

1. Introduction to the Cross Island Line Project



1.1 This Document

The LTA intends to construct a new Mass Rapid Transit (MRT) line, the Cross Island Line (CRL). Geotechnical site investigation (SI) works will be required as part of the engineering feasibility study for the CRL alignment options around the Central Catchment Nature Reserve (CCNR) ('the Project'). LTA called for an Environmental Impact Assessment (EIA) due to its recognition of the ecological sensitivity of the CCNR.

The EIA identifies and describes the environmental aspects likely to be affected by the SI works, assesses the significance of potential impacts and identifies mitigation measures to minimize these impacts.

This document presents a Non-Technical Summary (NTS) of the EIA report. It provides an overview of the site settings for two Alignment Options, summarises the findings of the EIA for the SI activities and the mitigation measures required to manage these impacts.

1.2 Overview

The CRL has been proposed by the LTA to provide a strategic underground rail link to enhance connectivity between the east/northeast and west of Singapore and to meet future transport demands. The CRL will be approximately 50 km in length and span the length of Singapore, connecting Changi in the east to the Jurong Industrial Estate in the west. The target for completion of construction and commencement of operations for the entire CRL MRT railway line is around 2030. A segment of the proposed CRL may pass through or around the Central Catchment Nature Reserve (CCNR), as shown in Figure 1.

As the CCNR, a gazette nature reserve, is an environmentally sensitive area containing a wide range of native flora and fauna resources, the LTA is considering two alternative alignments. The first would pass beneath the CCNR (Alignment Option 1) and the second would skirt the CCNR boundary (Alignment Option 2). The LTA has commissioned an EIA of both alternative alignments to determine the potential environmental impacts of each.

1.3 Environmental Studies and Stakeholder Engagement

As part of the EIA process, desktop reviews and fieldwork (in the form of ecological baseline surveys, ground truthing, short term and long term abiotic monitoring and sampling and user count surveys) were undertaken to establish a holistic baseline of the study area (see *Volume II* of the EIA report). Stakeholders such as nature group representatives, land use planning and geotechnical professionals were also consulted throughout the Project. Inputs pertaining to environmental and ecological data collected were subsequently provided to the Project engineers in an iterative process to inform the study of the two alignment options and associated SI works.

2. The Project



2.1 The Project

The Project involves the consideration of two underground alignment options in the CCNR area:

Alignment Option 1: undercrosses an area from the Singapore Island Country Club (SICC) Island Golf Course to the Pan Island Expressway (PIE). It will traverse under approximately 1.8 km of the CCNR MacRitchie area and pass below forested areas outside the CCNR boundary that serve as ecological buffer zones. These forested areas include the Windsor Interim Green and areas on the northern and western perimeter of SICC's Bukit-Sime golf courses.

Alignment Option 2: skirts around the CCNR and is approximately 9 km in length. It will travel southeast from the SICC Island Golf Course, running west beneath Lornie Road before turning north at Adam Road to run parallel to the PIE.

The LTA will conduct Site Investigation (SI) works prior to the construction of the Cross Island Line to determine the geological conditions of the proposed Project area. SI strategies specific to the site settings and sensitivities of each Alignment Option have been developed and the potential environmental impacts arising from the SI works of each Alignment Option were evaluated in the EIA.

The following sections detail the components of the SI works, an overview of the impact assessment (IA) methodology, alternatives considered throughout the course of the Project as well as the sequence of SI works.

2.2 Components of the Site Investigation

The SI works for Alignment Option 1 will comprise the components detailed below.

1. Preliminary Investigations

- Desktop Work
- Geological Mapping
- Site Reconnaissance
- Topographical Survey

2. Geophysical Surveys

- Seismic Refraction and Reflection Survey
- Electrical Resistivity
- Topography
- Gravity Survey

3. Intrusive Ground Investigations

- Mackintosh Probes
- Rotary Boreholes
- Horizontal Directional Coring

Alignment Option 2 will involve both **preliminary investigation** and **intrusive ground investigation** using the rotary borehole method.

2.3 Overview of IA Methodology

The IA was undertaken in accordance with a systematic process commencing from screening and scoping of possible impacts through to the assessment of impacts, identification of feasible mitigation measures and development of a management plan for implementation.

The significance of predicted impacts was evaluated by considering the magnitude and likelihood of occurrence, and the sensitivity, value and/or importance of the affected resource / receptors. Impact significance was designated using a matrix similar to that shown in *Figure 3*.

Figure 3 Example Impact Significance Matrix

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	Medium	High
Magnitude of Impact	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

Iterative discussions throughout the EIA process between LTA, ERM and the Engineering Feasibility Consultant were conducted to avoid and reduce the impacts as much as possible. A key outcome of these engagements was the consideration of Project alternatives detailed in the following section.

2.4 Consideration of Alternatives

Several alternatives to the standard approach adopted in Singapore were considered over the course of the Project.

Alignment Routing

Three alignment options were considered but the third alignment option, proposed to route beneath MacRitchie Reservoir, was ruled out primarily due to technical risks associated with its location along a geological fault line.

Alignment Option 1 was adjusted to follow closely under existing trails and disturbed areas within the CCNR, thereby avoiding the need to clear extensive tracts of vegetation to create SI worksites. The alignment distance through the CCNR was shortened by moving the western portion further south out of the CCNR boundary to dissect the Bukit Golf Course. Alignment Option 2 was fine-tuned to skirt outside the CCNR, following existing roads as much as possible.

Placement of Buffer Zones

Stream and wetland buffer zones were placed within the CCNR to create a water pollution hazard setback to protect these areas from unplanned events associated with drilling works. The placement of these buffer zones reduced the number of borehole locations from the standard SI campaign of 72 to 16 along Alignment Option 1.

Alternative SI Methods and Sequence

Due to the reduced number of boreholes, geophysical survey methods were selected to supplement the gaps in the geological profile of Alignment Option 1. In addition, horizontal direction coring (HDC) was also proposed along the alignment to confirm the rockhead level and to determine the potential locations of fault lines.

The design of standard A-frame drilling rigs for rotary boreholes was also modified to minimise impact to the environment.

Alignment Option 2 was expected to follow the standard borehole campaign but the presence of existing geological information enabled the refinement of borehole locations.

3. Alignment Option 1



3.1 Baseline Environment

Reconnaissance and field surveys were undertaken within a 600m wide corridor centred on Alignment Option 1, to establish the baseline of the following environmental aspects:

- Surface water quality
- Ambient noise
- Vibration
- Ambient air quality
- Ecology and biodiversity

Visual observations, in situ measurements and samples taken from streams upstream and downstream of the Project established that oil and grease content was low, though water quality parameters such as turbidity, total dissolved solids (TDS) and *Escherichia coli* content were found to be high at some streams. No intrusive tests were undertaken to sample groundwater but conditions were inferred from the geological conditions of the site, field observations, desktop research and review of existing borehole logs obtained from areas adjacent to the boundaries of the CCNR. Groundwater at the area is likely to interact with surface water bodies and was considered to be in continuity with the streams and watercourses feeding into MacRitchie Reservoir.

Ambient noise was monitored at selected locations within the study corridor, and was supplemented by short-term measurements and vehicular traffic counts. Readings demonstrate that noise levels due to natural sounds within forested areas ranged between 46 – 54 dB(A); human noises along the existing trails contributed to levels around 55 dB(A); and vehicular traffic along nearby roads and expressways led to levels between 56 – 61 dB(A). Maximum noise levels were recorded during a large scale operation held along the existing trails in the CCNR (up to 81 dB(A)), and during thunderstorms.

Baseline vibration levels were monitored over a day at Jelutong Tower and the service road to Bukit Kalang Service Reservoir. Peak particle velocity (PPV) levels were typical of passing vehicular traffic or heavy vehicles travelling on poor road surfaces.

Particulate matter (PM₁₀ and PM_{2.5}) was measured within the study corridor during the inter-monsoon and Northeast monsoonal periods, to establish the ambient air quality due to existing emission sources such as vehicular traffic along the PIE and Island Club Road. Baseline air quality results were generally below the Singapore air quality targets, although PM₁₀ measurements occasionally exceeded the standards during the inter-monsoon period (November/December 2014).

Ecological and biodiversity baseline surveys undertaken verified the presence of different forest types in varying stages of maturity, and relatively pristine stream habitats within the CCNR, as well as within forested areas outside the CCNR such as Windsor Interim Green. Surveyors were able to identify a number of species listed under the Singapore Red Data Book, International Union for Conservation of Nature (IUCN) Red List of Threatened Species and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendices.

A user count survey was also undertaken to establish the land use intensity of the study area. Findings show that MacRitchie Reservoir Park is a popular recreational area and public trails are regularly used by joggers and nature lovers, in particular over the weekends. Popular landmarks within the park include the HSBC treetop walk and the Jelutong Tower, which are accessed via the existing trails within the Project corridor.

3.2 IA Findings

3.2.1 Surface Water & Groundwater Resources

As observed from baseline studies, the streams within the study area provides an essential habitat to sustain biologically unique species in the CCNR, and are part of the freshwater cycle supplying drinking water to the MacRitchie Reservoir. They were therefore assessed to be of *High* sensitivity. Groundwater was assessed to be of *Medium* sensitivity as it forms part of the water environment and supports aquatic communities, but is not abstracted for use.

Potential impacts to surface water quality due to sediment loading and potential contamination from the use of maintenance oil were identified during geophysical surveys, rotary borehole and HDC drilling works. Taking into consideration embedded controls to limit the potential for sediments and potential contaminants reaching sensitive streams (ie buffer zones) and to limit the number and impact of personnel at off-trail locations, the magnitude of impact was considered to be *Small* during normal operations, and the significance of impact assessed to be *Moderate*.

The Project will develop a Water Pollution Control Plan and implement the recommended mitigation measures in the EIA EMMP (see *Section 5.3*). Measures include the relocation and reduction of the number of Mackintosh Probes (MPs) carried out. Other mitigation measures will be applied to all aspects of the SI campaign ie drilling, mobilization and demobilization. The residual impact significance is assessed to be *Negligible*.

The EIA further considered cumulative impacts on surface and groundwater arising from the development of the Windsor Nature Park. The cumulative impacts of Windsor Nature Park and SI works of Alignment Option 1 were also assessed to be of *Negligible* significance.

Unplanned events and related impacts to surface water were also assessed, for example uncontrolled runoff; fire; and vehicle accidents. Further details are summarized in *Section 3.2.5*.

3.2.2 Ambient Noise

The noise levels generated from the following activities of the SI campaign were assessed against baseline noise levels:

- Use of accelerated drop weight during seismic reflection and refraction geophysical surveys at off-trail locations within the CCNR;
- Operation of rotary drilling rig(s) along existing trails within the CCNR;
- Use of small vehicles for transportation of ancillary equipment and daily water supply during rig mobilization and operation; and
- Operation of HDC rigs from outside (but within close proximity to the boundary) of the CCNR.

Noise emissions from these activities were predicted using SoundPLAN software and levels experienced by human receptors were found to exceed current baseline levels by 4 to more than 10 dB(A). Due to the short term duration of exposure, and ad-

hoc frequency of some of the activities, noise impacts were assessed to range from *Minor* to *Moderate* impact significances.

The Project will manage noise impacts to as low as reasonably practicable (ALARP) by developing a Noise Management Plan and implementing the mitigation measures specified in the EIA EMMP (see *Section 5.3*). After the implementation of these mitigation measures, the residual significance of noise emissions from the SI activities is expected to range from *Minor* to *Moderate*.

Cumulative impacts may arise due to the development of Windsor Nature Park, which will involve the construction of boardwalks and habitat enhancement works near the CCNR boundary. Human receptors in the easternmost portion of CCNR such as the Venus Link and Venus Loop trails are assessed to be exposed to cumulative noise levels of *Moderate* impact significance.

3.2.3 Vibration

The PPV levels from borehole activities were estimated at more than 1.0 mm/s within 2 to 3 m from the drill rig, ie *Medium* impact magnitude. Due to the highlight localized extent and short duration of exposure, the impacts of vibration from these activities were assessed to be of *Minor* significance.

3.2.4 Ambient Air Quality

Human receptors within the study corridor comprise primarily of recreational users along existing trails in CCNR and in the adjacent golf courses. Human exposure to air emissions is therefore expected to be transient, ie up to 1 to 2 hours, which corresponds to a *Low* sensitivity. On the other hand, ecological receptors are considered to be of *Medium* sensitivity due to the designation of the CCNR as a nationally gazetted nature reserve.

Potential sources of impact to ambient air quality include dust generated from drilling operations and vehicle movements on exposed soil and unpaved ground. In view of the embedded controls such as the use of drilling fluid (i.e. water) as lubricants during drilling operations and implementation of speed limits at all unpaved areas, it was assessed that generation of dust from during drilling rig operation, mobilization and demobilization within the CCNR is expected to have *Negligible* impact significance to human and ecological receptors.

Dust generated from the HDC worksites are assessed to be of *Small* impact magnitude, due to the larger footprint of cleared ground. Impacts from HDC operation are therefore assessed to

be of *Negligible* significance to human receptors and of *Minor* significance to ecological receptors within 350 m of the HDC worksites.

The cumulative impacts of Windsor Nature Park were also considered. The magnitude of cumulative impact was assessed to be *Negligible*. Nevertheless, it is recommended that the SI works near the Windsor Nature Park development are not undertaken concurrently, wherever possible.

3.2.5 Ecology & Biodiversity

Developed areas outside the CCNR boundary were considered to be of *Low* value, whereas forested areas found outside the CCNR but contiguous with the habitats within the CCNR were considered to be of *High* sensitivity. The CCNR was treated as a *High* sensitivity area. Forests within the golf courses adjacent to the CCNR were considered to be of *Medium* sensitivity.

The components of SI activities that could lead to impacts on ecology and biodiversity include disturbance to vegetation from trampling impacts associated with off-trail works; disturbance to vegetation through human and vehicular movement during mobilization/demobilization and site access; disturbance to wildlife behaviour due to human interference, noise and vibration; and disturbance of aquatic habitats. The overall impact magnitude of SI activities after incorporation of embedded controls was assessed to be *Large* for highly sensitive areas and *Negligible* or *Small* for areas of low sensitivity.

The Project is committed to managing these potential impacts further by adopting a wide range of mitigation measures in addition to the embedded controls. This includes the reduction of the geophysical survey corridor; scheduling and zoning of off-trail survey works to limit the area of influence of the works at any one time; the training of all workers in managing wildlife encounters on and off trail and noise minimization measures; deployment of NParks staff and an ecologist to support the selection of off-trail access routes; conducting site reconnaissance and geophysical surveys during drier periods; cessation of works during and after rain events; daily removal of wastewater slurry etc. With these mitigation measures, the potential impacts are expected to be reduced to as low as reasonably practicable.

A key concern of the Project is the possibility of occurrence of unplanned events that may arise from SI activities. These include uncontrolled site run off, wastewater and spills during drilling; accidental spills of fuel/ lubricant/ drill fluids; roadkill and damage to vegetation from vehicle movement; and fire. The

Project will implement mitigation measures to reduce the risk of unplanned events occurring. These include the implementation of a 30 m stream/wetland buffer zone, the use of erosion control blankets, the establishment of a robust spill management plan, Emergency Preparedness Plan and Fire Safety Plan etc.

With the strict implementation of the above mitigation measures, residual impacts were expected to be reduced to *Small* to *Medium* magnitude. Thus the significance of residual impacts are mainly *Moderate* (*Moderate* to *Major*), with the possibility of escalating to *Major* only if the mitigating measures are not observed.

Similar to the assessments conducted for the other environmental aspects, the EIA included a study of cumulative impacts to ecology and biodiversity arising from committed developments around Option 1, such as the Windsor Nature Park. Based on the information available, it was assessed that no cumulative impacts on ecological resources and receptors are anticipated, assuming that the other proposed works will also be designed and scheduled to minimize adverse impacts on the ecological receptors. The EIA had thus recommended that the Project Proponents for all these projects overlapping with or adjacent to the study area keep an open channel of communication to ensure that there are no conflicts in scheduling or proposed works.

4. Alignment Option 2



4.1 Baseline Environment

Reconnaissance and field surveys were undertaken within a 400m wide corridor centred on Alignment Option 2, to establish the baseline of the following environmental aspects:

- Surface water quality
- Ambient noise
- Vibration
- Ambient air quality
- Ecology and biodiversity

Two concrete-lined canals were identified to be potentially influenced by SI works for Option 2. One is connected to the outlet of MacRitchie Reservoir and the other is linked to the streams at Windsor Interim Green. Sampling undertaken at these canals established that the water quality was within the standards for discharge to non-controlled watercourses as stipulated by law. Similar to the study carried out for Option 1, groundwater conditions were inferred from geological conditions of the site, field observations, desktop research and existing borehole data.

Ambient noise was monitored at selected noise sensitive receptors (NSRs) within the study corridor, such as residential areas and Mt Alvernia Hospital. This was supplemented by short-term measurements and vehicular traffic counts. Noise levels were dominated by vehicular traffic along the arterial roads Lornie Road and Upper Thomson Road. Peak hour traffic led to measurements ranging between 70 to 82 dB(A) in the daytime and evening, whereas night-time readings ranged between 60 – 70 dB(A).

Baseline vibration levels were monitored over a day at Venus Drive and along Lornie Road, near Mt Alvernia Hospital. PPV levels recorded were relatively high (0.762 – 0.889 mm/s) and could be due to the cumulative effect of heavy vehicular and pedestrian traffic.

Particulate matter (PM₁₀ and PM_{2.5}) was measured at selected locations within the study corridor during the inter-monsoon and Northeast monsoonal periods, to establish the ambient air quality due to existing emission sources such as vehicular traffic along Upper Thomson Road and Lornie Road. Baseline air quality results were generally below the Singapore air quality targets, although PM₁₀ measurements occasionally exceeded the

standards during the inter-monsoon period (November/December 2014).

The forested areas within the study corridor comprise a small southern section of the CCNR and along Venus Drive, and the areas bordering the CCNR boundary. Ecology and biodiversity baseline surveys undertaken established that these areas possess a patchwork of forests of varying maturity and stages of regeneration, and streams habitats. Less wildlife and species of conservation interest were found utilizing these areas, which were influenced by edge effects from vehicular traffic and human development. The non-forested areas within the Alignment Option 2 study corridor are largely developed, indicating that these areas are of low ecological value and has undergone intensive disturbance.

4.2 IA Findings

4.2.1 Surface Water & Groundwater Resources

The two concrete canals serve to collect and channel surface run-off from the surrounding areas and eventually feed into the Marina Bay Reservoir, a potable water source in Singapore. However, as these two canals form a minor part of the central watershed and does not support aquatic habitat or populations, the sensitivity of these surface water resources were evaluated as *Medium* sensitivity. Groundwater is not abstracted for use, and assumed not to support aquatic habitats or populations. Hence it was assessed to be *Low* sensitivity.

The water quality of concrete canals could also be impacted by spillage and leakage of hazardous fluids or runoff of wastewater generated during borehole drilling works. In consideration of the embedded controls in place to prevent spills, leaks and adequately manage wastewater, the magnitude of impact to quality of water resources for Option 2 was assessed to be *Negligible*. The overall significance of impact was thus evaluated as *Negligible*. Nevertheless, precautionary measures such as the cessation of borehole operations during rainfall, and the use of a Fluid Containment Tank (FCT) during drilling works, were recommended.

The EIA further considered cumulative impacts arising from the ongoing Thomson Line development along Upper Thomson Road, and the proposed development of a new park connector along the southern and eastern boundary of the CCNR. It was

assumed that these developments would be undertaken in accordance with regulatory requirements. Cumulative impacts to water quality in nearby canals were therefore assessed to be of *Negligible* significance.

4.2.2 Ambient Noise

The assessment considered acoustic impacts arising from the simultaneous operation of four standard A-frame rigs along Alignment Option 2 and utilized SoundPLAN modelling software for the prediction of noise levels. Predicted noise emissions from the drilling operations were found to be of *Large* magnitude for residential and recreational land uses within 3 m of the worksites, as well as for Mt Alvernia Hospital and Assisi Hospice. Due to the short duration of noise exposure, the impact due to noise emissions was assessed to be of *Moderate* significance. Impacts at other identified NSRs were assessed to be of *Negligible to Minor* significance.

The Project will manage impacts by relocating worksites to maintain a minimum distance from the above NSRs, and adopting mitigation measures requiring the use of low noise equipment, acoustic enclosures for drilling rig engine, and training of workers in noise minimization techniques. These mitigation measures would reduce the noise levels to within the applicable regulatory limits, ie residual noise impact is of *Negligible* significance.

Noise generated during SPTs were also calculated and assessed. Predicted levels were found to be of *Small* magnitude. Considering the intermittent frequency of testing during the drilling campaign, the impacts due to noise generated from SPTs were assessed to be of *Minor* significance.

4.2.3 Vibration

Vibration levels due to SPTs were calculated using empirically derived formulae for percussive piling, and were predicted to be of *Minor* impact significance to residents within 2 m of the worksites. It was determined that the worksites must be situated at least 30 m from Mt Alvernia Hospital to avoid significant impacts to sensitive equipment.

Groundborne vibration levels were measured from a standard A-frame drilling rig during drilling operations. Results indicate that vibration levels would be less than 1.0 mm/s at distances greater than 3 m from the rig. Receptors within 3 m of the rig, such as some residential areas and St Theresa's Home, might be exposed to levels above 1.0 mm/s, ie levels would be perceptible. However, due to the short-term duration of the SI drilling works, the impacts are evaluated to be of *Minor* significance.

Mt Alvernia Hospital was the only receptor identified that might house vibration sensitive equipment. As the hospital is situated

near the junction of two arterial roads (including the MacRitchie viaduct), the hospital is already exposed to high baseline vibration levels. Vibration from borehole drilling is therefore likely to be masked by vibration from existing sources of vibration. Furthermore, it is likely that controls such as vibration isolation of equipment, would have already been implemented within the hospital. In view of the short-term duration of the SI drilling works, the impacts are evaluated to be of *Minor* significance.

Cumulative noise impacts from other developments in the area, such as the Thomson Line construction, Assisi Hospice expansion and the development of the North South Expressway, are predicted to lead to an exceedance of no more than 3 dB(A) of the relevant limits. Due to the short-term duration of the SI works, the impact of cumulative noise generated is assessed to be of *Minor* significance.

4.2.4 Ambient Air Quality

Due to the high density of residential properties, healthcare institutions and schools present along Alignment Option 2, the human receptors associated with these entities have been evaluated to be of *High* sensitivity due to the possibility of long-term exposure. Ecological receptors include the CCNR and forested areas within 350 m of the SI worksites were assessed to be of *Medium* sensitivity.

Potential sources of air emissions from the SI works include dust from excavation of starter pits, borehole drilling and from temporary stockpiling of excavated materials onsite. The SI works for Alignment Option 2 will proceed largely on paved roads and measures will be in place to minimize the quantity of soil tracked out from the worksites. Furthermore, the quantity of material excavated is considered to be negligible, and the impacts of dust emissions are expected to be short-term given the entire SI works are anticipated to be completed within 4-8 months. Although the soil underlying the surface at the site has been classified as moderately dusty, given the abovementioned reasons, the magnitude of impact was evaluated to be *Negligible*, translating to an impact significance of *Negligible* for both human and ecological receptors.

The EIA considered cumulative impacts from proposed developments such as the development of a park connector at the boundary of CCNR, and the construction of a MacRitchie observation tower. The scale of construction of these developments is likely to be small, with minimal earthworks and it is assumed that dust emissions will be managed in accordance with local regulations. The duration of the SI works is expected to be short term. Cumulative impacts were therefore deemed to be of *Negligible* significance.

4.2.5 Ecology and Biodiversity

Developed areas including roads, and the northern corner of Windsor Interim Green and Venus Drive were considered to be of *Low* sensitivity. Forests within the CCNR north of Lornie Road, were considered to be of *High* sensitivity. Forests south of Lornie Road within the designated Tree Conservation Area, will likely be fragmented by ongoing roadworks through Bukit Brown Cemetery and have therefore been considered to be of *Medium* sensitivity.

Potential impacts on ecology and biodiversity receptors are likely to be associated with wildlife disturbance from human presence at the worksites and transportation routes, and noise and vibration generated from rig mobilization, demobilization and operation. SI worksites for Alignment Option 2 are observed to be located away from any highly sensitive ecological areas. Furthermore, ecological receptors are deemed to be habituated to high baseline levels of noise and vibration from human / vehicular traffic within the study corridor. Considering the implementation of embedded controls (such as restriction to daytime work), the short-term duration of SI works, and the likelihood that mobile receptors would move away from the worksites, the impact to ecological areas was assessed to be *Negligible* along Lornie Road, and *Minor* for areas near Venus Drive and SICC Island Golf Course.

Cumulative impacts to ecological receptors in the area were assessed for the following ongoing or committed developments:

- Windsor Nature Park
- Park Connector & MacRitchie Observation Tower
- New road at Lornie Road

It was assumed that the works would be designed and undertaken in accordance with regulatory requirements and the SI worksites will be located within developed areas, or away from areas of high ecological sensitivity, the cumulative impacts are largely expected to be minimal.

5. Environmental Management & Monitoring Plan



5.1 Overview

Through the EIA, the Project has identified and committed itself to a number of environmental measures designed to mitigate adverse impacts. These are compiled in the EMMP presented in *Volumes III and IV* of the EIA. Responsibilities for implementing and means of verification of the actions required prior to and during the SI works are detailed in the EMMP.

LTA will assume overall accountability for the environmental performance and regulatory compliance of the Project during the SI works. In line with this, the LTA will undertake routine audits of the worksites to verify that the Contractors are implementing the mitigation measures outlined in the EMMP as well as statutory requirements and other LTA requirements. As Environmental Advisor, ERM will support the verification and monitoring of mitigation measures.

5.2 Key Mitigation Measures

Mitigation measures were identified through consultation with the Project planning and engineering design team, as well as stakeholders, to ensure feasibility in implementation. Key mitigation measures are summarized below.

5.1.1 Alignment Option 1

Mitigation measures include but are not limited to:

- Contractors will undergo training on how to manage wildlife encounters. Contractors are strictly prohibited from handling/touching any wildlife encountered, including forcing movement of wildlife away from the work areas. In the event that wildlife are encountered and do not move away from the transportation route or worksite, Contractor to notify NParks and await further instructions.
- NParks staff and ecologist to accompany off-trail geophysical survey works to support the SI contractor in the selection of off-trail access routes and working areas following a set of Accessibility Criteria which will minimize the disturbance to flora and fauna as far as practical.
- Access and works to be prohibited within the 30 m stream/wetland buffer zone.

- Fluid Containment Tank (FCT) to be used at all times during operation of rotary drilling and HDC rigs to ensure containment of slurry. FCT to be positioned on absorbent mat or within secondary containment to contain potential spill / leak to the ground.
- Rigs and ancillary vehicles to move along trail at a constant and low speed of less than 5 km/hr with a contractor walking (slowed to 3 km/hr) at a safe distance in front of the rig/vehicle to spot for any wildlife (including that which may be present on vegetation which extends over the trails). If encountered, vehicles to stop movement, contractors to remain still and silent until such time as the wildlife has moved away from the trail. In the instance wildlife does not move from the trail/vegetation, Contractor to notify NParks and await further instruction before continuing to move vehicles.
- Vegetation clearance, cutting or breaking or damaging branches of trees, shrubs and climbers are strictly prohibited.
- Borehole drilling operations to be suspended during rainfall. All equipment to be covered with tarpaulin, and all containment vessels (FCTs, wastewater tote tank) to be closed to prevent generation of contaminated runoff and overflow.
- Inform the community on the SI works schedule and details such as noise generating activities and complaints reporting procedure prior to commencement of works.
- All worksites to be reinstated following completion of SI works to original site conditions.

5.1.2 Alignment Option 2

Mitigation measures include but are not limited to:

- All rotary drill rig operators to be briefed on noise minimization measures during equipment handling.
- Inform the community, in particular residents within housing estates along Upper Thomson Road and Lornie Road, recreational users of Taman Permata Park and SICC Island Golf Course, and Mt Alvernia Hospital, on the SI works schedule and details such as noise generating activities and complaints reporting procedure prior to commencement of works.

Further details of all mitigation measures for both alignments can be found in Volumes III and IV of the EIA Report.

6. Conclusion



6.1 Overview

The EIA has been undertaken following a systematic process and in accordance with international guidelines, for two alignment options for the CRL passing under or around the CCNR.

Impacts which have been assessed to be of *Moderate* or *Major* significance prior to mitigation, are as follows:

Alignment Option 1

- Sediment loading and potential contamination of surface water & groundwater resources;
- Annoyance impacts to recreational users due to elevated noise levels;
- Disturbance to vegetation from walking off trail (i.e. trampling) and daily movement of personnel / vehicles;
- Disturbance to wildlife behaviour due to human interference, noise and vibration; and
- Disturbance of aquatic habitats.

Alignment Option 2

- Annoyance impacts to humans due to elevated noise levels from drilling works.

Mitigation measures have been identified for the management of the identified impacts to as low as reasonably practicable (ALARP). These measures have been consolidated in an Environmental Management and Monitoring Plan (EMMP), which will delineate responsibilities for implementation and monitoring during site investigation works.

After implementation of the mitigation measures as described above, the potential impacts associated with the site investigation works for Alignment Options 1 and 2 are expected to be reduced to as low as reasonably practicable.