Proposed Downtown Line 2 Extension and a New Station on Existing North-South Line Environmental Study (ES)

Non Technical Summary (NTS)

Land Transport Authority's Objectives

With the vision to strengthen the connectivity and resilience of land transport network in Singapore to support a car-lite nation, Land Transport Authority (LTA) has set off with an ambitious journey with one of the key targets being the expansion of rail network to about 360km by 2030. This means connecting eight in 10 households to within 10 minutes of a train station. With 360km of rail network, Singapore will have a total rail length that is longer than major cities such as Tokyo or Hong Kong today, and be on par with London and New York City.

The Downtown Line 2 Extension (DTL2e) is required to extend the Downtown Line (DTL) alignment to form an interchange with North South Line (NSL), hence enhancing public transport connectivity for North West Region. The project will contribute to time savings through better connectivity for commuters in northern Singapore.

Overview

The proposed Downtown Line 2 Extension (DTL2e) is currently at Advance Engineering Study (AES) stage. An Environmental Study (ES) has been undertaken to assess the potential environmental impacts arising from and associated with the construction and operation of the proposed Project on both human and ecological receptors. However, in this document, only impacts related to ecological receptors are detailed.

This Document

This Document presents a Non-Technical Summary (NTS) of the findings from the Environmental Study (ES) conducted for both construction and operational phase only on the ecological receptors in the vicinity of the alignment.

Scope and Objective of ES

The **Scope of the ES** covers the construction and operational impacts on the environment from above and below ground (i.e., biodiversity, hydrology and surface water quality, air quality, airborne noise, vibration, soil and groundwater). Where the impacts were deemed to be "Significant" or "Moderate/Major", appropriate mitigation measures were also recommended, along with the proposed Environmental Monitoring and Management Plan (EMMP) to manage these impacts.

The **Objective of ES** is to present an assessment of the potential environmental impacts arising from and associated with the construction and operation of the Project on ecological receptors in the vicinity of the alignment. The Project is in close proximity to Sungei Pang Sua, Rail Corridor and Pang Sua Canal. These identified areas along the alignment have formed the Biodiversity Study Area for this report. The study of pre-construction environmental baseline conditions along this route was also conducted and included as part of the ES.

The Project

Project Location and Components

The Project is planned to be located within or close to the Rail Corridor, Sungei Pang Sua and Pang Sua Canal. These areas of ecological concerns have been identified as Biodiversity Study Areas as shown in

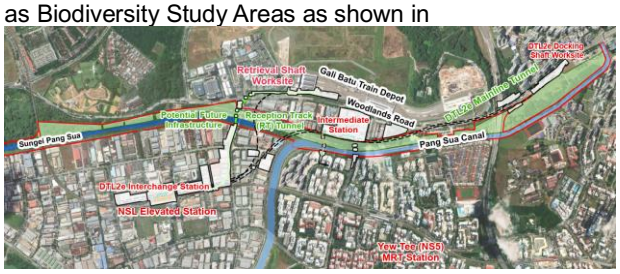


Figure 1, which were assessed against the worksites along the DTL2e as listed below. An above-ground potential future infrastructure to connect the Interchange Station and Gali Batu Train Depot was considered in this report. However, the viability of this potential future infrastructure is still under study and will be shared when ready.

- Interchange Station worksites, intended for the construction of station with its associated facilities and also Tunnel Boring Machine (TBM) launching of main tunnel towards Intermediate Station and reception track towards Gali Batu Train Depot;
- Intermediate Station worksites, intended for the construction of station with its associated facilities and Tunnel Boring Machine (TBM) launching of main tunnel towards docking shaft worksite;
- Docking shaft worksites, intended for the docking of TBM from Intermediate Station with the existing DTL2 overrun tunnel from DT1 Bukit Panjang station;
- Worksites for a provisional potential future infrastructure development to connect Interchange Station and Gali Batu Train Depot. The viability of the potential future infrastructure is still under study and will be shared when ready;
- Retrieval shaft worksites, intended for the retrieval of reception track tunnel from Interchange Station and also construction of reception track and the potential future infrastructure;
  Pedestrian Linkbridge column worksites, intended for construction of elevated bridge to connect Intermediate Station and HDB estate of Choa Chu

Kang Crescent; and Vehicular Bridge column worksites, intended for construction of elevated heavy vehicle bridge to connect Choa Chu Kang North 7 and Woodlands Road.

Figure 1 Project Location and Proposed Worksite Areas

To prepare the worksites for construction works, the Project will start with activities such as building demolition and piles removal, road and utility diversion works, common utility trench, installation of instrumentation, site clearance and construction of site access. Ground improvement works may be required in order to improve the soil stability in the area, while rock breaking and excavation may be required at the Interchange Station Worksite.

The construction of MRT structures would be carried out before reinstatement and/or landscaping works during the final stage of construction phase.

Environmental Consultation Process and Stakeholders Engagement

Prior to the commissioning of the ES, an Environmental Consultation Process was undertaken by LTA with the relevant technical Agencies (i.e., MPA, SFA, NEA, NParks, URA/ MND, PUB) to confirm the scope of the ES of the Project which was then documented in the form of an Inception Report for approval from the relevant Agencies.

Nature Groups were also engaged throughout the process to share the ES findings, as well as to discuss design optimisation / mitigation measures and any other key biodiversity issues related to this Project. LTA will continue to engage Nature Groups throughout the Project on further measures to mitigate any potential environmental impact even during the construction phase.

Environmental Impact Mitigation Through Design Optimisation

Extensive engagements were made with stakeholders (including Nature Groups) to discuss measures to reduce environmental impacts during the ES process. The project location and components described above have taken the principle of avoidance of environmental impacts as one of its consideration. Some of the considerations are described below:

- The location of Intermediate Station is sited within JTC land providing direct access to JTC future development as part of JTC's redevelopment of Sungei Kadut. Additionally, the station box avoids Rail Corridor and this is expected to minimize impact on biodiversity in terms of ecological connectivity, fauna mortality and human wildlife conflict. Additionally, it aims to reduce air quality, noise and vibration impact on ecological receptors and Rail Corridor users.
- Yew Tee residents will have direct access to the station through the above ground pedestrian linkbridge and a vehicular bridge.
- With the above ground pedestrian linkbridge and vehicular bridge, the construction of subways through extensive cut and cover construction which affects the sensitive gas pipes, Pang Sua Canal and E63 drain, can be avoided as there is no requirement to divert the Pang Sua canal and E63 drain. The above ground structures are expected to have less environmental impact compared to the construction of the underground subway.
- In terms of construction methodology, tunnelling using TBM is chosen rather than cut and cover tunnel construction, as the former will minimise the environmental impact towards sensitive receptors along the tunnel alignment.
- The worksite for the potential future infrastructure (footings, storage and access routes) is planned to be located at least 5 m away from the banks of Sungei Pang Sua and does not affect the existing conditions (hydrology, water quality and slope stability) of Sungei Pang Sua and the mangroves along it. This is expected to reduce habitat degradation, accidental injury or mortality of fauna, and water quality impact on ecological receptors.

Overview of Assessment Methodology

The assessment was undertaken by identifying the Study Area, categorising the sensitive receptors within Study Area, followed by the prediction and evaluation of impacts, and then recommendation of mitigation measures and EMMP where relevant. The environmental impacts studied were direct impacts to biodiversity, or indirectly via other environmental aspects such as air quality, airborne noise, vibration, hydrology and water quality and soil and groundwater.

Definition of Study Area and Identification of Sensitive Receptors

The Study Area, defined as a representative area covering the construction / operational footprint of the Project, was used for the assessment of environmental impacts. The Study Area identified for each environmental parameter varies based on the relevant legislation or international guidelines as detailed in **Table 1**.

Table 1: Summary of Study Area

Environmental Parameter	Study Area
Biodiversity	• Sungei Pang Sua

Environmental Parameter	Study Area
	• Pang Sua Canal • Rail Corridor
Hydrology and Surface Water Quality	Any watercourse with direct impact from the Project
Air Quality	• 50 m around the construction worksite area for ecological receptors for construction phase • 250 m around the above ground Project Footprint for operational phase
Airborne Noise	• 150 m around above ground construction worksite area for construction phase • Boundary of above ground Project Footprint for boundary noise assessment • 70 m from the train at-grade and on viaduct for traffic noise assessment
Ground-borne Vibration	100 m around above ground construction worksite areas and from the centreline of DTLe alignment as a starting point.
Soil and Groundwater	250 m on both sides of DTLe alignment and above-ground potential future infrastructure

The assessment criteria for each parameter were also established based on the similar sources of local and international guidelines or precedent reports and are detailed in the ES.

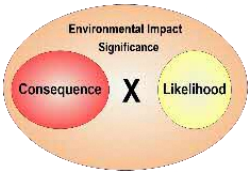
The sensitive receptors identified for this ES were mainly flora and fauna of their habitats within the Biodiversity Study Areas nearby the construction worksites, i.e., Sungei Pang Sua, Rail Corridor and Pang Sua Canal. The ecologically sensitive receptors were classified into Priority 1, 2 and 3, which were defined differently within each environmental discipline (viz., air, noise, vibration, hydrology and surface water quality, and soil and groundwater) and detailed in the ES Baseline Data Collection.

Baseline Data Collection

To establish the baseline conditions of the Study Area, pre-construction environmental baseline data was collected from both primary sources (e.g., on-site water sampling, air, noise and vibration monitoring, site reconnaissance survey) and secondary sources (e.g., review of available environmental surveys, soil and groundwater baseline reports, publicly available data such as maps and weather data from online database, existing literature, books, etc.).

Prediction and Evaluation of Impact

Impacts were evaluated based on their Significance, which is a measure of the weight that should be given to each impact in decision making and if it warrants impact management. It was assessed with consideration of two main factors: Impact Consequence and Likelihood of Occurrence.



Impact Consequence is a function of a range of considerations including impact spread, impact duration, impact intensity and nature, legal and guideline compliance. Likelihood of Occurrence refers to how likely an event would occur during the project construction and operational phases, which considers the frequency of exposure to the receptor.

In general, a risk-based matrix was used for summation of Impact Consequence and Likelihood of Occurrence as shown in **Figure 2**.

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

Figure 2 Impact Significance Matrix (General)

The application of these matrices may differ slightly for ground-borne vibration and air quality impact assessments. The full definitions of impact assessment terms and methodology were detailed in the ES.

Impact Mitigation, Monitoring and Management

The mitigation, monitoring and management approach was defined in line with the NParks Biodiversity Impact Assessment (BIA) 2020, and the international risk assessment guidelines adopted in Singapore, as shown in **Figure 3.**

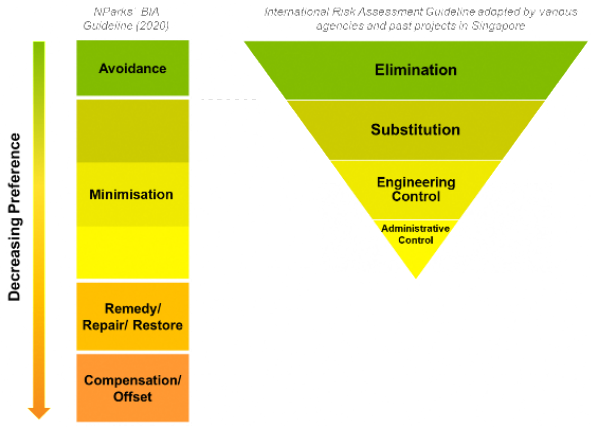


Figure 3: Mitigation Hierarchy

Baseline Environment

Both primary and secondary sources of information were used to establish the baseline conditions at the surrounding areas of this Project.

Other than secondary sources, on-site field surveys and monitoring works were conducted to establish the baseline conditions of:

- Biodiversity
- Hydrology and Surface Water Quality
- Air Quality
- Airborne Noise
- Ground-borne Vibration

The baseline data review for Soil and Groundwater was carried out via secondary source only, i.e., from the findings of Historical Land Use Survey (HLUS) as well as site investigations recorded in separate studies.

Biodiversity

Sungei Pang Sua is first observed in the 1945 Topography Map. It is seen to run along Woodlands Road and then the existing Singapore Kranji Railway track. Another river called Sungei Kadut is seen in the 1953 Topography Map. This river has a similar alignment to the existing constructed Pang Sua Canal. In the early 2000s, the waterbodies that were initially cutting through the Rail Corridor were widened to form Pang Sua Canal to make it more interconnected with other waterbodies throughout Singapore, as part of PUB's effort to connect reservoirs and waterbodies in Singapore.

The Biodiversity Study Area is part of the Rail Corridor and serves as a passageway for the dispersal of wildlife along the Rail Corridor. Species using the surrounding green spaces (e.g., Kranji woodland, Bukit Mandai forest to the northeast and Bukit Gombak forest to the south) may use the Rail Corridor as an ecological corridor to move to other green spaces.

Field surveys were conducted from November 2021 – March 2022 covering all known vegetation and habitat types to understand the biodiversity within the Biodiversity Study Area.

Flora

The Biodiversity Study Area comprises six habitat types. The largest habitat is urban vegetation (33.74 ha; 36.65%), followed by scrubland 19.51 ha; 21.19%, mangrove forest (11.04 ha; 11.99%), and exotic-dominated secondary forest (6.38 ha; 6.93 %). Altogether, spontaneous vegetation takes up 40.12 % (36.93 ha) of the Study Area. The remaining non-vegetated habitats are waterbodies, such as Pang Sua Canal (9.55 ha; 10.37%), Sungei Pang Sua (7.02 ha; 7.63%), and a natural stream. Other infrastructure and amenities take up (4.82 ha; 5.24%) of the Study Area.

One terrestrial habitat (mangrove) and one aquatic habitat (Sungei Pang Sua) were assessed to have overall high ecological value, i.e., Priority 1. Two terrestrial habitats (scrubland and exotic-dominated secondary forest) and one aquatic habitat (stream) were assessed to have overall medium ecological value, i.e., Priority 2. One terrestrial habitat (urban vegetation) and one aquatic habitat (Pang Sua Canal) were assessed to have overall low ecological value, i.e., Priority 3. Refer to **Figure 4** for habitat types within Biodiversity Study Area.

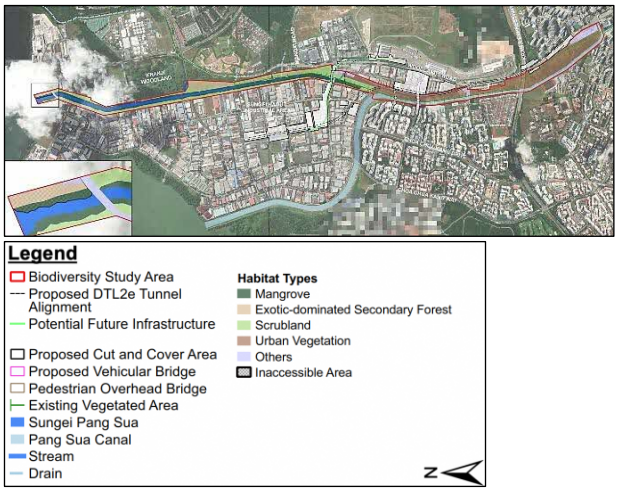


Figure 4: Habitat Types within Biodiversity Study Area

Of the 206 species (including 2 species groups), 16 were considered species of conservation significance. All 16 species are associated with coastal and/or mangrove habitats, except for the Vulnerable *Bridelia stipularis* and *Digitaria longiflora.* The distribution of the species of conservation significance was recorded mostly within the mangrove forest. Some of these species are Critically Endangered *Sonneratia caseolaris, Finlaysonia obovata,* nationally Endangered *Ceriops zippeliana, Halophila beccarii, Lumnitzera littorea, Lumnitzera racemosa,* and nationally Vulnerable *Nypa fruticans*. Specimens of *Sonneratia caseolaris* largely contributes to the total number of specimens of species of conservation significance that was recorded in the Study Area, of which, a higher number of seedlings and young saplings were recorded inland. The population was observed to be thriving and propagating. The highest density of *Sonneratia caseolaris* was observed inland of Sungei Pang Sua (refer to **Figure 5**).

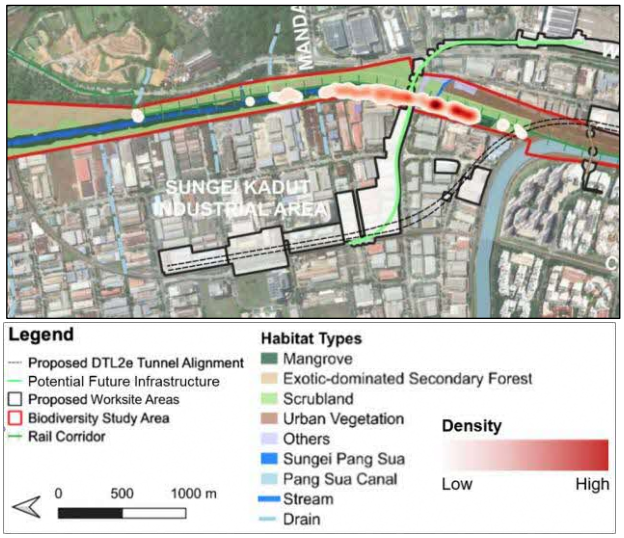


Figure 5: Heat Map Showing Density of S.caseolaris

A total of 226 large plant specimens are recorded in the Study Area, of which, 163 specimens are exotic, 61 are native and 2 are cryptogenic. With 47 individuals recorded, Senegal mahogany (*Khaya senegalensis*), forms the majority of large plant species, followed by raintree (*Samanea saman*) with 42 individuals recorded. Eight specimens were identified as other specimens of value, of which six were bamboo clusters and two were albizia trees with raptor nest belonging to changeable hawk eagle (*Nisaetus cirrhatus)* and white-bellied sea eagle (*Haliaeetus leucogaster*) respectively. The raptor nests are located on the edge of the Study Area. Finally, a total of 1,762 specimens belonging to 56 species and 1 species group (i.e., *Syzygium* cf *malaccense*) were tagged and recorded during tree mapping survey. More than half (52.1%; 918 specimens) of these trees are exotic, 47.4% (835 specimens) are native and the remaining 0.5% (9 specimens) are cryptogenic.

Sonneratia caseolaris

Finlaysonia obovata

Halophila beccarii

Ceriops zippeliana

Lumnitzera racemosa

Lumnitzera littorea

Figure 6: Examples of Flora Species within Biodiversity Study Area

Fauna

The faunistic field assessment recorded 293 faunal species within the Study Area, including 228 terrestrial species and 65 aquatic species. The terrestrial fauna community is dominated by birds (99 species) and butterflies (59 species), while the aquatic fauna community is dominated by molluscs (37 species). Terrestrial fauna observed are typical of secondary forest, woodland and scrubland habitats. Aquatic fauna observed is characterized by species from a continuum of habitat from slightly brackish to mostly marine, with tidal influence. This is because Sungei Pang Sua receives both freshwater inputs inland and tidal influence at the coast.

Twenty-one species of conservation significance were recorded. This comprised 18 bird, 1 non-volant mammal, 1 decapod and 1 horseshoe crab species. Species of conservation significance were distributed across the Study Area, although there appears to have higher records from the central to northern part of the Study Area.

Bird species of conservation significance recorded include waterbirds, such as the purple heron (*Ardea purpurea*) and yellow bitter (*Ixobrychus sinensis*); raptors such as the white-bellied sea eagle (*Haliaeetus leucogaster*) and changeable hawk-eagle (*Nisaetus cirrhatus*); passerine birds such as the oriental magpie-robin (*Copsychus saularis*) and the spotted wood owl (*Strix seloputo*). A nest of a pair of white-bellied sea eagle and a changeable hawk-eagle were observed within the Kranji woodland located just outside of the Study Area. Twenty-two migratory birds were recorded, including 16 common or abundant species such as the arctic warbler (*Phylloscopus borealis*); 5 uncommon species such as the black-capped kingfisher (*Halcyon pileata*); and 1 rare migrant, the yellow-browed warbler (*Phylloscopus inornatus*). These records show that the Study Area has value in supporting species of conservation significance and migratory birds.

A family of smooth-coated otter (*Lutrogale perspicillata*), with up to seven individuals, was seen within the Study Area. A spraint site of the otter was observed under the train track adjacent to Sungei Pang Sua. While not recorded in this study, the globally and nationally Critically Endangered Sunda pangolin (*Manis javanica*) was deemed likely to occur in the Study Area. The Study Area

lies partially along the Rail Corridor can serve as a passageway for the dispersal of these wildlife.

Sungei Pang Sua is also home to mangrove- and mudflat-associated species. A dead mangrove horsecrab (*Carcinoscorpius rotundicauda*) was also observed, although local breeding population is unlikely present. Yet, it is home to nationally Endangered mud lobsters (*Thalassina* spp.). While not observed in this study due to its cryptic nature, the presence of active mounds suggests its presence. The highest density of mud lobster mounds was observed inland of Sungei Pang Sua (refer to **Figure 7**). Although only striated heron (*Butorides striata*) was observed roosting within Sungei Pang Sua, it is a potential roosting habitat for other ardeids, such the black-crowned night heron (*Nycticorax nycticorax*), purple heron and grey heron, which were also observed in the Study Area. On the other hand, Pang Sua Canal is poor in aquatic life but may provide connectivity for some aquatic species such as the otters, and birds to move between waterways.

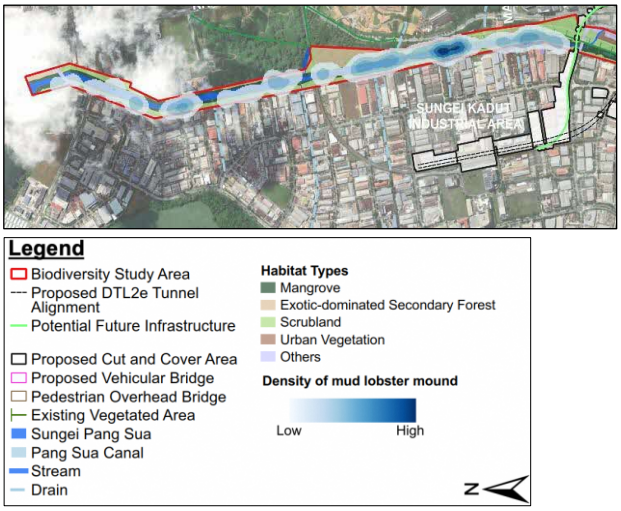


Figure 7: Heat map showing density of mud lobster mounds


Purple heron


Grey heron

Smooth-coated otter


Mangrove horseshoe crab

Figure 8: Examples of Fauna Species within Biodiversity Study Area

Hydrology and Surface Water Quality

While the hydrological baseline study aimed to identify watercourses present in the Study Area including their location, water flow conditions and bank characteristics, the water quality surveys determined the water quality of the surface watercourses.

Pang Sua Canal has perennial flow with water flow ranging from 0.2 to 0.6 m/s observed during dry weather and the water flow could be more than 2 m/s during heavy storm throughout the canal. Sungei Pang Sua is a tidal-influenced stream and has perennial flow with slow water flow (i.e., ranged from 0.04 to 0.3 m/s) and even could be in almost stagnant condition at some areas. A few surface runoff discharge outlets (i.e., E63 Drain, Drain 2, Drain 3, Drain 4, Drain 5, Drain 6, Drain 7 and Drain 8) which originated from urbanized area and forest area (i.e., Stream 1) were observed along the Sungei Pang Sua.

Figure 9: Water Sampling Location in the vicinity of Biodiversity Study Area

In order to get comprehensive data that is representative of baseline conditions of water quality and to capture the possible changes in water quality parameters over time and different events, the identified watercourses were sampled during dry and wet weather conditions. Five (5) water quality stations were located at the upstream (i.e., WQ1, WQ2), midstream (i.e., WQ3, WQ4) and downstream (i.e., WQ5) of Pang Sua Canal. Another ten (10) water quality stations (i.e., WQ6, WQ7, WQ8, WQ9A, WQ9, WQ10A, WQ10, WQ11A, WQ11 and WQ12) were sampled along Sungei Pang Sua as well as at the streams (i.e., Stream 1) and drains (i.e., E63 Drain, Drain 3 and Drain 6) which eventually discharge to Sungei Pang Sua. Three (3) water quality stations (i.e., WQ13, WQ14 and WQ15) were also sampled at the marine area near Sungei Pang Sua in order to capture the water quality from Sungei Pang Sua. The surface water samples were tested for the physical and chemical parameters relevant for sustenance of aquatic life including temperature, pH, salinity,

conductivity, total dissolved solids (TDS), dissolved oxygen (DO), turbidity, total suspended solids (TSS), biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), total organic carbon (TOC), oil & grease (total), total phosphorous (TP), orthophosphate (PO_4-P), total nitrogen (TN), nitrate (NO_3-N), ammoniacal nitrogen (NH_4-N), *Enterococcus*, chlorophyll-a, cadmium, chromium, copper, zinc, lead, iron, mercury, nickel, arsenic, cyanide, barium, chloride, phenol and calcium. The data results of the water quality stations were compared with respective NEA discharge guideline of Singapore, international criteria for aquatic life and Singapore Marine Water Quality (SMWQ) guideline accordingly.

From the results of the hydrological and water quality baseline assessment, it could be inferred that the Pang Sua Canal was generally perennial (fed from stormwater), however, the water quality results indicate poor water quality for survival of aquatic life. This also aligns with biodiversity findings, which shows that only Pang Sua Canal supported poor aquatic life at the time of survey. For perennial Sungei Pang Sua, the water quality of the environment was mostly affected by the tidal influence and its surrounding urbanised areas (i.e., industrial area). Despite high nutrients, turbidity with some heavy metals contamination and lower DO found along the watercourse, the mangroves along Sungei Pang Sua still supports certain flora and fauna species of conservation significance as described in biodiversity findings.

Air Quality

Air quality impacts from the construction and operation of the proposed project were assessed on air sensitive receptors (ASRs) in the vicinity of the project site. Potential impacts to the neighbouring sensitive receptors during construction phase mainly include emissions from the heavy vehicular exhaust and dust emitted from the earthworks, construction and track out activities. During the operational phase, emissions from vehicle exhaust due to increased traffic in the vicinity of the proposed development is identified as the predominant air emission source. In order to assess the current baseline air quality in the Study Area, baseline air quality data were collected for 1 week at each of 5 representative monitoring locations between February – March 2022.

PM_{10} and $PM_{2.5}$ concentrations were monitored at all monitoring locations and additionally NO_2 concentration was also monitored for areas that is potentially impacted during operational phase (i.e., A01, A02 and A05). Based on the monitored results, all pollutants' Singapore Ambient Air Quality Long Term Targets were met throughout the monitoring duration at all 5 monitoring locations.

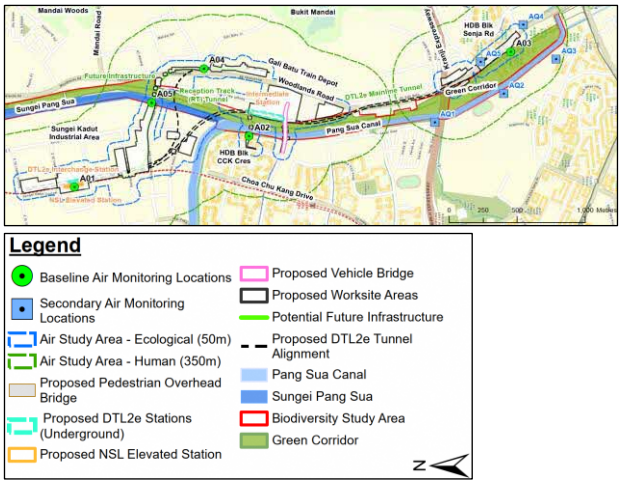


Figure 10: Air Baseline Monitoring in the vicinity of Biodiversity Study Area

Airborne Noise

Baseline airborne noise monitoring was conducted for 1 week across July – November 2021 at eleven (11) locations within the 150 m Airborne Noise Study Area established accordance with noise legislations outlined in EPM, 2008 (see **Figure 11)**. Secondary baseline airborne noise data were also referenced and adopted in this study where applicable. The Norsonic 131 Sound Level Meter was used to record the baseline noise levels over time periods of average 12 hours (long term), 1 hour and 5 minutes (short term) at each location.

Upon consultation with relevant agencies, the average pre-construction baseline served as the criteria for ecologically sensitive receptors and the predicted noise levels were assessed by "no-worse-off than baseline" approach. This is generally much more stringent than NEA's noise criteria for human receptors.

The average baseline noise levels for Rail Corridor north of KJE is $L_{eq(5min)}$ 54 dB(A) daytime and $L_{eq(5min)}$ 51 dB(A) nighttime. While the average baseline noise levels for Rail Corridor south of KJE is $L_{eq(5min)}$ 58 dB(A) daytime and $L_{eq(5min)}$ 56 dB(A) nighttime.

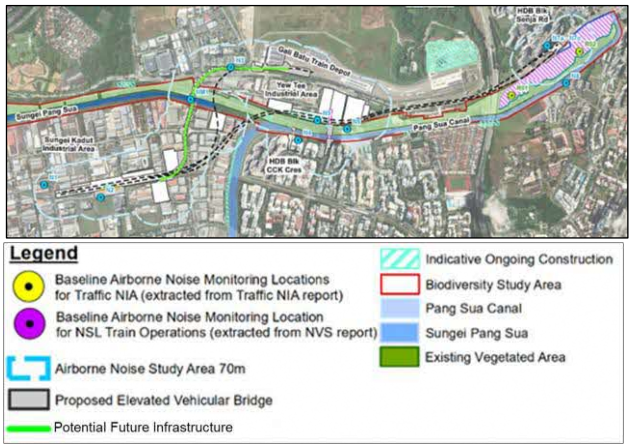


Figure 11: Noise Baseline Monitoring in the vicinity of Biodiversity Study Area

Ground-borne Vibration Baseline

Ground-borne vibration impact assessments have been carried out for piling and tunnel boring works. The impact assessment identifies ecologically sensitive receptors within 100 m from the construction worksites and centre of the alignment.

Baseline vibration monitoring was conducted at representative locations within the Biodiversity Study Area to gather information on the existing ground-borne vibration levels experienced by the sensitive ecological receptors and used as the assessment criteria for ground-borne vibration impact assessment for construction and operational phase.

The 99th percentile of the ground-borne vibration levels measured across the 17 locations for baseline study ranged from PPV, 0.03 to 0.28 mm/s. Along the Rail Corridor, it ranged from PPV, 0.03 to 0.09 mm/s. Locations V1, V3, V10 and V11 stood out with PPV, 0.15 to PPV, 0.28 mm/s. This could be due to the locations being close to factories and roads or existing viaduct and could have been affected by the industrial operations and road traffic, leading to a higher recorded vibration level. The remaining locations, V2, V4 to V9 and VR1 to VR6, had results close to PPV, 0.03 to 0.10 mm/s.

The Study assessed ground-borne vibration impacts from construction and operational phases on the potential of burrow and mud lobster mounds damage/collapse (i.e., structural impact assessment) and the ecological behaviour of the sensitive receptors. The biodiversity habitats/fauna species classifies in Priorities 1, 2 and 3 as ecologically sensitive receptors based on their ecological values and sensitivity towards vibration. The indicator species selected in this area were pangolin and mud lobster.

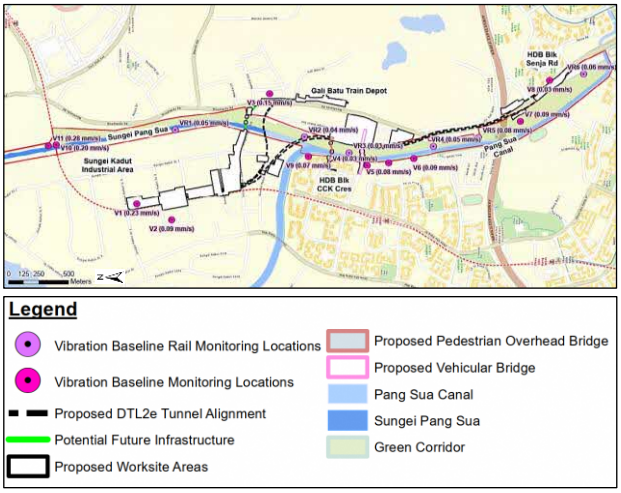


Figure 12: Vibration Baseline Monitoring in the vicinity of Biodiversity Study Area

Soil and Groundwater

Soil and groundwater impact assessment was carried out qualitatively based on the HLUS study findings.

Based on the information obtained during the intrusive soil investigation study, the soil profile encountered at the study area generally consisted of clay. Furthermore, layers of clayey sand, sandy clay and silty clay were also encountered within the study area.

Soil samples collected from the study area reported detections of metals (i.e., arsenic, barium, chromium, copper, nickel and zinc) and Total Petroleum Hydrocarbons (TPH). These detections were all below the Dutch Intervention Values (DIVs).

Based on the groundwater data available at the time of writing this Report, groundwater level ranged from +1.73 mSHD to +9.80 mSHD with average groundwater levels ranging from +2.65 mSHD to +9.28 mSHD. Generally, higher groundwater elevations were observed at the southern portion of the site, slowly decreasing towards the north and generally following the topography of the area. Oscillations of groundwater levels were relatively low, with average difference between highest and lowest observed groundwater levels being 1.38 m.

Groundwater samples collected from the study area reported detections of metals (i.e., arsenic, barium, cadmium, chromium, cobalt, copper, lead, molybdenum and zinc), Polynuclear Aromatic Hydrocarbons (PAHs) and Total Petroleum Hydrocarbons (TPH). All of the detections were below their respective DIVs and Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZGFMWQ).

Minimum Controls

Minimum controls are non-site-specific measures which comprise of common best site practices mandatory for implementation at all construction worksites, as well as basic practices required under local regulations and guidelines. As per the impact assessment methodology, minimum control measures were considered as the basis of impact prediction and evaluation. In other words, minimum controls were sometimes known as upstream mitigation measures integrated as part of the initial impact assessment before the additional mitigation measures being proposed during the residual impact assessment later in the ES process.

Key Minimum Controls in Construction Phase

A list of minimum control measures was summarized for each assessed environmental parameter in the ES, in which some key examples for construction phase are:

- Prepare Safety Operational Procedures (SOPs) and Emergency Response Plans on site, which include Noise Management Plan (NMP), Erosion Control Measures (ECM) plan, Air Pollution Control Plan (APCP) and other plans (e.g., for chemical storage and handling, waste storage and handling, etc.) to avoid and minimise environmental impacts. A review

of Noise Impact Assessment (NIA) was suggested if there are changes to Project activities or worksite design which differs from that in the ES;

- Engage arborists, flora and fauna specialists to clearly mark out the Tree Protection Zones, wildlife or nesting structures that are being active before site clearance;
- Engage a qualified erosion control professional (QECP) to formulate and implement ECM plan (e.g., install silt fences along site hoarding) in accordance with PUB requirements to eliminate risk of discharging construction wastewater into natural stream, where the robust ECM plan will include but not limited to:
  - Practice due diligence in proper handling and storage of all construction wastes including hazardous wastewater (e.g., oily wastewater, thinners, solvents, paints from surface run-off and machinery), as well as ensure proper disposal by authorized dealers or licensed waste collectors;
  - Install CCTV monitoring including Silty Imagery Detection System (SIDS) at the public drains to monitor surface run-off discharge to these drains;
  - Include ECM tanks/ponds prior to discharge of treated effluent (only stormwater runoff) at worksite and treated water to be tested prior to discharge;
  - Adequate drainage, cut off drains, sump pit, road kerb, piping and toe wall will be designed for channelling of construction process wastewater and storm runoff separately.
- Design and implement proper Earth Retaining Stabilizing Structures to limit impact from unstable slopes and groundwater settlement;
- Implement Reduce, Reuse and Recycle hierarchy for solid waste and wastewater generated onsite;
- Avoid placing food waste in bins situated outside of worksite to avoid human-wildlife conflict. Where site staff take breaks outside, all waste must be disposed in the bins provided. This potential issue will be included within the biodiversity toolbox talk; and,
- Adopt construction method and use construction equipment that generates less noise, dust and vibration, which includes but not limited to the following, where applicable:
  - Construct paved access roads where possible before starting work on site;
  - Reduce the number of operating powered mechanical equipment (PME) used. The operating schedule will also be optimised to minimise intermittent noises from machines;
  - Equipment emitting directional noise, to be directed away from ecologically sensitive receptors;
  - Apply noise abatement measures, include covering PMEs with acoustic shed/enclosure, applying silencers or mufflers on equipment, etc., whenever possible.

Key Minimum Controls in Operational Phase

Similarly, some key examples of minimum controls for the operational phase include but not limited to:

- Permanent drainage systems should be designed in accordance with the requirements in PUB's Code of Practice on Surface Water Drainage;
- 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., as well as eventual discharge of treated water;
- Ensure no trade effluent other than that of a nature or type approved by NEA Director-General will be discharged into any watercourse or land;
- Proper handling, storage and disposal of hazardous and non-hazardous new or used chemicals during operational process. Provide spill kit where necessary;
- Maintenance of track alignment, rail joints, switches crossings and associated elements to be conducted regularly; and
- Acoustic treatment for equipment to meet noise level limit at site boundary where necessary.

Impact Assessment Findings

Overview of Impact Assessment

In short, the impact of all assessed environmental parameters in the ES was first evaluated along with the consideration of design optimisation and minimum controls as the basis. Thereafter, additional mitigation measures were provided for Moderate impacts and incorporated as part of the residual impact assessment, where relevant.

Biodiversity

Table 2: Summary of Biodiversity Impact Assessment

Sensitive Receptor	Impact Significance with Minimum Controls	Residual Impact Significance with Mitigation Measures (if required)
Construction Phase		
Habitat	Negligible – Moderate	**Negligible – Minor**

Sensitive Receptor	Impact Significance with Minimum Controls	Residual Impact Significance with Mitigation Measures (if required)
Flora	Negligible – Minor	**Negligible – Minor** (Note 1)
Fauna	Negligible – Moderate	**Negligible – Minor**
Operational Phase		
Habitat	Negligible – Minor	**Negligible – Minor**
Flora	Negligible – Moderate	**Negligible – Minor**
Fauna	Negligible – Moderate	**Negligible – Minor**
Note: 1. The initial impact assessment with minimum controls was considered insignificant (Negligible to Minor), no residual impact assessment was undertaken, hence the impact significance remained the same. This does not indicate that impacts are eliminated.		

Three impacts were assessed for habitat receptors during construction phase, namely i) loss of vegetation, ii) habitat degradation and iii) change in species composition. The impact significance ranged from Negligible – Moderate. Moderate impact was expected from habitat degradation as the worksite was located close to the Sungei Pang Sua mangrove habitat. Proposed mitigation measure include designing the working space of the potential future infrastructure at least 5 m away from the banks of Sungei Pang Sua to minimise chance of habitat degradation. The residual impact significance is assessed as **Negligible** – **Minor**. Similarly for operational phase, i) habitat degradation and ii) change in plant species composition were assessed. Impacts were considered Negligible, and the residual impact significance remains as Negligible, as they have been reduced to a level that is as low as reasonably practicable.

Four impacts were assessed for the flora species receptors during construction phase, namely i) injury/mortality, ii) impediment to seedling recruitment, iii) competition from exotic species and iv) decline in plant health. The impact significance ranged from Negligible – Minor. While impacts are considered insignificant, mitigation measures were proposed to further minimise ecological impacts. This includes (but not limited to) proper installation of silt fences and earth control measures, engaging arborist for pruning of tree specimens, salvaging and harvesting of trees/saplings of conservation significance and monitoring of plant health. The residual impact significance remains **Negligible** – **Minor**.

Similarly, three impacts were assessed during the operational phase, namely i) mortality, ii) poaching and iii) competition from exotic species. Impact significance ranged from Negligible – Moderate. Four flora species receptors (i.e., *Cerbera odollam*, *Syzygium polyanthum*, *Terminalia catappa* and *Taliparitilaceum)* were assessed with Moderate impact significance for the impact of competition from exotic species. Proposed mitigation measures include replanting unused cleared or bare areas with native planting palette, as well as in-fill or dense planting. With implementation of mitigation measures, impacts from competition from exotic species were reduced to Minor. The residual impact significance for the remaining flora species receptors of all impact type is assessed as **Negligible** – **Minor**, as they have been reduced to a level that is as low as reasonably practicable.

Six impacts were assessed for the faunal species receptors during construction phase. The impact significance ranged from Negligible – Moderate. Moderate impacts were expected from accidental injury and mortality for 5 species that are either susceptible to roadkill or entrapment in construction site. Proposed mitigation measures for design and construction phase include integrating speed-calming measures. With the implementation of mitigation measures, impacts from accidental injury or mortality was reduced to Minor. Moderate impacts from loss/reduction of ecological connectivity for faunal movement was mitigated with a 30-m wide corridor that will be maintained on site for faunal movement, except during beam launching for construction of vehicular bridge and pedestrian link bridge, therefore, impact significance was reduced to **Negligible** – **Minor**.

During operational phase, impact significance ranged from Negligible – Moderate. Moderate impact was expected from human-wildlife conflict for 2 species (long-tailed macaque and smooth-coated otter). Proposed mitigation measures include proper waste management. With implementation of mitigation measures, impacts were reduced to **Negligible – Minor**.

Hydrology and Surface Water Quality

Table 3: Summary of Hydrology and Water Quality Impact Assessment

Sensitive Receptor	Impact Significance with Minimum Controls	Residual Impact Significance with Mitigation Measures (if required)
Construction Phase		
Habitat and biocenosis of Sungei Pang Sua	Moderate	**Minor**
Habitat and biocenosis of Pang Sua Canal	Minor	**Minor** (Note 1)
Operational Phase		
Habitat and biocenosis of Sungei Pang Sua	Minor	**Minor** (Note 1)
Habitat and biocenosis of Pang Sua Canal	Minor	**Minor** (Note 1)

Sensitive Receptor	Impact Significance with Minimum Controls	Residual Impact Significance with Mitigation Measures (if required)
Note: 1. The initial impact assessment with minimum controls was considered insignificant (Negligible to Minor), no residual impact assessment was undertaken, hence the impact significance remained the same. This does not indicate that impacts are eliminated.		

Based on the assessment of the hydrology and water quality related impacts on the various sensitive receptors, the activities of construction and operational phases were assessed qualitatively to cause Minor to Moderate impacts on human receptors and the habitat and biocenosis of Sungei Pang Sua and Pang Sua Canal during construction and operational phases, even with implemented minimum controls. In terms of quantitative impact assessment, it was assessed that there will be no impacts on the hydrodynamics of Sungei Pang Sua and that the upstream riverbed level is expected to be brought back to the baseline condition within 2 years' time during the construction phase. As a mitigation measure, it was recommended that all the discharges from the construction worksites to Sungei Pang Sua should not contain Total Suspended Solids (TSS) in concentrations greater than the prescribed limits under Regulation 4(1) of the Sewerage and Drainage (Surface Water Drainage) Regulations. With such mitigation measure, the residual water quality impact on habitat and biocenosis of Sungei Pang Sua could be reduced to **Minor** as shown in Table 3.

Air Quality

Table 4: Summary of Air Quality Impact Assessment

Sensitive Receptor	Impact Significance with Minimum Controls	Residual Impact Significance with Mitigation Measures (if required)
Construction Phase		
Flora within Biodiversity Study Area	Moderate – Major	**Minor**
Operational Phase		
Flora within Biodiversity Study Area	Minor	**Minor** (Note 1)
Note: 1. The initial impact assessment with minimum controls was considered insignificant (Negligible to Minor), no residual impact assessment was undertaken, hence the impact significance remained the same. This does not indicate that impacts are completely eliminated.		

Potential impacts to the neighbouring sensitive receptors during construction phase mainly include emissions from the heavy vehicular exhaust and dust emitted from the demolition, earthworks, construction and trackout activities. Air quality impact assessment for construction phase were undertaken in accordance with the UK IAQM Guidance on the Assessment of Dust from Demolition and Construction. Dust generated during construction works can have adverse effects upon vegetation restricting photosynthesis, respiration and transpiration. Furthermore, it can lead to phytotoxic gaseous pollutants penetrating the plants. The overall effect can be a decline in plant productivity. The results of the assessment show that unmitigated impacts are classified as Moderate to Major largely because of the large extent of the construction worksite located very close to the neighbouring sensitive receptors. Upon implementation of mitigation measures, the significance of impacts is anticipated to be reduced to **Minor**. The key control and mitigation measures include but not limited to development and stringent implementation of air pollution control plan, dust control measures on site, site hoarding, planning of dust causing activities-location and timing, reinstating land upon completion of works amongst several others.

During the operational phase, emissions from vehicle exhaust due to increased traffic in the vicinity of the proposed development is identified as the predominant air emission source. With the assumption that all new vehicles are to meet their Euro emission standard, presence of buffer from some green areas which will not be disturbed as part of the Project will provide cleaner air and reduction of overall number of vehicles on roads after Project operation, the air quality impact contributed from the proposed development is assessed to be **Minor** during the operational phase. No additional mitigation measures are required during operational phase as no significant air quality impact is expected from Project operation.

The construction contractor is recommended to prepare an air quality management plan incorporating a range of monitoring and mitigation measures. Details are provided in the ES Report.

Airborne Noise

Table 5: Summary of Airborne Noise Impact Assessment

Sensitive Receptor	Impact Significance with Minimum Controls	Residual Impact Significance with Mitigation Measures (if required)
Construction Phase		
Fauna with auditory sensitivity within Biodiversity Study Area	Negligible – Major	**Negligible – Major** (Note 1)
Operational Phase		
Fauna with auditory sensitivity within Biodiversity Study Area	Negligible	**Negligible** (Note 2)
Note:		

Sensitive Receptor	Impact Significance with Minimum Controls	Residual Impact Significance with Mitigation Measures (if required)
1. Due to the surrounding ambient noise levels which are naturally very low, the fact that sensitive receptors are in close proximity, meaning receptors in these locations will still be impacted. Collectively, these therefore mean, that impact significance cannot be reduced further. 2. The initial impact assessment with minimum controls was considered insignificant (Negligible to Minor), no residual impact assessment was undertaken, hence the impact significance remained the same.		

Noise impact assessment was carried for the construction and operational phases of the proposed worksites for the Project.

For the classification of receptor sensitivity to airborne noise, auditory sensitivity of the respective species was used to assign receptor priority. Species that use sound for communication, foraging and breeding or are known to have their behaviours disrupted by sound were assigned Priority 1 status for auditory sensitivity. Species that are less affected by airborne noise but are of Conservation Significance were assigned Priority 2. Species that are less affected by airborne noise and are not of Conservation Significance were assigned Priority 3. Habitat sensitivity map was used for this project as basis to decide the probability of a finding of species in the area, and for this assessment. The noise study areas are Biodiversity Study Area and the area within the 150m from construction worksites.

The noise levels generated from the equipment used during the construction phase were predicted using Sound PLAN ver 8.2. Topography played an important role in noise propagation and was included in this assessment.

A quantitative means of assessment detailing noise levels predicted with noise models based on inputs of effective SWL of proposed PMEs was conducted for three (3) assessment scenarios defined for assessment in the construction phase – Scenario 1: Advanced Works; Scenario 2: Station, Docking Shaft, Pedestrian Linkbridge construction; and Scenario 3: Aboveground potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction.

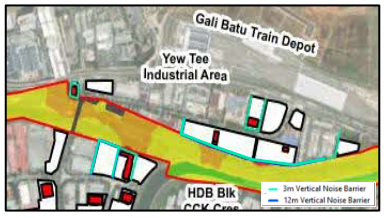
In predicting for the construction noise impacts associated with the three (3) assessment scenarios, the highest overall SWLs of the construction stages associated with each assessment scenario were selected to assess for the worst-case noisiest scenarios. The rationale behind deducing the worst-case scenarios is under the assumption that if the construction stage with the highest SWL can be mitigated for instance with permanent fixtures such as noise barriers or other means, noise impacts from other construction stages/ activities with lower SWLs will also be addressed. It is to be noted that impacts on higher elevation receptors such as bird species are likely able to find alternative habitats. Therefore, fauna near the ground level up to 1.5 m height is the primary focus in the construction noise impact assessment.

For all three (3) scenarios, the resulting base scenario overall Impact Significance was evaluated to range from Negligible – Major within the Biodiversity Study Area.

Mitigation measures were proposed and considered during the residual noise impact assessment, which include but not limited to:

- Scenario 1:
  - Keep buildings fronting Rail Corridor as barrier while demolishing building immediately at the back, erect 3m perimeter noise barrier of STC20 and localized noise netting of STC18
  - For buildings fronting Rail Corridor, any 2 buildings demolished at same time shall keep distance at least 300m away, erect 3m perimeter noise barrier of STC20 and localized noise netting of STC18
- Scenario 2 and 3:
  - Erect Noise Barriers of 3m and 12m of STC20. This has been proposed based on height of receptors in vicinity of the construction worksites and viability of implementation with consideration of space required to stabilize and erect the barriers
  - 15m high full enclosure with open façade opening at the northern and southern sides for TBM work around the docking shaft location
  - Localized enclosures/ movable barrier for construction machinery/ equipment within worksites
- Administrative measures including:
  - To avoid early morning day-time noisy activities between 7 to 9 am as far as possible on site to reduce impact to avifauna
  - Restrict above-ground night works after 7pm except emergency and safety critical activities, such as ERSS related works (installation of D-wall, sheet pile) and TBM related works

Scenario 1:



Scenario 2:

Scenario 3:

Figure 13: Noise Barrier Location

Due to the proximity of the noise sources to the Biodiversity Study Area, the proposed mitigation measures were found only to be effective in reducing noise minimally. The overall residual Impact Significance remained **Negligible – Major** within Biodiversity Study Area.

Although the proposed mitigation measures were not able to eliminate the noise exceedances, a closer look into the comparison of the distribution of areas of Impact Significance reveals a significant reduction of areas of Moderate – Major Impact Significance. This suggests that while Impact Significance remains unchanged, ecological NSRs will still benefit from the implementation of proposed mitigation measures with more land area to traverse, forage and seek shelter from a reduction of noise impacted areas. Also, majority of Moderate – Major impact is only expected during short period of time: approximately 2 years for Scenario 1; 6 months for Scenario 2 day time; 18 months for Scenario 2 night time; and 3-12 months for Scenario 3 day time. After this period, the noise impact is expected to further reduce until the end of construction period.

During the operational phase, the potential impacts would arise from the ACMV noise at the ventilation buildings, train noise from the aboveground train operations and traffic noise from the vehicular bridge. Based on the results predicted by the noise models, the resulting overall Impact Significance from vehicular bridge and operations of the potential future infrastructure was evaluated as **Negligible**. As such, no mitigation measures were proposed for ecological NSRs subjected to noise from the operational phase.

Ground-borne Vibration

Table 6: Summary of Ground-borne Vibration Impact Assessment

Sensitive Receptor	Impact Significance with Minimum Controls	Residual Impact Significance with Mitigation Measures (if required)
Construction Phase		
Fauna with vibration sensitivity within Biodiversity Study Area	Negligible – Major	**Negligible – Moderate** (Note 1)
Operational Phase		
Fauna with vibration sensitivity within Biodiversity Study Area	Minor	**Minor** (Note 2)

Note:
1. Construction activities such as tunnel boring produce high PPV levels at the biodiversity sensitive receptors. The duration of Moderate impact significance is expected to be over within 13-19 days with impacted area of only up to 0.6 ha.
2. The initial impact assessment with minimum controls was considered insignificant (Negligible to Minor), no residual impact assessment was undertaken, hence the impact significance remained the same. Note that this does not indicate that impacts are completely eliminated.

Impacts from rock breaking and excavation at Sungei Kadut Station, rotary bore piling, vibratory piling, vibratory compactors and tunnel boring (hypothetical overall and spots) were assessed for ground-borne vibration. The impact significance caused by rotary bored piling and vibratory compactors were predicted to be Negligible – Minor. Rock breaking and excavation at Sungei Kadut Station, vibratory piling, and tunnel boring at Spot 3 were predicted to cause Negligible – Moderate impact significance, while tunnel boring (hypothetical overall, Spot 1 and Spot 2) were predicted to cause Negligible – Major impact significance.

Mitigation measures were proposed for construction activities with Moderate – Major impact significance. By reducing the Maximum Instantaneous Charge (MIC) to 0.8 kg or by providing GI pipes with canvas sheet with sandbags at the bottom along Woodlands Road at different extent depending on the MIC, the impact can be reduced to **Negligible** – **Minor** for rock breaking and excavation at Sungei Kadut Station. While by avoiding construction work at night, the impact significance of vibratory piling can be reduced to **Negligible – Minor**. With regards to TBM, EMMP measures should be further enhanced, monitored and applied. The Contractor shall control construction vibration levels using the best available techniques (BAT). The Study recommends controlling vibration levels emitted to PPV, 8 mm/s where burrows and mud lobster mounds are sighted to prevent damage/collapse of the burrows and entombing the species. With this, residual impact of the TBM is assessed to be **Negligible – Moderate** impact significance. However, the duration of Moderate impact significance is

expected to be over within 13-19 days with impacted area of only up to 0.6 ha.

Operational vibration impact assessment results indicate that standard track forms do not cause exceedances in vibration levels or produce moderate or major impact significances towards ecological receptors. Thus, no mitigation measures are required. The residual impact significance on ecological behaviour is **Minor** along the Rail Corridor on ecologically sensitive receptors.

Soil and Groundwater

Table 7: Summary of Soil and Groundwater Impact Assessment

Sensitive Receptor	Impact Significance with Minimum Controls	Residual Impact Significance with Mitigation Measures (if required)
Construction Phase		
Ecological habitat within Biodiversity Study Area	Negligible – Minor	**Negligible – Minor** (Note 1)
Operational Phase		
Ecological habitat within Biodiversity Study Area	Negligible – Minor	**Negligible – Minor** (Note 1)
Note: 1. The initial impact assessment with minimum controls was considered insignificant (Negligible to Minor), no residual impact assessment was undertaken, hence the impact significance remained the same. This does not indicate that impacts are eliminated.		

The sensitivity of ecological receptors has been determined based on their ecological significance and their dependency on groundwater. Urban vegetation, scrubland, exotic-dominated secondary forest and Pang Sua Canal have been assessed as Priority 3, while Mangrove forest and Sungei Pang Sua as Priority 2 sensitive receptors.

The potential impacts on soil and groundwater resources associated with the construction phase of the Project include groundwater level decrease due to soil dewatering and decreased infiltration into the ground due to increase in impervious surfaces. Additionally, soil and groundwater quality could be affected due to seepage of contaminants from excavated contaminated soil (if encountered) and extracted groundwater, soil erosion as well as leakage of toxic chemical waste and chemicals used and stored on site.

During the operational phase of the Project, it is anticipated that the impact on soil and groundwater quality will be limited as the use of chemicals and generation of toxic chemical waste is expected to be of limited quantities. Although more impervious surfaces are expected to decrease infiltration into the ground, it is anticipated that the groundwater table in the long-term will equilibrate to its new level.

Based upon implementation of the minimum controls, the prediction and evaluation exercise of soil and groundwater impacts showed that there will be **Negligible – Minor** impact during both construction and operational phase of the Project. Therefore, no additional mitigation measures have been proposed to further minimize the adverse effect on the environment and receptors.

Environmental Monitoring & Management Plan (EMMP)

Overview

An EMMP was proposed to monitor and manage environmental impacts of the construction and operational phases associated with the Project. The EMMP also aimed to provide an overall picture of the potential roles and responsibilities required during each phase of the Project. The coverage of the proposed EMMP involved environmental parameters that were assessed in this ES, namely biodiversity, hydrology and surface water quality, air quality, airborne noise, ground-borne vibration, soil and groundwater. The EMMP detailed how recommended mitigation measures prepared for the impact assessment are to be implemented and specified recommended monitoring measures to assess the effectiveness of the mitigation measures.

EMMP during Construction Phase

The proposed EMMP during construction phase include following General LTA's Safety, Health and Environmental (SHE) Specifications guidance document throughout the construction phase. Additional project specific EMMP includes the following, but not limited to:

- Flora and fauna monitoring and management programme, e.g., conduct pre-site clearance inspection (including pre-felling tree inspections) to minimize fauna injury and mortality during site clearance, monitoring of vegetation along the hoarding line for unauthorized vegetation clearance and forest edge effects, enact wildlife response plan when trapped/dead/dangerous animals are encountered around or within the worksite, etc.

Figure 14: Example of Flora Monitoring Along Hoarding

- Inspect hoarding and perimeter drains daily to ensure no discharge of untreated surface runoff and no clogging;
- Perform site inspection during heavy storm event to ensure no flooding;
- Install necessary instrumentations to monitor changes in groundwater level during construction;
- Perform online real-time monitoring for TSS, as well as conduct in-situ water quality monitoring (suggested monthly) for the remaining in-situ parameters (i.e., temperature, pH, conductivity, TDS and DO) at discharge points of construction sites and at Sungei Pang Sua and Pang Sua Canal throughout construction period;
- Perform ex-situ water quality monitoring (suggested monthly) for all the ex-situ parameters (i.e., BOD_5, COD, TN, NO_3-N, NH_4-N, total alkalinity, TOC, TP, PO_4-P, oil & grease - total, oil and grease - hydrocarbon, lead, zinc, mercury, detergents and *Enterococcus*, ,), at discharge points of construction sites if discharging into public drains and at Sungei Pang Sua and Pang Sua Canal;
- Perform monitoring of PM_{10} and $PM_{2.5}$ at Rail Corridor near Intermediate Station worksite and Sungei Pang Sua riverbank near the worksites for above ground potential future infrastructure development, 1 week prior to site clearance averaged over 1-day period; and continuous monitoring of dust deposition in mg/m^2/day during construction phase averaged over 4-week period;
- Perform pre-construction airborne noise monitoring of $L_{eq(12\ hours)}$, $L_{eq(1\ hour)}$, and $L_{eq(5\ min)}$ prior to site clearance and continuous monitoring within Rail Corridor throughout the construction period;
- The Contractor will control construction vibration levels using best available techniques (BAT) for tunnel boring;
- The Contractor will monitor vibration levels for any construction activities at Biodiversity Study Area (excluding the worksite area) do not exceed PPV, 8 mm/s;
- Set up barriers using GI pipes and canvas sheet with sandbags at the bottom along Woodlands Road to prevent road kills during rock breaking at Interchange Station (extent of barrier depends on MIC); and
- During and after rock breaking for at least 30 minutes and during TBM (biweekly), ecologist to observe fauna behaviour and suggest ways to mitigate on site if required.

EMMP for Commissioning/ Operational Phase

The proposed EMMP during commissioning/ operational phase include but not limited to:

- In general, Contractor/Operator will perform regular site inspection and environmental audit during the commissioning phase (first 3 months), especially on:
  - Drainage system within and in the vicinity of the station, especially during heavy storm event
  - Log of waste generation and condition of storage of hazardous chemicals
- Regular site inspections for both flora and fauna in the initial commissioning phase (first 3 months) to be conducted to evaluate any impact from the development on sensitive habitats, such as Sungei Pang Sua and mud lobster mounds;
- Prepare Compliance Report after the scheduled audit; and
- Schedule and perform monitoring for biodiversity, water quality and airborne noise against the criteria specified in the ES.

The detailed lists of EMMP for construction and commissioning / operational phases are provided in the ES.

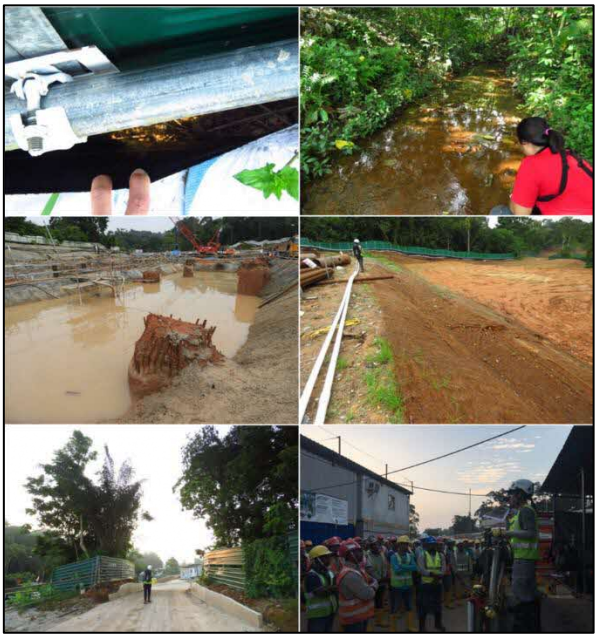


Figure 15: Examples of photographs showing monthly monitoring and inspection on-site

Conclusion

The ES was carried out based on the relevant local and international guidelines. Minimum controls were formed by referring to these guidelines and the common best practices in the industry, incorporated as the basis of impact assessment. Where the implementation of minimum controls was insufficient to alleviate any significant environmental construction or operational impacts (with “Moderate” to “Major” impacts), additional general and Project-specific mitigation measures were further proposed in consultation with LTA and Nature

Groups to mitigate the potential environmental impacts to as low as reasonably practicable. The summary of impact significance with minimum controls and potential residual impact significance with mitigation measures of the assessed environmental aspects for both construction and operational phases are presented in the following table.

Table 8: Summary of Impact Assessment

Environmental Parameter	Impact Significance with Minimum Controls	Residual Impact Significance with Mitigation Measures (if required)
Construction Phase		
Biodiversity	Negligible – Moderate	**Negligible – Minor**
Hydrology & Surface Water Quality	Minor – Moderate	**Minor**
Air Quality	Moderate – Major	**Minor**
Airborne Noise	Negligible – Major	**Negligible – Major** (Note 2)
Ground-borne Vibration	Negligible – Major	**Negligible – Moderate** (Note 3)
Soil & Groundwater	Negligible – Minor	**Negligible – Minor** (Note 1)
Operational Phase		
Biodiversity	Negligible – Moderate	**Negligible – Minor**
Hydrology & Surface Water Quality	Minor	**Minor** (Note 1)
Air Quality	Minor	**Minor** (Note 1)
Airborne Noise	Negligible	**Negligible** (Note 1)
Ground-borne Vibration	Minor	**Minor** (Note 1)
Soil & Groundwater	Negligible – Minor	**Negligible – Minor** (Note 1)

Note:
1. The initial impact assessment with minimum controls was considered insignificant (Negligible to Minor), no residual impact assessment was undertaken, hence the impact significance remained the same. This does not indicate that impacts are eliminated.
2. Due to the surrounding ambient noise levels which are naturally very low, the fact that sensitive receptors are in close proximity, meaning receptors in these locations will still be impacted. Collectively, these therefore mean, that impact significance cannot be reduced further.
3. Construction activities such as tunnel boring produce high PPV levels at the biodiversity sensitive receptors. The duration of Moderate impact significance is expected to be over within 13-19 days with impacted area of only up to 0.6 ha.

A few of the key proposed monitoring, management or mitigation measures which are worth highlighting, including but not limited to:

Impact mitigation through design optimisation (Avoidance of Impact)

- The location of Intermediate Station is sited within industrial land instead of Rail Corridor with main construction access coming from Woodlands Road.
- To connect the Intermediate Station and HDB estate of Choa Chu Kang Crescent, pedestrian linkbridge and vehicular bridge are planned instead of underground subways.
- The worksites for the potential future infrastructure is planned to be located at least 5 m away from the banks of Sungei Pang Sua

Additional mitigation for residual impact during construction phase after design optimisation (Minimisation of Impact)

- 30-m wide corridor that will be maintained on site for faunal movement, except during beam launching for construction of vehicular bridge and pedestrian linkbridge;
- Avoid peak breeding seasons (March to July) for tree-felling activities, as much as possible;
- Replanting unused cleared or bare areas with native planting palette, as well as in-fill or dense planting;
- Integrate speed-calming measures;
- Discharges from the construction worksites to Sungei Pang Sua should not contain Total Suspended Solids (TSS) in concentrations greater than the prescribed limits under Regulation 4(1) of the Sewerage and Drainage (Surface Water Drainage) Regulations;
- Proper waste management;
- Air quality related measures, such as air pollution control plan, dust control measures on site, site hoarding, planning of dust causing activities-location and timing, reinstating land upon completion of works;
- Noise related measures:
  - Erect Noise Barriers of 3m and 12m of STC20;
  - 15m high full enclosure with open façade opening at the northern and southern sides for TBM work around the docking shaft location;
- Provide GI pipes with canvas sheet with sandbags at the bottom along Woodlands Road at different extent depending on the MIC level;
- Above-ground works not critical for safety reasons within worksite will only be allowed from 0800-1800h.If night works are essential, suggest to:
  - Prevent areas from being artificially lit, only install lighting where necessary
  - Limit duration of lighting, avoid peak nocturnal fauna activity
  - Reduce trespass of lighting and change spectrum of lighting

- Setting dark buffers, illuminance limits and zonation
- Species-specific strategy
- Reduce operating power mechanical equipment to minimum

A robust EMMP was then provided in ES, detailing the environmental monitoring and management plans to review the effectiveness of the proposed mitigation measures during the construction, commissioning and operational phases.