Centre of Clementi Road for Station Construction (B2); - Demolition Site for the Existing Pedestrian Overhead Bridge (B3); and, - Worksite at Nursery (B4). • Stage 2 Worksites: <ul style="list-style-type: none"> - Worksite at Centre of Clementi Road for Station Construction and TBM Launch Shaft (C1); and, - Worksites for Construction of Entrance and Vent Shaft (C2 and C3). 	<p>Inspection of potential mosquito breeding grounds (stagnant water), rodent burrows and droppings of other vectors (e.g. cockroaches, flies)</p>	<ul style="list-style-type: none"> • Daily inspection across different zones (see example in Figure 13-8) and their respective Gravitraps, with each zone inspected at twice a week; • Weekly inspection by an external NEA-licensed Pest Control Operator.



¹ According to LTA's Guidebook in Vector Control at LTA Sites, "Search and Destroy" refers to the search for and destruction of potential mosquito breeding grounds. This includes clearing of stagnant water, removal of unwanted water-bearing receptacles and eliminating conditions that are prone to water stagnation.

Figure 13-8 Example of Zoning Method and Vector Control Program

13.10 Environmental Audit during Construction Phase

13.10.1.1 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 are in compliance 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 to 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 properly implemented at all the work areas during the construction phase. The EM/ECO shall submit an Environmental Performance/Inspection Report which covers 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.

13.10.1.2 External Environmental Audit by Independent EMMP Consultant

It is suggested for the Project Owner (LTA) to engage an independent EMMP consultant to perform routine environmental audit (for all assessed environmental parameters) throughout the construction period.

The environmental audit exercise would also include the documentation review of onsite monitoring records against the proposed measures and findings in this study. This is to ensure proper implementation of the recommended minimum control measures, mitigation measures and EMMP, as well as to identify and/or resolve potential environmental incompliances and potential gaps with the findings of this study, if any observed during the audit.

13.11 Summary of Proposed EMMP

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

- Stakeholder Communications Plan;
- Air Pollution Control Plan;
- Site log for all monitoring activities and complaints;
- Construction Logistics Plan;
- Standard Operating Procedures;
- Emergency Response Plan;
- Inventory of wastewater streams;
- Vector Control Plan;
- Training protocols for staff, where appropriate; and
- Maintenance and Audit Schedules.

Table 13-7 Proposed Environmental Monitoring and Management Plan

Environmental Parameter	Environmental Issue	Minimum Controls	Mitigation / Management Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{2,3}
General	Exclusion of the evaluation of certain environmental impacts where detailed design is not available for review at the time of conducting this study	<ul style="list-style-type: none"> This PES was conducted based on preliminary worksite design. The current worksite design excludes any inputs in terms of locations of piezometers, utilities/ road diversion areas, site elements (e.g. workers dormitory, detention tank, site office etc.). If this be available at later stage, the Contractor shall update the findings of this PES. 	N/A	N/A	<ul style="list-style-type: none"> N/A 	N/A	CT	N/A
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 crushing or screening of demolished construction material shall be performed onsite; and Road construction shall be completed first and paved before the construction of other development commences. 	<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 onsite or off- site, and the action taken to resolve the situation in the logbook. 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) onsite 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 windowsills 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 PM₁₀ and PM_{2.5} at suitable locations (refer to Section 13.4) <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. 	PM ₁₀ , PM _{2.5}	<ul style="list-style-type: none"> Singapore University of Social Sciences (SUSS) 19 Clementi Crescent 	<p>Continuous monitoring of the mentioned parameters during excavation and other major construction works</p> <p>Furthermore, before the commencement of construction works on site, baseline air quality monitoring shall be conducted for the mentioned parameters at the mentioned locations for 1 week.</p>	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 parameters exceed Singapore long term air quality targets. If complaints are received due to Project activities. If visual non-compliance to any of the minimum control or mitigation measures are observed onsite.

² Resident Technical Officer (RTO) and Site Officers (SO, EHS Officer, and ECO) check the Project site for construction progress and implementation of environmental mitigation measures.

³ 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 Controls	Mitigation / Management Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{2,3}
			<p>Boundary screens should be at least as high as any stockpiles or dust emission sources on site.</p> <ul style="list-style-type: none">• 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 onsite, 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.• 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 vehicles or engines. Clear signs shall be erected at site entrance to inform all visitors.• 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					
			MITIGATION MEASURES FOR EARTHWORKS					

Environmental Parameter	Environmental Issue	Minimum Controls	Mitigation / Management Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{2,3}
			<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.• Sand and aggregates shall be delivered in a dampened stage and shall be re-wetted before being dumped into storage bunker.• Drop heights at transfer points shall be minimised to lessen dust generation• Special covered area shall be provided for loading and unloading process• Water sprays or sprinklers shall be employed at conveyor transfer points• 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.• Vent shall be provided with efficient fixed filter bags to comply with the dust emissions criteria.• Silos shall not be filled up with cement more than 90% of its loading capacity, to avoid overfilling.• Silos shall be equipped with overfill protection: audible high-level sensor alarm and automatic shut-down switch, which could be activated to close when a problem is detected.					
			<p>MITIGATION MEASURES FOR TRACKOUT</p> <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 onsite 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 logbook.• Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowzers and regularly cleaned.• Implement a wheel washing system (with rumble grids to dislodge accumulated dust					

Environmental Parameter	Environmental Issue	Minimum Controls	Mitigation / Management Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{2,3}
			<p>and mud prior to leaving the site where reasonably practicable).</p> <ul style="list-style-type: none"> • 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. • 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.), as listed in Appendix F	<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 utilized 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 utilized 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 exceeding 3 hours each, with a minimum respite period of one hour between each block, if possible; • 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 utilized, wherever practicable, in screening noise from on-site construction activities. • 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. The optimisation of worksite to be situated away from ecological sensitive sites as far as practicable. 	<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 (see Figure 13-3) of minimum Sound Transmission Class (STC) 20 are proposed to be erected at all the following locations:</p> <ul style="list-style-type: none"> - 12 m high noise barrier at the west construction boundary of Main Civil work worksite fronting noise sensitive receptors; - 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. - Due to the safety of traffic, only limited high (9m) noise barrier can be constructed at the entrance construction worksite near SUSS. <ul style="list-style-type: none"> • 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 sound proof baffles can be 	<p>Leq 12hours, Leq1hour and Leq 5mins</p>	<ul style="list-style-type: none"> • Singapore University of Social Sciences • 479 Clementi Road 	<p>Before commencement of any construction works (including site clearance)</p> <ul style="list-style-type: none"> • One-time airborne noise monitoring for 1 week at these locations, for establishment of latest baseline. <p>During Construction Phase</p> <ul style="list-style-type: none"> • Continuous monitoring at this location for the entire duration of construction. • Records on noise levels from construction sites should be properly kept and produced when requested. 	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 onsite. <p>If there are any cracks / leaks present on the noise barrier erected.</p>

Environmental Parameter	Environmental Issue	Minimum Controls	Mitigation / Management Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{2,3}
		<ul style="list-style-type: none"> Activities may be scheduled to minimize noise generated at certain areas during periods which may be particularly sensitive to noise, Works using machines or vehicles that generate noise should be prohibited in the night and the dawn; Appropriate hearing protectors shall be used by personnel operation the plant or equipment, the hearing protector must attenuate the exposure of the user to sound pressure levels below 85 dB (A). Signage to remind personnel to put on hearing protection will be put up at work areas that emit excessive noise. Choice of hearing protector such as ear plugs (for < 100 dB (A)), earmuffs (for 100 dB (A) to 120 dB (A), ear plugs and ear muffs (for > 120 dB (A)) in various noise exposure level. Noise awareness briefing shall be conducted regularly and highlighted the noise mitigation measures such as position of machinery, making use of portable noise barriers and dos and don'ts for use of machinery at night. Utilize school holiday time and minimize daytime noisy activities especially during entrance construction period. Avoid noisy work at school examination time. 	mounted directly on the machine around the engine cowling.					
Ground-borne Noise and Vibration	Ground-borne noise and ground-borne vibration from construction machines and equipment (e.g. vibratory roller, hydraulic hammer / rock breaker, jackhammer), (rock breaking and excavation) of rocks and tunnel boring machine.	<ul style="list-style-type: none"> Use low vibration equipment and construction techniques; Use micro piling techniques for the foundations of the building; and Liaison with the occupants of the receptors is the best method of mitigating the temporary impacts from the tunnel boring activity by providing prior warning and details on the likely duration of the impact (whilst the tunnel boring machine passes). Control vibration due to rock braking and excavation based on best practical means. Control vibration due to rock breaking and excavation based on best practical means. 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. Limiting the number of vehicles on site during working hours. 	<ul style="list-style-type: none"> Vibration generating activities shall be conducted 24 hrs. Real time continuous vibration monitoring program can be conducting during the construction phase at the nearest sensitive building receptor to the construction area. The monitoring program shall be capable to transmit 'trigger level alert' and 'stop work alert' messages to the Client to manage the ground-borne vibration levels emitted to the nearby sensitive receptors. If there are justified complaints from the operations, particularly from the piling works, then the operation may need to consider the use of reduced energy to the driving of the pile, i.e. reduced drop height of the driving weight, or smaller weight. Schedule high vibration activities during the daytime. Restrict high vibration activities to below the vibration threshold of cosmetic damage, i.e., PPV, 15.0 mm/s. No night works should be conducted after 7 pm for all non-safety critical activities since the site is next to the human receptors. If there are justified complaints from the construction works, particularly from the rock breaking, tunnel boring and bulldozer, the operation may need to mitigate vibration to the most practical levels. While using vibratory compactors, shut off the vibrator when reversing direction (the highest level of vibrations is often generated when quickly stopping and changing direction). Utilise a vibratory compactor that can adjust the impulse energy and frequency, compact soil with a static method (no vibrations), and oscillation compaction in 	PPV, mm/s	<ul style="list-style-type: none"> 1 Clementi Crescent, Clementi Green SIM headquarter 479 Clementi Road, Rosedale Singapore University of Social Sciences (SUSS) 	<ul style="list-style-type: none"> In the event of a valid complaint, until the complaint has been resolved. 	CT, ECO	<p>Investigation and corrective actions to be taken, when</p> <ol style="list-style-type: none"> The monitoring program log documentation is found inadequate / missing. 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 Controls	Mitigation / Management Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{2,3}
			<p>place of conventional vibratory action, as far as practicable.</p> <ul style="list-style-type: none"> Reduce MIC to 0.3 kg is recommended. Community Engagement: Notify nearby vibration sensitive receptors in advance of the construction activities to allay potential concerns. Altering the tunnelling operation parameters such as cutterhead rotation and driving force. 					
Surface Water Quality	<ul style="list-style-type: none"> Solid & Toxic Waste Generation Liquid Effluent and stormwater run-off Generation Improper Management of Chemical Substances 	<p>Key Minimum Controls</p> <p>1. Solid & Toxic Waste Generation:</p> <ul style="list-style-type: none"> Development of a Standard Operation Procedure (SOP) for safe handling, transfer, storage and disposal of solid waste; Effective Earth Control Measures (ECM) and monitoring implemented as required 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; ECM measures include but are not limited to minimisation of formation of bare soil, coverage of all bare/erodible surfaces, slope stability, concrete cut-off drains, silt fences/traps along the perimeter cut-off drain, turbidity curtains for works adjacent to watercourses, etc.; Implementation of CCTV including Silty Imagery Detection System (SIDS) at the public drain to monitor the surface run-off 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); Provision of enclosed bins and waste disposal facilities cleared up as often as necessary to prevent build-up. Housekeeping checks will be carried out once a day to ensure all litter is cleared from site; 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.); and Appropriate disposal of any waste listed in the Environmental Public Health (General Waste Collection) Regulations by licensed waste operator/collector. <p>2. 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; Regular audits on environmental management procedures shall be carried out on site; No unmanaged discharge of wastewater stream permitted; Reduce, reuse, and recycle hierarchy principle to be applied to wastewater onsite; No hazardous liquids to be sent to the detention ponds/tanks; 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; 	<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 (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. 	<p>All parameters identified as below:</p> <ul style="list-style-type: none"> In-situ parameters (temperature, pH, Turbidity, and Dissolved Oxygen) Ex-situ parameters (Biochemical Oxygen Demand, Total suspended Solids, Nitrate, Orthophosphate, oil & grease (total), oil & grease (hydrocarbon), Lead, Zinc and Mercury) <p>And any flooding issues should be recorded and inspected.</p>	Before every discharge outlet and at the sensitive streams (i.e. D/S1 and D/S22).	<ul style="list-style-type: none"> Online real-time turbidity monitor installed at every discharge outlet. Implementation of CCTV including a SIDS at every discharge outlet to monitor the surface run-off discharges from the sites. 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. Daily inspection on perimeter drains to ensure no surface runoff flowing out from the site untreated done by the site officer with routine audit. 	CT, EM/ECO	<p>Investigation and corrective actions to be taken, when:</p> <ol 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 Sewerage and Drainage (Surface Water Drainage) Regulations; 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 onsite.

Environmental Parameter	Environmental Issue	Minimum Controls	Mitigation / Management Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{2,3}
		<ul style="list-style-type: none">• Detention ponds/tanks will be of impervious material and be designed with sufficient capacity to hold volumes of wastewater produced onsite, as well as allowance for stormwater run-off and potential fire-fighting wastewater;• Temporary storage volumes should be provided for overflow situations. Temporary storage to be of sufficient capacity to capture any additional volumes that may be expected to ensure untreated wastewater is not released to watercourses unless it complies with Singapore NEA Guidelines on trade effluent discharge concentrations;• A responsible person (e.g. ECO) to be assigned to oversee the efficient operation of the detention ponds/tanks where 'Good Housekeeping' practices would be adhered to. Also, the area would be carefully managed to avoid spills, leaks, and odour issues, with the detention ponds/tanks checked at least daily to ensure proper functionality;• Daily record volume of wastewater, as well as volumes of sludge and other produced wastes;• The wastewater from tunnelling activities should be stored, treated onsite and disposed to public sewer based on PUB Sewerage and Drainage (Trade Effluent) Regulations;• The treated effluent from bentonite slurry treatment/plant should be treated onsite and disposed to public sewer based on PUB Sewerage and Drainage (Trade Effluent) Regulations;• 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;• The detention ponds/tanks, as well as wastewater generating areas onsite, to be equipped with spill clean-up kits;• Adequate drainage, cut-off drains sump pit, road kerb, piping and toe wall shall be designed for channelling of construction process wastewater (e.g. concrete batching, wash water, etc.) and stormwater runoff separately through detailed design for capture and treatment in the detention ponds/tanks. 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;• Implement a construction EMMP and ensure full preparation of associated plans and procedures including the following:<ul style="list-style-type: none">• EMMP to include SOPs, an Emergency Response Plan (ERP), an inventory of wastewater streams, training of staff as well as an inspection, maintenance and audit schedule; and• Full development of EMMP Wastewater Management Procedures to include dedicated management and monitoring procedures that covers all eventualities related to the proper operation of the detention ponds/tanks, or any other wastewater discharge location/equipment.• Regular and dedicated procedures for the inspection and maintenance of wastewater collection, storage, and treatment infrastructure, such as pipes, oil water separators, silt screens, etc.;• Regular and dedicated procedures for the management of stormwater collection, settling, testing and eventual discharge of 'clean' water to watercourses. This should also include associated measures required (e.g. silt curtains) to prevent high						

Environmental Parameter	Environmental Issue	Minimum Controls	Mitigation / Management Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{2,3}
		<p>sediment concentration stormwater drainage to watercourses;</p> <ul style="list-style-type: none">• A training programme for all onsite workers, including sub-Contractors, in relation to their obligations for ensuring proper water quality management.• Surface runoff from the worksite A1-W1 will be treated with ECM system before discharge to the nearby watercourses along the Island Club Road with the following measures:<ul style="list-style-type: none">• Routine monitoring and maintenance of the ECM treatment plant-related equipment; and• Spare pumps, piping and other ancillary equipment will be stored at the worksite for redundancy to enable prompt replacements/repairs are made to allow for smooth operation of the ECM system at all times.• Provision of portable toilets and onsite septic tank;• Regular cleaning of the portable toilets and clearing of sewage waste;• Appropriate location of toilet facilities away from any nearby watercourses;• Inspections and audits to ascertain the hygienic conditions onsite;• The toilet facilities will be placed at least 30 m away from any nearby watercourse;• Training of workers on the best practices to contribute in environmental protection;• Appropriate disposal of any waste listed in the Environmental Public Health (General Waste Collection) Regulations by licensed waste operator/collector.• Surface Water Drainage, to be endorsed by a Qualified Erosion Control Professional (QECF) and submitted to PUB;• Implementation of the ECM plan before the start of any construction work;• Effective ECM and monitoring implemented as recommended in the Code of Practice on Surface Water Drainage to ensure that discharge into stormwater drainage system does not contain TSS in concentrations greater than the prescribed limits under the Sewerage and Drainage (Surface Water Drainage) Regulations;• ECM measures include but are not limited to minimisation of formation of bare soil, coverage of all bare/erodible surfaces, concrete cut-off drains, silt fences/traps along the perimeter cut-off drain, turbidity curtains for works adjacent to water bodies (canals, drains, streams), etc.• Implementation of CCTV including a SIDS at the public drain to monitor the surface run-off discharges from the sites as per the PUB circular on Preventing Muddy Waters from the Construction Sites (October 2015);• 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 work site shall be effectively drained away without causing flooding in the vicinity;• Protection of stockpiles with erosion blanket coverage and proper scheduling of the demolition and earthworks to reduce the quantity of stockpiles to be stored onsite;• Coverage of temporary/open storage of excavated materials;						

Environmental Parameter	Environmental Issue	Minimum Controls	Mitigation / Management Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{2,3}
		<ul style="list-style-type: none">All vehicles should run via wheel washing process before leaving the site to ensure no earth, mud, debris, etc., is deposited on roads; and the wastewater hence generated should be stored and removed for treatment and disposal off-site by an approved Waste Management Contractor;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.ECM measures include but are not limited to minimisation of formation of bare soil, coverage of all bare/erodible surfaces, concrete cut-off drains, silt fences/traps along the perimeter cut-off drain, turbidity curtains for works adjacent to watercourses (canals, drains, streams), etc.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.; andRegular 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>3. 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);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 (SS 593: Code of Practice for Pollution Control, 2013);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; andAppropriate disposal of toxic waste as per required in the Environmental Public Health (Toxic Industrial Waste) Regulations by licensed waste operator/collector.						
Soil and Groundwater	Improper Management and Disposal of Excavated Soil and Groundwater	<ul style="list-style-type: none">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,	<ul style="list-style-type: none">Not Applicable.	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 storedAt locations where toxic chemical wastes	<ul style="list-style-type: none">Monitoring records of the amount and type of toxic chemical waste generated, once a weekInspection of hazardous chemical /substances storage conditions, once a week.	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; andThere is evidence of poor handling/ storage

Environmental Parameter	Environmental Issue	Minimum Controls	Mitigation / Management Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{2,3}
		<p>necessary precautionary measures as per the safety data sheets (SDS) including personal protective equipment should be implemented on site.</p> <ul style="list-style-type: none">• 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 the Figure 13-6. 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 the Figure 13-6.• Discharge of extracted groundwater shall be to an area approved for such disposal by the NEA and the proposed location as identified in the Figure 13-6 and following the process set out in the Figure 13-7. 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 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.• 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			<p>are generated and stored</p> <ul style="list-style-type: none">• At locations where hazardous chemicals /substances are used and stored.	<ul style="list-style-type: none">• Routine environmental audit by independent EMMP consultant, during construction phase.		<p>of toxic chemical waste and hazardous chemical.</p>

Environmental Parameter	Environmental Issue	Minimum Controls	Mitigation / Management Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{2,3}
	Toxic Chemical Waste Generation during Construction Phase	<p>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 the Figure 13-6.</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 Contractor will need to seek approval from relevant authorities (i.e. PUB & NEA) as per PUB Sewerage and Drainage (Trade Effluent) Regulations if the wastewater will be disposed to public sewer or NEA's Trade Effluent Discharge Limits to controlled watercourse if the treated trade effluent will be disposed to surface watercourses. If such discharges are not approved, the trade effluent will be stored, treated or recycled on site and finally disposed off-site 						
	Improper Handling of Hazardous Chemicals/Substances during Construction Phase	<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 						

Environmental Parameter	Environmental Issue	Minimum Controls	Mitigation / Management Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers ^{2,3}
		<p>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.</p> <ul style="list-style-type: none"> 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. 						
Vectors	Accumulation of stagnant water, poor housekeeping and improper handling/disposal of solid waste (especially food waste)	<ul style="list-style-type: none"> Adhere to Control of Vector and Pesticide Act (CVPA) and ensure good housekeeping onsite. Preparation and implementation of an effective vector control plan and measures as required under LTA's SHE Specifications and LTA's Guidebook in Vector Control at LTA Sites, as well as the NEA's Code of Practice for Environmental Control Officers. (See Section 13.9) Ensure water-bearing receptacles, gaps on grounds and equipment (e.g. openings at concrete barriers), as well as stockpiled areas are covered or sheltered, especially during the northeast monsoon season between November to January. Scheduled daily housekeeping to ensure clearance of stagnant water and unwanted items are discarded properly. Site entrance shall be paved to avoid ground depression. Milled waste can be used to level the ground before laying steel plates. Provide movable roof over shaft to prevent rainwater ingress. Pump shall be deployed to clear water at areas where drainage is not possible, as well as for larger recessed surfaces. Install pitched roof on top and/or seal up bottom of site container office. After trees clearance, top of tree stumps has to be either remove thoroughly or patched up. Pipette can be used for larvae-checking at the hard-to-reach parts of a tree. Food disposal should be clearly allocated and disposed of on a daily basis to discourage rodents from establishing nests on site and to prevent cockroaches/flies' infestation. Store food in rodent proof storage containers/cabinets with at least 60 cm clearance above ground level. Thermal Fogging shall only be carried out when there is a Dengue outbreak or when high mosquito population is detected at construction worksite. Regular fogging is not encouraged as it may build up the mosquitoes' resistance over time. 	Not Applicable.	<ul style="list-style-type: none"> Inspection of potential mosquitoes breeding grounds (water ponding) Inspection of rodent burrows Inspection of cockroaches and flies' droppings 	Within and/or at boundary of construction worksites, as well as any other temporary and permanent utilities diversion work areas or any other relevant work areas associated with this Project.	<ul style="list-style-type: none"> Daily inspection and housekeeping check across different zones and the Gravitrap, with each zone inspected at twice a week. Weekly inspection by an external NEA-licensed PCO. 	CT, EM/ECO	<p>Investigation and corrective actions (i.e. Stop Work Orders) to be taken, when:</p> <p>a. Worksite is found to have vector-breeding habitats.</p> <p>b. There is an occurrence of suspected dengue outbreak cases.</p>

