Environmental Impact Study for Keppel Club, PSA Club, Bukit Chermin, Berlayer Creek and Former BP Oil Refinery Site

Executive Summary

Housing & Development Board and Urban Redevelopment Authority

Project reference: URA/T/20/001

Project number: 60645518

April 10, 2022

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Executive Summary

AECOM Singapore Pte Ltd was appointed by Urban Redevelopment Authority (URA) to carry out the *Environmental Impact Study (EIS) for Keppel Club, PSA Club, Bukit Chermin, Berlayer Creek and Former BP Oil Refinery Site*. The Study Area has an area of approximately 77.8 hectares (ha) and is located in the southwest of Singapore. The site has been mainly zoned for "Residential (Subject to Detailed Planning)", "Park", "Waterbody", "Reserve Site" and "Road" as shown in Figure 1. The site is located in an ecologically sensitive area, which complements the surrounding rich and diverse green assets of the Southern Ridges, which consists of Telok Blangah Hill Park, Mount Faber Park, Kent Ridge Park and Labrador Nature Reserve. Furthermore, Berlayer Creek is a tidally influenced natural waterbody which supports one of the two mangroves located in the southern part of mainland Singapore and it provides a repository and dispersal site for mangrove seeds to other co-dependent mangrove sites within Singapore, thereby highlighting its ecological importance.

With the current proposed developments within the Study Area, there is a need to: (1) understand the baseline ecological and environmental conditions of the Site; (2) assess potential impacts on the local biodiversity and environment associated with and/or caused by the Project during both construction and operational phases; (3) recommend mitigation measures to safeguard the existing ecological and avian connectivity, and incorporate them into the future development; and (4) to develop an Environmental Monitoring and Management Plan (EMMP).

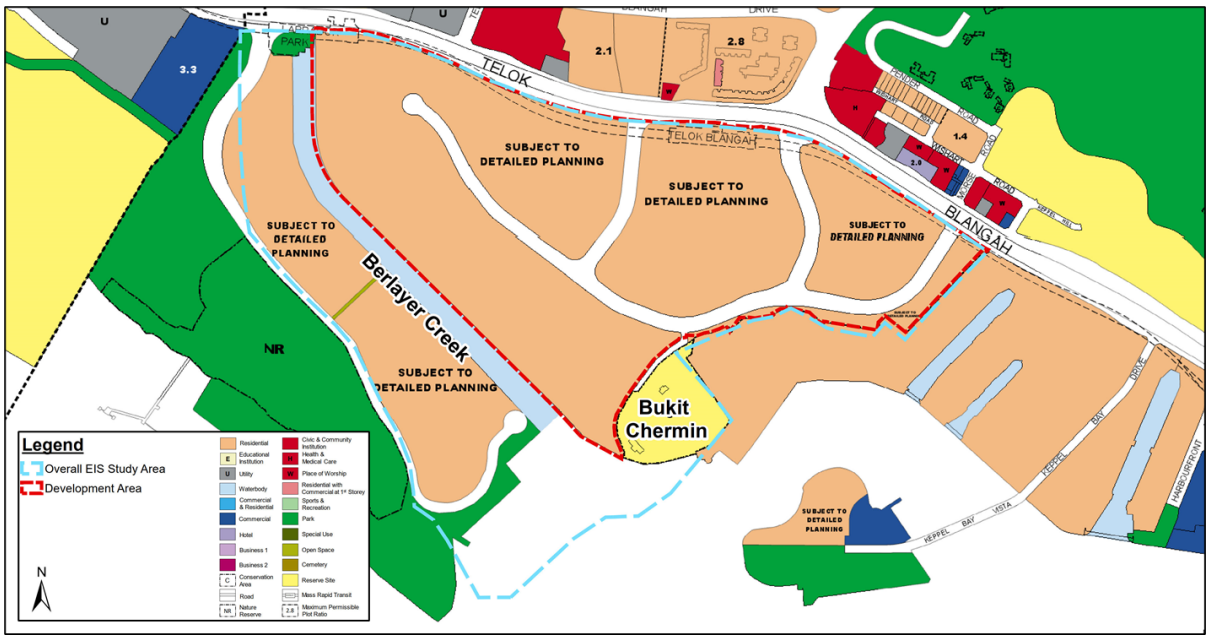


Figure 1 Current land use zoning of the Study Area and its surroundings (Source: URA's gazetted Master Plan 2019)

Environmental Baseline Findings

Baseline studies on biodiversity, hydrology and water quality, soil and groundwater, air quality and airborne noise were conducted for the Study Area, and a summary of the findings is provided below. More information can be obtained from Sections 7, 8, 9, 10 and 11 of the report, respectively.

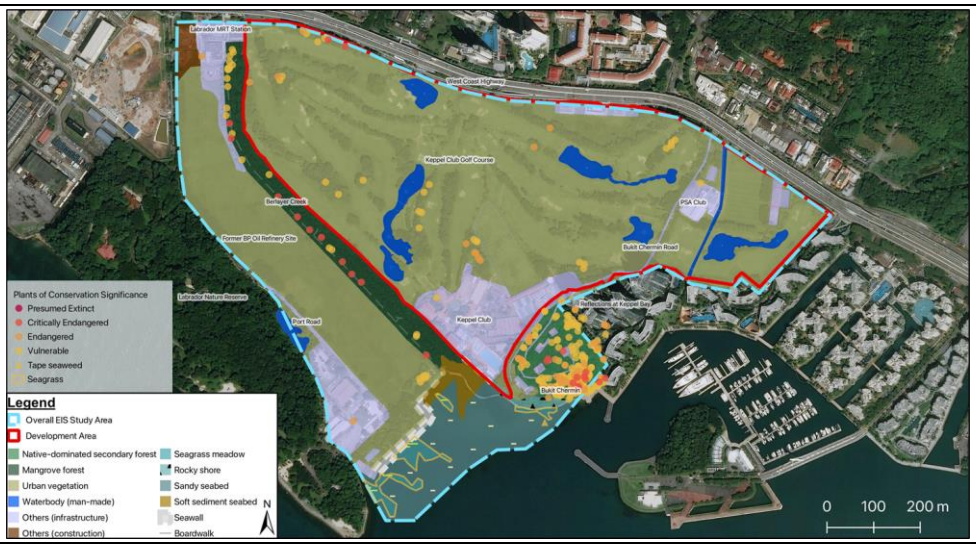


Figure 2 Distribution of habitats, vegetation, plant specimens of conservation significance

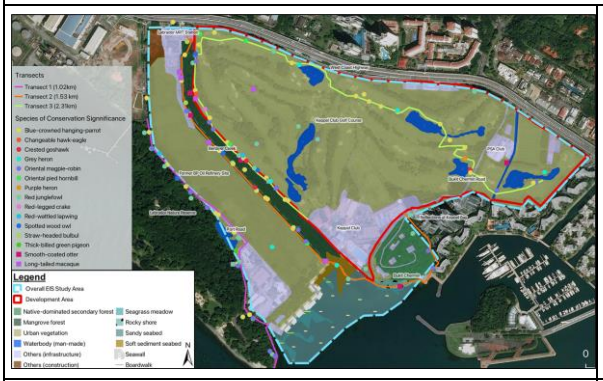


Figure 3 Distribution of terrestrial fauna of conservation significance

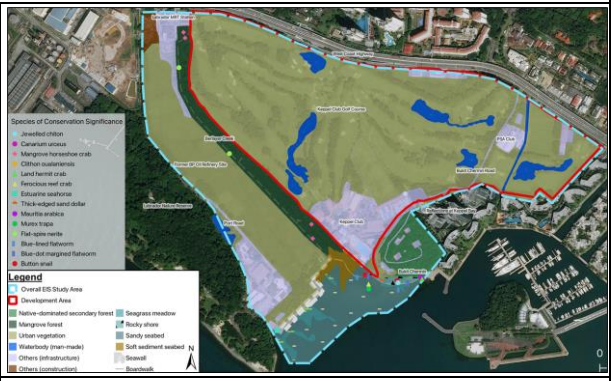
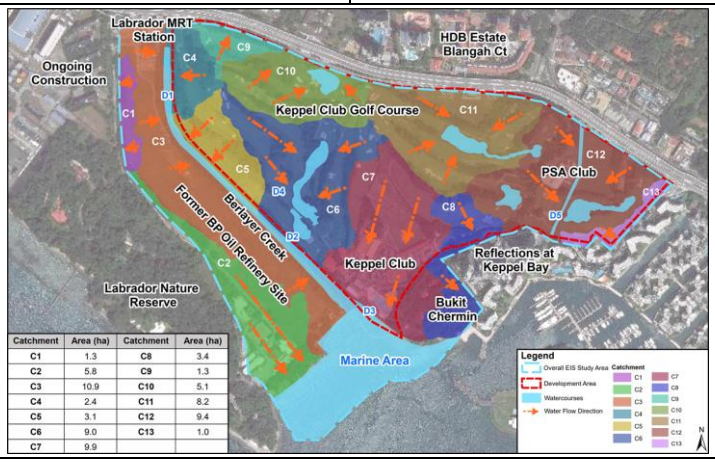


Figure 4 Distribution of marine fauna of conservation significance



Catchment	Area (ha)	Catchment	Area (ha)
C1	1.3	C8	3.4
C2	5.8	C9	1.3
C3	10.9	C10	5.1
C4	2.4	C11	8.2
C5	3.1	C12	9.4
C6	9.0	C13	1.0
C7	9.9		

Figure 5 Catchment map with watercourses

- **Habitats and Vegetation Distribution** (see Figure 2) – Study Area consists of ten (10) different terrestrial and marine habitats and vegetation types. Majority of the site consists of terrestrial habitats, which include urban vegetation (52.1 ha; 66.9%), native-dominated secondary forest (coastal) (2.2 ha; 2.9%) and mangrove forest (4.0 ha; 5.2%). Fresh waterbodies consist of 2.9 ha (3.6%), which are all man-made. Marine habitats

consist of sandy seabed (4.6 ha; 6.0%), seagrass meadows (0.8 ha; 1.0%), rocky shore (0.3 ha; 0.4%) and soft-sediment seabed (0.7 ha; 0.9%). The final marine habitat type within the Study Area is the man-made seawall at only 0.3 ha (0.4%). The remaining areas includes two non-vegetated sites where infrastructure (9.5 ha; 12.2%) and an active construction site are located.

- **Biodiversity, Flora, Large Plant Specimens and Other Specimens of Value** (see Figure 2) – More than 390 species of plants were recorded. A total of 36 plant species are of conservation significance, which includes the three threatened seagrass species (i.e. *Halophila ovalis, Halodule* sp. and *Enhalus acoroides*) recorded in the Marine Area. Of the total plant species recorded, 152 large plant specimens (trees with girth >3m) were recorded, with the majority of these specimens (103; 67.8%) recorded within the Keppel Club golf course; such large specimens can provide valuable habitats and food sources to fauna. One heritage tree (*Tamarindus indica*) was recorded at Keppel Club golf course.
- **Biodiversity, Fauna** (see Figure 3, Figure 4) – A total of 384 species were recorded (194 marine and 190 terrestrial), where birds dominated in the terrestrial environment with 93 species – of which 21 species are migratory – and molluscs in the marine environment (95 species). Of which, 27 species (12 marine and 15 terrestrial) are of conservation significance. No crustaceans were recorded within Keppel Club golf course.
- **Hydrological and Hydrodynamic Conditions** (see Figure 5) – Thirteen (13) water catchment areas within the Study Area contribute to the freshwater ponds within the Keppel Club golf course, concrete drain D5 in the east of Study Area, Berlayer Creek, the Marine Area and roadside drains located on the left perimeter of Former BP Oil Refinery. The runoff collected by Berlayer Creek D1, concrete culverts D2 and D3, man-made pond D4 within Keppel Club golf course and concrete drain D5 eventually ends up in the Marine Area near the mouth of Berlayer Creek. The Marine Area is a mixing zone of freshwater, brackish water and sea water. Berlayer Creek has slow perennial flow during dry and wet weather. Its flow pattern (i.e. flow direction, flow rate and water level) is significantly influenced by the tidal flow. Manmade pond D4 was almost stagnant and was equipped with an aeration system. Concrete Drain D5 receives runoff from residential area north of Study Area and has a slow perennial flow during both dry and wet weather. The flow direction and water level in the Marine Area (i.e. near the mouth of the Berlayer Creek and near Labrador Nature Reserve) was largely dependent on the flood and ebb tides during spring and neap tidal periods.
- **Surface Water Quality** – Ten (10) sampling stations were identified for the Study Area. The surface water quality at the Berlayer Creek and concrete drain D5 had high levels of turbidity, total suspended solids (TSS), nutrients (nitrogen and phosphorus compounds) and enterococcus during wet weather. Elevated levels of these abovementioned parameters were likely also due to runoff discharged from the urbanised area outside of the Study Area, as well as due to fertiliser used for the trees and golf course lawns. The ponds within Keppel Club also were found to have high total organic carbon during wet weather, likely due to contributions from runoff from the surrounding turf soils. The water quality in these inland ponds were noted to have exceeded the respective parameters of NEA Trade Effluent Discharge Limits, ASEAN Marine Water Quality Criteria and international criteria for aquatic life for certain parameters, which indicates that the watercourses may have conditions that are less favourable for aquatic life.
- **Soil Quality** – Sixteen (16) soil samples were collected from seven (7) boreholes. The soil profile generally consisted of silty clay, and all detected parameters were noted to be below their respective Dutch Intervention Values (DIV). The source(s) of detected parameters above their respective limits of reporting could not be conclusively ascertained. Presence of metals, PAHs and TPHs is a common occurrence in urban soils that are exposed to anthropogenic activities. Furthermore, certain parameters, such as metals, are also naturally occurring elements in the environment and their presence in soil might be due to soil weathering process. As the detected parameters are below their respective DIVs, it is assessed that they do not pose unacceptable risk to sensitive receptors. In previously carried out study within Former BP Oil Refinery, arsenic and pesticides exceeded their respective DIVs. Such exceedances were not detected in this EIS.
- **Hydrogeological conditions** – The average stabilized groundwater level (SWL) ranged from 0.50 m reduced level (mRL) (i.e. 2.196 m bgs) to 5.39 mRL (i.e. 1.94 m bgs), with majority of the groundwater level in the seven wells show limited oscillations and variations over time. No significant difference between groundwater levels during low and high tide conditions was observed. Groundwater flow within Study Area follows the topography of the site and can be inferred to be flowing towards major waterbodies (i.e. Berlayer Creek and Marine Area).
- **Groundwater Quality** – Seven (7) groundwater samples were collected weekly. Metals were detected from these samples, whose concentrations were noted to be below their respective DIVs and Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZGFMWQ) for freshwater (95% level of protection), except for the exceedance of concentrations of cadmium, chromium, copper and zinc in various

wells across the site. Although these values have exceeded ANZGFMWQ, none of the ecological receptors are currently known or reported to be affected by the detected concentrations. Previously carried our study within Former BP Oil Refinery showed exceedances of barium, pesticides, zinc and mineral oil above their respective DIVs. No such exceedances were detected in this EIS.

- **Air Quality** – Primary baseline air quality monitoring was conducted at one (1) representative location. All measured pollutant concentrations at A1 were well below the Singapore Ambient Air Quality Long Term Targets for both PM_{10} and $PM_{2.5}$.

- **Airborne Noise** – Baseline monitoring was carried out at four (4) locations within the Study Area. Baseline noise levels of most monitoring locations near the proposed construction worksites/ Study Area (i.e. locations N1, N2 and N4) were well within the maximum permissible noise limits established by NEA. This was due to low environmental noise contributed from human visitors to the sites such as Berlayer Creek as well as low road traffic along Bukit Chermin Road. While for N3, noise levels were considerably higher than other monitoring locations and had exceeded the most stringent noise limit established by NEA for noise sensitive buildings due to the existing noisy conditions dominated by road traffic from West Coast Highway and Telok Blangah Road.

Impact Assessment Methodology

Sections 7, 8, 9, 10 and 11 of the EIS report discuss the methodologies used for impact identification, prediction and assessment on environmental parameters including biodiversity, hydrology, hydrodynamics, water quality, soil and groundwater, air quality and airborne noise during the construction and operational phases of the development.

Key Mitigation Measures

Table 1 summarises the key mitigation measures that have been developed to minimise the adverse impacts throughout the course of the Project. More details can be found in Sections 7, 8, 9, 10 and 11 of the report.

Table 1 Summary of key mitigation measures and best management practices

Environmental Parameter	Recommended Key Mitigation Measures and Best Management Practices	
	During Pre-construction & Construction Phase	During Operational Phase
Biodiversity	• The future development should, preferably, avoid areas with high value habitats. • The proposed 30 m buffer to Berlayer Creek and areas of high conservation value should be observed at all times. • Enhance ecological connectivity through the provision of ecological corridors as outlined in Figure 6. • Minimise felling trees and clearing vegetation during the peak bird breeding season (March to July). • Wildlife shepherding via directional clearing should be adopted. • Pre-felling fauna inspection should be conducted before felling any trees or removing any vegetation.	• Forest species composition in planting scheme should be as similar to adjacent forest patches and include as many native species as possible. • Regular site inspections in the initial phase (first 12 months) to ensure proposed mitigating measures are effective.
Hydrology, Hydrodynamic and Water Quality	• For any construction activities that may alter the alignment of or block drains, appropriate measures such as watercourse diversion should be carried out to avoid localised flooding. The design should follow PUB Code of Practice on Surface Water Drainage, and the diverted flow shall be treated to meet NEA Trade Effluent Discharge Limits prior to discharge. • Provide silt curtains at each of the main outlets which discharges flow from the proposed construction sites into the surrounding watercourses.	• Provide ABC Waters Design features within the development (wetland, bioretention swales, rain garden, etc.) or more softscape areas and pervious areas within the development to increase seepage of surface water into the soil to reduce peak flow and flooding risks within the development. • To create green areas around watercourses to buffer against the edge effect of future development. • To design protection structures at proposed stormwater outlets discharging from the development to Berlayer Creek to minimise local scouring at mangrove area along Berlayer Creek.

Environmental Parameter	Recommended Key Mitigation Measures and Best Management Practices	
	During Pre-construction & Construction Phase	During Operational Phase
Soil and Groundwater	• Install piezometers to monitor the changes in groundwater level in compliance with Building Control Regulations 2003 as part of its instrumentation and monitoring plan to be endorsed by the Qualified Professional; and • Conduct a construction risk assessment and prepare a comprehensive construction health, safety and environment plan. If health impacts to workers are foreseen due to the handling of such waste, necessary precautionary measures as per the safety data sheets (SDS) including personal protective equipment should be implemented on site.	• Incorporate more pervious surfaces in the development plan; • Installation of recharge wells, if necessary; • Ensure no trade effluent other than that of a nature or type approved by NEA Director-General shall be discharged into any watercourse or land; and • Conduct regular inspections on waste storage system within the Project to prevent system's clogging and leachate entering the underlying soil and/or surrounding watercourses, if any.
Air Quality	• Implement dust control measures e.g. dust screens, equipment with dust suppression etc. • Install hard surfaced haul routes. • Impose and signpost maximum speed-limit of 25km/hr on paved roads and 15 km/hr on unpaved roads and work areas. • Closed turfing to the exposed areas where possible and maintain proper storage of soil stockpiles.	No mitigation measures to be proposed as the predicted increase in air quality pollutant levels is likely to be insignificant, due to: • Current large traffic volume along existing roads, and thus, any increase in traffic due to the development will not lead to a significant change in air quality. • Continued implementation of increasingly stringent Euro emission standards on new vehicles.
Airborne Noise	• Use equipment with lower noise levels; • Access routes should avoid facing receptors; • Staggered building heights should be considered to reduce duration of noisy activities near receptors; and • Noise barriers should be erected along boundary of worksites facing noise sensitive receptors (where necessary).	• Utilize noise attenuators and other Best Available Technology (BAT) and Best Environmental Practice (BEP) to mitigate potential noise from air conditioning and mechanical ventilation (ACMV) systems; • Utilize low speed postings, speed humps, speed limit signages at drop-off points and parking areas to mitigate noise from increased road traffic; and • Consider alternative siting of roads away from areas with noise sensitive receptors.

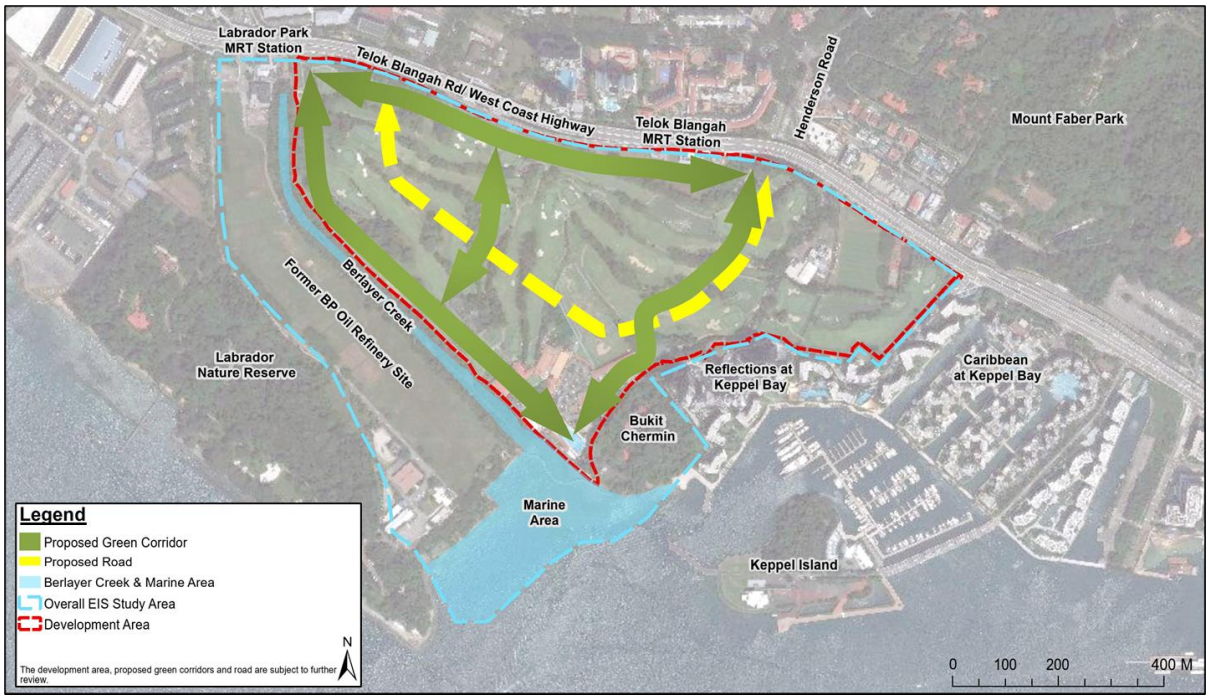


Figure 6 Conceptual Connectivity Plan

The Conceptual Connectivity Plan of the Project Site (Figure 6) has undergone rounds of revision as per discussion and feedback from the Nature Group representatives and other Technical Agencies during Nature Group Engagements. It has been further adjusted to minimize potential environmental impact. This Plan considers the proposed mitigation measures and proposed ecological connectivity with the surrounding habitats at Labrador Nature Reserve, Bukit Chermin and the Southern Ridges for birds and potentially small mammals.

This includes:

1. An ecological corridor along Berlayer Creek (herein referred to as Berlayer Corridor). Once densely planted, this will also serve as a transition layer that will help to buffer the high value habitat from an expected increase in light and noise from the proposed development.
2. An ecological corridor across the middle of the development (herein referred to as Central Green Corridor). Located at the 'valley' of the site, this provides opportunities for habitat creation, with potential to incorporate waterbodies. For example, this could allow transition of habitats from mangroves (at the intersection with Berlayer Creek) to back mangroves to freshwater habitat further inland.
3. An ecological corridor on the east aligned to the planned Nature Way along Henderson Road (herein referred to as Henderson Road Corridor).
4. A northern green corridor is proposed along West Coast Highway to further enhance connectivity between the three ecological corridors.

Further details and additional functions of these corridors are provided in Section 7.10.1.3.

Summary of Impact Assessment

With the implementation of mitigation measures, the overview of impact evaluation for both construction and operational phases are summarised in Table 2.

Table 2 Summary of Impact Significance for Construction and Operational Phases (Range if applicable)

Environmental Parameter	Impact Significance (with minimum controls/best practices)	Residual Impact Significance (with mitigation measures)
Biodiversity	Negligible to Major	Negligible to Major[1]
Hydrology and Surface Water Quality	Minor to Moderate	Positive to (Negative) Minor
Hydrodynamic Conditions and Marine Water Quality	No Impact to Minor	No further mitigation measures are required, since unmitigated impacts are deemed to be minor.
Soil and Groundwater	Negligible to Minor	No further mitigation measures are required, since unmitigated impacts are deemed to be minor.
Air Quality	Major	Minor
Airborne Noise • **Ecological Receptors** • **Human Receptors**	 • Minor to Major • Minor to Major	 • Negligible to Moderate • Negligible to Major[2]

Note:

(1) Mitigated impact significance to Biodiversity due to the loss of vegetation remains "Major" even though the Keppel Club golf course is not of the highest conservation value. This is because the vegetation of the golf course is presently being used by a range of fauna species. The removal of the green areas will likely result in permanent loss of habitats and fauna displacement. If there are no deliberate attempts to replace the greenery lost here with establishment of an equal value habitat off site, cumulative impairment will occur. As such, the EIS report has recommended safeguarding four green corridors through the site to maintain and enhance the ecological connectivity between Labrador Nature Reserve and Southern Ridges and facilitate habitat creation within the site.

(2) Due to the height of the human receptors along Bukit Chermin Road, noise barriers of up to 12 m height will not be able to eliminate the direct line-of-sight that the receptors will have of the worksite, particularly for residences staying on higher floors. Nonetheless, mitigation measures can be put in place before works begin, to minimise the noise, dust and air pollution during the construction period. For example, the noise level of various construction works is regulated by NEA and is controlled at stipulated levels during different periods of the day.

A set of Environmental Monitoring and Management Plan (EMMP) has also been developed for each environmental parameter, which will be updated and implemented during construction and operational phases, to ensure the effectiveness of the proposed mitigation measures. The EMMP is described in Section 12 of the EIS report.