Sentosa Development Corporation

Final Environmental Impact Assessment Report

(Part I – Executive Summary)

Tanjong Rimau Slope Stabilisation

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1. Executive Summary

This Environmental Impact Assessment (EIA) outlines the environmental findings for the proposed works at Tanjong Rimau, Sentosa. Developed alongside an engineering study, the EIA evaluates how the proposed slope stabilisation works may affect the Project's coastal and terrestrial environments. It provides a structured assessment of potential impacts on the biological and physical components of the Project Area, herein referred to as "Study Area", and identifies appropriate mitigation and management measures. The purpose of this report is to support informed decision-making and to ensure that project implementation remains aligned with Singapore's regulatory requirements and broader environmental sustainability objectives.

An Environmental Monitoring and Management Plan (EMMP) has also been formulated based on the findings from the EIA to ensure the implementation compliance by the Contractor and assess effectiveness of the proposed mitigation measures.

1.1 Proposed Key Developments

Slope stabilisation works will be carried out at four locations (Sites A, B, C1, and C2) along Tanjong Rimau (**Figure 1-1**). At all sites, works will commence with the clearance of loose soil, rocks, damaged structures, and vegetation, followed by the installation of temporary staging for safe access. At Site A, the slope will be reinforced with soil nails and grid beams, complemented by XblocPlus and conventional amour rock revetment at the base to reduce wave-induced erosion at the toe of the slope. Surface drainage will also be provided at Site A to manage runoff and minimise water accumulation along the stabilised slope. Stabilisation at Site B will involve the installation of rock dowels and rock netting. Sites C1 and C2 will be treated with erosion control blankets and further protected through the construction of an XblocPlus and conventional amour rock revetment at the base to reduce wave-induced erosion at the toe of the slope. At Site C2, drainage will be incorporated by utilising existing gullies that have naturally formed onsite to facilitate surface water conveyance and reduce erosion along the slope face.

The primary mode of construction access will be via sea, with a barge transported by tugboat to deliver construction materials and equipment to the slope stabilisation worksites. As the barge is unable to directly access the worksites, a temporary bund will be constructed within the intertidal zone, with minor extension into the subtidal area, to facilitate offloading operations. Materials and equipment will subsequently be transferred along the bund to the respective worksites. Two access routes will be established: one for Site A, and another for Sites B, C1, and C2. Barge movements are anticipated to occur no more than twice daily at high tide under a worst-case scenario, and the barge may be stationed at the bund for periods of three to four days using spud-down piles. These movements will occur throughout the construction phase, with higher frequencies expected during mobilisation and demobilisation stages. The temporary bund will be removed upon completion of the works. In addition, a 2 m wide footpath within the coastal forest may be established to facilitate worker access to Site A; this access route will be used solely for worker movement, with no transport of materials or equipment anticipated.

Where feasible, the design of the revetment may incorporate features that enhance habitat complexity and better reflect characteristics of natural rocky shore environments. This may include the use of varied rock sizes, irregular placement, and the inclusion of surface textures, crevices, and void spaces that can provide shelter and attachment surfaces for marine organisms. Such design considerations can facilitate the colonisation of intertidal and subtidal species (e.g., algae, sessile invertebrates, and small mobile fauna), thereby supporting local biodiversity and promoting ecological connectivity with adjacent habitats. These measures are intended to complement the primary engineering function of the revetment while providing additional ecological value within the Study Area.

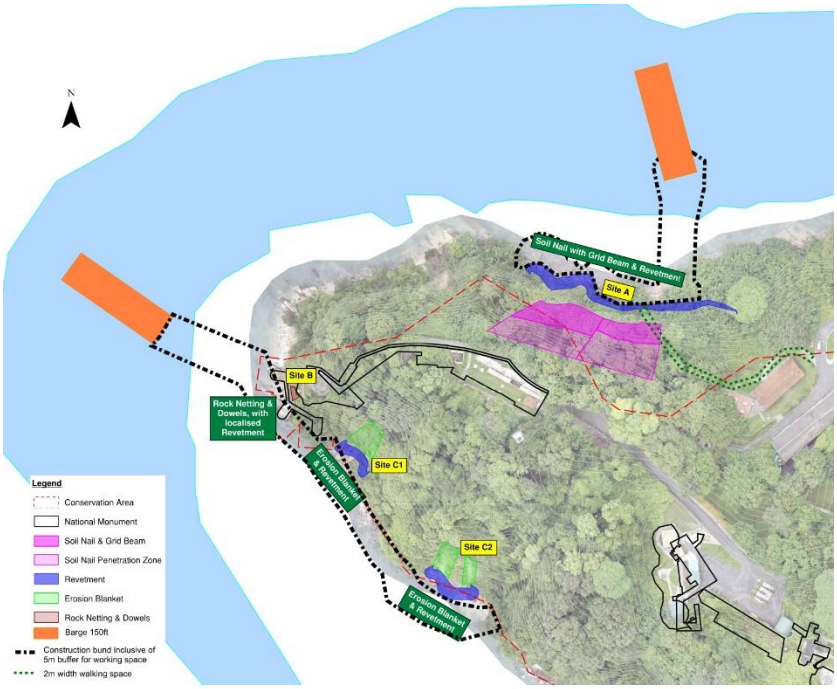

Figure 1-1 Study Area

1.2 EIA Approach and methodology

The EIA which includes the environmental baseline surveys and the impact assessment, was carried out using the methods as described in the NParks BIA Guidelines (2024). Impacts assessed as Negligible or Minor require no additional management or mitigation measures (on the basis that the intensity of the impact is sufficiently small, or that the receptor is of low sensitivity, or the likelihood is low and/or that adequate controls were already included in the project design). Further management or mitigation measures will be required for impact significance assessed as Moderate and Major to minimize or reduce the impact to an acceptable level as much as possible. The framework of the mitigation hierarchy (avoid, minimise, restore, and further measures to compensate) served as a prioritised set of possible management responses to anticipated impacts.

1.3 Summary of Environmental Baseline Findings

1.3.1 Biodiversity

Within the Study Area, a total of 94 flora species were recorded, 90 terrestrial flora species and four seagrass species. Of these 94 flora species, 27 were of conservation significance, including three seagrass species (**Figure 1-2**). The seagrass meadows comprise both continuous and patchy areas, providing essential habitat for fauna and acting as a sediment stabilizer in the intertidal zone. Terrestrial fauna opportunistic surveys recorded a total of 12 species, of which four were of conservation significance—three birds and one mammal.

Five intertidal survey locations (I01–I05) were established, revealing a mosaic of abiotic substrates (46.5%) and algae (45%) as dominant cover types. In the intertidal zone, a total of 156 intertidal species were recorded, including 11 species of conservation significance (**Figure 1-3**).

Subtidal surveys across three transects (S01–S03) showed that abiotic substrates dominated (66–91%), with hard corals as the main biotic component. The highest coral cover (12.5%) and diversity occurred at survey location S02. Throughout the entire Study Area, a total of 256 hard coral colonies were recorded, comprising 48 species with six species of conservation significance.

In addition, 75 other subtidal species were identified, of which seven fish species are of conservation significance. While no soft corals of conservation concern were recorded, sea fans and sea whips were present, functioning as keystone structures that support associated species such as whipcoral gobies (*Bryaninops sp*).

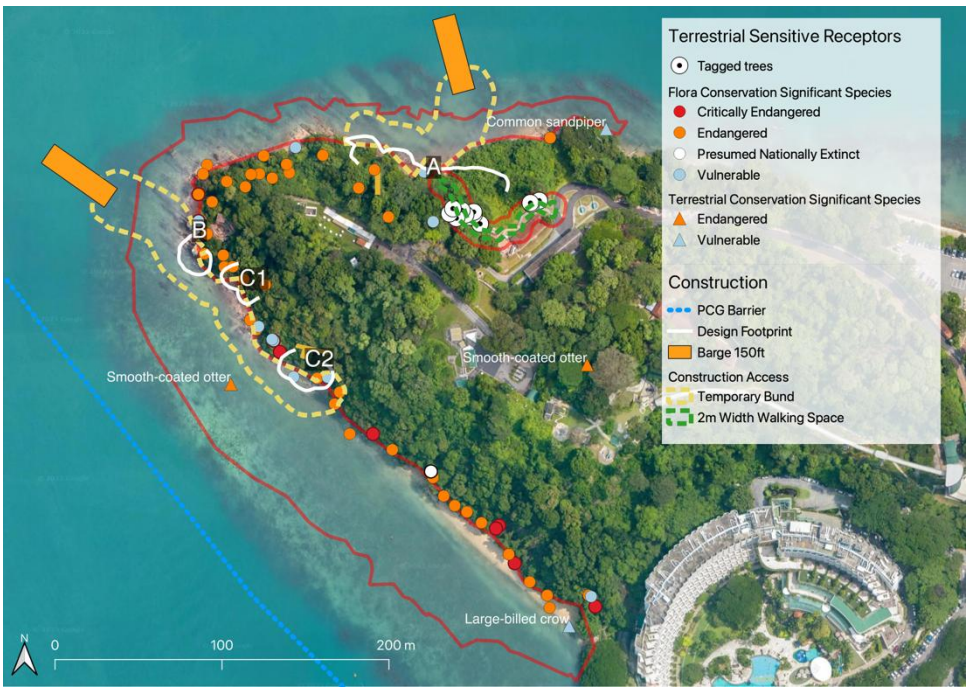

Figure 1-2 Location of conservation significant terrestrial flora and fauna species

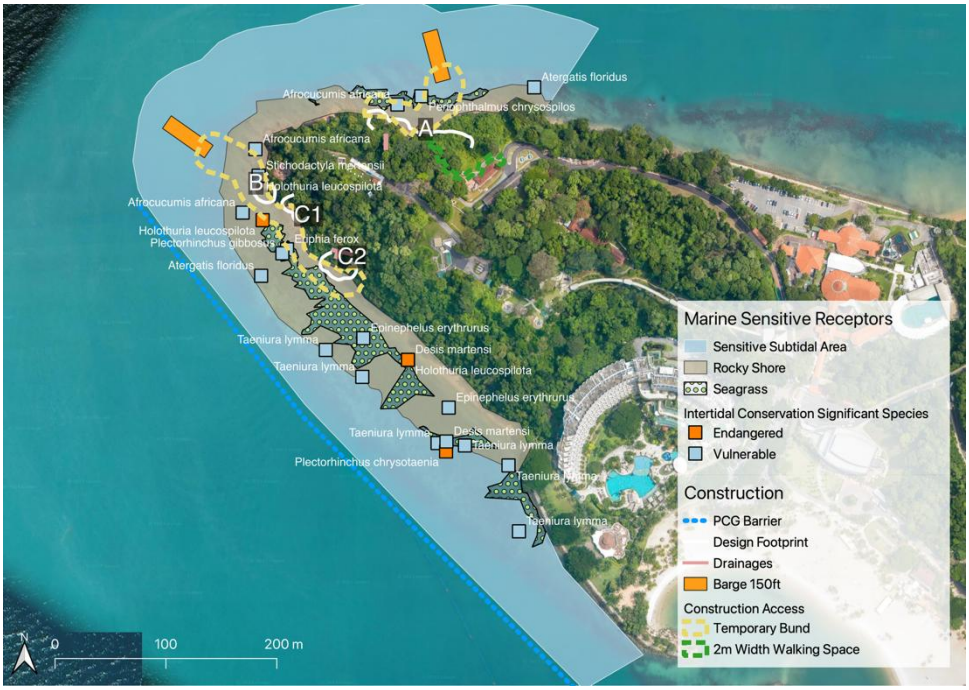

Figure 1-3 Location of conservation significant intertidal flora (seagrass) and fauna species

1.3.2 Physical Environment

The physical environment at Tanjong Rimau is in good overall condition. Marine water quality was generally of good quality and largely complies with the ASEAN Marine Water Quality Criteria (AMWQC) for aquatic life protection, with localised elevations of nitrate and a single elevated Enterococci result. Ambient air quality data show generally good levels that complies with the Singapore Ambient Air Quality Targets (SAAQT), except for SO_2 at A2 on certain days—likely due to transient plumes from external combustion sources such as passing marine vessels. Similarly, ambient noise were below the corresponding NEA permissible noise limits, except for two exceedances. However, these isolated exceedances were interpreted as arising from existing activities and represent the prevailing acoustic environment prior to the proposed works. Lastly, the baseline ground vibration

data demonstrates low structural risk as all measured values were substantially below BS 5228-2 cosmetic damage thresholds and tolerable to humans.

The integrated baseline dataset, supported by accredited laboratory analysis and calibrated field instrumentation, provides a robust reference condition for the risk-based impact assessment and for the design of targeted mitigation and monitoring programmes. The subsequent Environmental Impact Assessment will use these baseline conditions, together with the applicable regulatory criteria, to demonstrate that the proposed slope stabilisation works can be implemented without causing unacceptable degradation of marine water quality, ambient air quality, ambient noise or ground vibration at Fort Siloso, Shangri La Rasa Sentosa Resort and the surrounding coastal environment.

1.4 Summary of Impact Assessment

Section 1, 3 and **4** of the main EIA report discusses the methodologies used for impact identification, prediction and assessment on environmental parameters including biodiversity (habitat, flora and fauna), physical environment (i.e., marine water quality, ambient air quality, ambient noise, ground vibration and hydrodynamic) during the construction and operation phase of the project.

A breakdown of impact to the environment (biodiversity and physical environmental) is presented in **Table 1-1**.

1.4.1 Biodiversity

Construction work will temporarily affect some natural habitats and flora specimens in the area. The seagrass meadows will see the most significant impact, as some loss is unavoidable during the works. For other vegetation, measures like avoidance through a tree protection zone and plant salvaging before construction will reduce impacts considerably. Once construction is complete, conditions are expected to recover well, with no significant long-term effects anticipated.

Animals in the area may be disturbed during construction in several ways—through loss of feeding grounds, risk of accidental injury, increased human presence, and light from night works. These risks will be managed through wildlife protocols and careful site practices. Some impact on habitats and food sources will remain even after these measures are applied, but most other disturbances are expected to be Minor or avoided altogether.

Upon completion of the slope stabilisation works, the overall impact on habitats, flora, and fauna is expected to be negligible in a long run. The natural environment should return largely to its pre-construction state, with ecological connectivity—the ability of animals to move through the area—preserved.

1.4.2 Physical Environment

The works will temporarily affect the surrounding environment in a few ways. Disturbing the seabed will stir up sediment and reduce water clarity nearby, while machinery will generate dust, exhaust fumes, and noise. These effects are expected to range from Minor to Moderate at their worst, but practical measures—such as adopting good practices such as turning off the boat engine whenever it is idle to minimise unnecessary disturbance to seabed, dust suppression on site, and quieter equipment where possible—will bring most impacts down to a Minor or Negligible level.

Some vibration from construction activity is unavoidable, particularly during any drilling or equipment use. There is potential that vibration could be felt at nearby sensitive locations such as Fort Siloso and the Shangri-La Rasa Sentosa Resort. However, by using appropriate equipment and working methods, vibration levels can be kept within acceptable limits throughout the works.

Upon completion of the slope stabilisation works, impacts to the physical environment is expected to return to Negligible levels. No ongoing impacts from the completed structures are anticipated, meaning the surrounding environment and nearby properties should not experience any long term impacts.

1.4.3 Hydrodynamic Modelling

During construction, hydrodynamic impacts are primarily associated with propeller wash-induced sediment plumes, leading to potential localised seabed erosion and sedimentation. These impacts are generally limited, with no observable effects on most corals, seagrasses, or recreational beaches such as Siloso Beach; only slight, localised impacts to some corals near barge activity areas are anticipated, and minor sedimentation effects are

expected for isolated coral specimens. During operation, changes in current flow and seabed morphology due to the revetments are predicted to be minimal, with no hydrodynamic or sedimentation impacts on navigation channels, coral reefs, or seagrass habitats, resulting in an overall Negligible impact significance.

1.5 Key Mitigation Measures

To reduce impacts to the sensitive environment at Tanjong Rimau, below are some key mitigation measures that have been proposed:

a) Avoid clearing trees of conservation significant; if any, these trees are recommended to be retained in Tree Protection Zone to ensure survival and proper maintenance throughout construction phase.

b) If possible, salvage saplings of conservation value to be impacted before construction.

c) If possible, salvage seagrass to be impacted before construction.

d) Retain ground cover as long as possible; implement erosion control measures when removed.

e) Maintain good housekeeping and waste management on site.

f) Conduct biodiversity awareness training, emphasising wildlife encounters (long-tailed macaques and smooth-coated otters) and prohibiting harvesting of intertidal flora/fauna.

g) Restrict personnel to working areas; prohibit access to intertidal, subtidal, and coastal forest zones.

h) Working hours should be between 0800h-1800h. Implement Light Management Plan if night work is required. Night work should be prohibited during coral spawning season.

More details on proposed mitigation measures can be found in **Section 4, 5** and **6** of the Main EIA Report. With the implementation of proposed mitigation measures, it is expected that Major and Moderate impacts will be reduced to Moderate and Minor–a breakdown is presented in **Table 1-1**.

Table 1-1 Summary of impact significance for construction and operations phase

Environmental Aspect	Impact Significance (Unmitigated)	Residual Impact Significance (Post-mitigated)
Construction Phase		
Habitat	Negligible to Moderate	Negligible to Moderate
Flora	Negligible to Major	Negligible to Moderate
Fauna	Negligible to Moderate	Negligible to Moderate
Marine water quality	Minor to Moderate	Negligible to Minor
Ambient air quality	Negligible to Moderate	Negligible to Minor
Ambient noise	Minor to Moderate	Minor
Ground vibration	Minor to Moderate	Negligible to Minor
Operations Phase		
Habitat	Negligible	N/A
Fauna	Negligible	
Marine water quality	Minor	
Ambient air quality	Negligible	
Ambient noise	Negligible	
Ground vibration	Negligible	

Note:
N/A – where the impact significance with minimum controls is scored Negligible to Minor, no mitigation measures were proposed and hence, did not warrant for further assessment.

1.6 Environmental Management and Monitoring Plan

To ensure the effectiveness of the proposed mitigation measures, an Environmental Monitoring and Management Plan (EMMP) has also been developed for each environmental parameter, which should be updated and implemented during the construction phase by the Contractor. As the project could evolve over time, the EMMP would be an adaptive document meant to be amended where necessary. Approval from relevant authorities would be required for any amendments which deviate from the findings and suggestions of the EMMP measures in this

EIA. The EMMP is described in **Section 6** of the Main EIA report and the list of monitoring that phase is summarised in **Table 1-2** with **Figure 1-4** showing the monitoring locations.

Table 1-2 Summary of monitoring during EMMP phase

Monitoring Type	Scope / Description	Locations (Figure 1-4)	Baseline	Construction Phase	Post-construction
Daily Site Inspection	Routine inspections of pollution control and ECM compliance. Check for trapped/injured fauna; assess entrapment risks (ECBs, pits, drains, TPZs)	Entire worksite boundary and intertidal areas	NA	Daily	NA
Fauna Site Inspection	Entrapment risks, food waste issues, ECM non-compliance	Entire worksite boundary and intertidal areas	NA	Monthly	NA
Intertidal Survey[1]	Monitor for changes in intertidal biodiversity due to the construction using intertidal Transect and Quadrat method and monitoring of transplanted coral specimens (if any).	T01-T10	Once	Once every two months	Once every two months
Subtidal Survey[1]	Monitor for changes in subtidal biodiversity due to the construction using and monitoring of transplanted coral specimens (if any)	S01- S03	Once	Once every two months	Once every two months
Sedimentation [1]	Measures sedimentation rate using sedimentation traps.	S01- S03	Once one month before construction	Monthly	Monthly
Arboriculture Inspection	Monitor the health of retained trees, TPZ compliance and forest-edge condition. Monitor the health and survival of any terrestrial tree that is transplanted within the worksite boundary.	Retained trees; forest edge (10 m zone)	When needed	Monthly	Once every two months
Flora Inspection	Monitor for unauthorised clearance, invasive species and habitat degradation. Monitor the health and survival of any terrestrial flora that is transplanted within the worksite boundary.	Flora monitoring boundary	Once	Monthly	Once every two months
Marine Water Quality[1]	Monitor for changes in water quality due to the construction activity and to ensure that water quality levels are back to baseline values after construction. One in-situ and ex-situ monitoring event covering spring and neap tides, both flood and ebb conditions	S01- S03	Once	Monthly	Once every two months
Ambient Air Quality	Continuous PM and gas monitoring ($PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, O_3) to monitor for construction impact and to ensure that air quality levels are back to baseline values after construction.	P01 & P02	7 consecutive days	Continuous (≥95% uptime/month)	7 consecutive days
Ambient Noise	Continuous LAeq monitoring to ensure that vibration levels are within the limit	P01 & P02	7 consecutive days	Continuous (≥95% uptime/month)	7 consecutive days
Ground Vibration	Establish PPV baseline and regular monitoring to ensure that vibration levels are within limit	P01 & P02	3 consecutive days	Continuous, during high noise activity	3 consecutive days

[1]Surveys should follow the prescribed monitoring frequency (e.g. intertidal surveys once every two months during construction and post-construction phases). If scheduled surveys do not coincide with the coral spawning season, the dates should be adjusted such that intertidal and subtidal surveys are conducted within two weeks prior, and water quality and sedimentation surveys within one month prior to the spawning season. These surveys should not be conducted during the coral spawning event

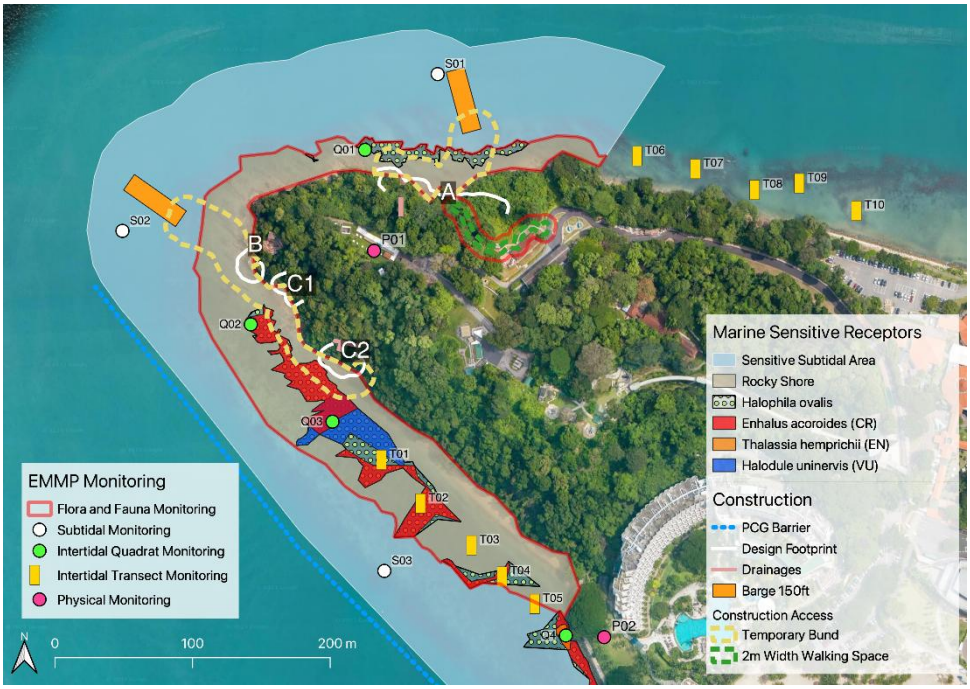

Figure 1-4 EMMP monitoring location

1.7 Conclusion

The proposed slope stabilisation works at Tanjong Rimau, Sentosa, can be implemented in an environmentally responsible manner. While the Study Area supports a rich diversity of terrestrial and marine life—including conservation-significant flora, fauna, seagrass meadows, and coral communities—the EIA finds that most construction-phase impacts can be reduced to Minor or Negligible levels through the application of targeted mitigation measures. The unavoidable loss of some seagrass habitat and plant specimens remains the most significant residual impact, and will be managed through salvaging and monitoring programmes. During the operational phase, all environmental parameters are predicted to return to Negligible impact levels, with no long-term degradation to the surrounding coastal environment. With the implementation of the Environmental Monitoring and Management Plan (EMMP) and adherence to the mitigation hierarchy, the Project is likely to achieve its engineering objectives while safeguarding the ecological integrity of Tanjong Rimau.