08 MITIGATION MEASURES

8.1 Introduction

This chapter will discuss all Pollution Prevention and Mitigation Measures (P2M2) that will be adopted and incorporated during and after the Project implementation stage to effectively eliminate, prevent or minimize the predicted adverse impact. The mitigation measures discussed here include structural, non-structural, procedural or administrative in nature. Also, compensation/*ex-gratia* and offset programmes will be conducted to counterbalance the impacts that cannot be mitigated and/or considered as total loss.

8.2 Summary of Predicted Impacts and Proposed P2M2

The predicted adverse impacts caused by the proposed Project that have been discussed in detail in *Chapter 7: Evaluation of Impacts* are summarised together with the proposed P2M2 in T8.1. Particulars for each proposed P2M2 is discussed in the following sub-sections according to the applicable environmental component.

8.3 Water Quality

P2M2 for water quality can be divided into two different aspects tackling specific impacts on the water quality, namely sediment dispersion from dredging and land reclamation activities, and reduced flushing capacity because of reclamation footprint.

8.3.1 P2M2 for Sediment Dispersion

Sediment dispersion caused by the dredging and land reclamation activities can be managed and mitigated using several measures. For this Project, the proposed measures include:

a) combination of perimeter bund and silt curtain;
b) controlled dredging operation; and
c) dredger type.

Details of each P2M2 proposed are as in the following sub-sections.

T8.1 Summary of impacts and proposed P2M2

ESAs / Receptors	Location	Point	Environmental Impact										Proposed P2M2
			1	2	3	4	5	6	7	8	9	10	
River Outlet	Sungai Gertak Sanggul	R1	✓		✓	✓ (Sedimentation)		✓					a) Bed level changes ■ Maintenance dredging for sedimentation every 5 years, depending on bathymetric survey. ■ Coastal protection structure (hard and soft) for erosion such as revetment and beach nourishment. b) Water quality ■ Implementing Green River Programme to improve the water quality for major rivers in southern Penang Island as detailed in *Section 8.2.2.1.* ■ Reduction in pollution load especially for BOD (up to 70%), phosphorus (up to 99%) and ammoniacal nitrogen (up to 81%). ■ Widening of navigation channel based on results of detailed hydraulic analysis. ■ Control land use and point source discharge within the southern Penang Island area.
	Sungai Gemuruh	R2	✓		✓			✓					
	Sungai Teluk Kumbar	R3	✓		✓			✓					
	Sungai Mati	R4	✓		✓			✓					
	Sungai Batu	R5	✓		✓	✓ (Sedimentation)		✓					
	Sungai Bayan Lepas	R6	✓		✓	✓ (Erosion)		✓				✓	
	Bayan Lepas Main Drain	R7	✓		✓	✓ (Erosion)		✓				✓	
	Sungai Ikan Mati	R8	✓					✓				✓	
Hatcheries	Near Sungai Pulau Betung	H1											a) Sediment dispersion ■ Combination of perimeter bund and silt curtain in managing the sediment plume during reclamation. ■ Upgrading of filtration system, based on feedback from consultation with the operators. ■ Controlled dredging operation. b) Footprint ■ Relocation of seawater intake pipe to suitable area, based on feedback from the operators. c) Water Quality ■ Implementing Green River Programme to improve the water quality as detailed in *Section 8.2.2.1.* ■ Reduction in pollution load especially for BOD (up to 70%), phosphorus (up to 99%) and ammoniacal nitrogen (up to 81%). ■ Widening of navigation channel based on results of detailed hydraulic analysis. ■ Best Management Practices (BMPs) for solid waste, scheduled waste and wastewater.
	Gertak Sanggul	H2					✓	✓	✓				
	Teluk Kumbar	H3					✓	✓	✓				
	Permatang Damar Laut	H4											
Corals	Pulau Kendi	C1											a) Sediment dispersion ■ Using small rocks as bedding layer of the rock bund construction along the south eastern edge of Island A (section closest to Pulau Rimau) as an alternative to the sandy material. The small rocks will not produce significant plume as compared with sandy material. Refer to simulation model presented in *Section 8.2.1.1.* b) Offset programme ■ Provide grant or financial support for coral related research. ■ Construction of artificial reefs.
	Pulau Rimau	C2	✓		✓		✓						
Turtle-Landing Area	Gertak Sanggul	T1	Total loss (trade-off)										Offset programme ■ Provide grant for turtle research or financial support to research centres such as: i) Turtle Conservation Centre at Pantai Kerachut (National Park) in Penang (managed by Fisheries Department). ii) Turtle and Marine Ecosystem Centre (TUMEC) in Rantau Abang (managed by Fisheries Department). iii) SEATRU, Universiti Malaysia Terengganu (UMT).
	Pasir Belanda	T2											
	Teluk Kumbar	T3											
	Sungai Batu	T4											
	Teluk Tempoyak Besar	T5											
Aquaculture	Pulau Betung	A1											Insignificant impact, thus no P2M2 proposed
	Sungai Pulau Betung	A2											
	Batu Maung	A3											
Recreational Beach	Pantai Pasir Panjang	B1						✓		✓		✓	a) Beach enhancement ■ Enhancement work shall be conducted at beaches that are currently eroding according to the NCES (2015) e.g. Pantai Nelayan, Pantai Tanjung Assam and Pantai Gertak Sanggul. b) Monitoring survey ■ Periodic bathymetry and nearshore surveys to assess beach and bed level changes during and after Project implementation. c) Beach nourishment ■ If beach erosion is detected from monitoring survey, beach nourishment shall be conducted.
	Pantai Gertak Sanggul	B2						✓		✓		✓	
	Pantai Tanjung Asam	B3						✓		✓		✓	
	Pantai Nelayan	B4						✓		✓		✓	
	Pantai Bakar Kapor	B5						✓		✓		✓	
Islands	Pulau Betung												A sufficient buffer zone is provided between the proposed reclamation layout and Pulau Rimau (500 m buffer) as well as Pulau Kendi (3 km buffer).
	Pulau Rimau												
	Pulau Kendi												
Marine Biology	Mudflat		Total loss within the Project's footprint (trade-off). The value of mudflat services loss is monetised as described in the Economic Valuation of Environmental Impact section in *Chapter 7: Evaluation of Impacts*.										Offset Programme ■ Restoration of fish habitat in Penang. ■ Provide grant or financial support for Fisheries Research Fund (Fisheries Department of LKIM) which includes study on the migration route of greasyback shrimp. ■ Mangrove replanting programme.
	Plankton						✓		✓				Offset programme ■ Deployment of Fish Aggregating Device (FAD). ■ Deployment of artificial reef. ■ Mangrove replanting programme. ■ Construction of eco-engineering structures on PSR.
	Macrobenthos		Total loss within the Project's footprint (trade-off)										
	Fish fauna						✓	✓	✓				

Note: 1: Current Speed, 2: Water Level, 3 Wave Heights, 4: Bed Level Changes, 5: Sediment Spill Dispersion, 6: Water Quality, 7: Footprint, 8: Noise, 9: Air Quality, 10: Aesthetics, (✓) indicates 'has impact'
The proposed P2M2 for impacts from Pre-dredging Phase: Construction of Workers' Quarters is described in *Section 8.3.3.1*.

T8.1 Summary of impacts and proposed P2M2 (cont'd)

ESAs / Receptors	Location	Point	Environmental Impact										Proposed P2M2
			1	2	3	4	5	6	7	8	9	10	
Recreational Fishing Staging Area	Sungai Pulau Betung	RF1										✓	New recreational fishing staging area ■ Propose other recreational fishing staging locations in Penang Island. ■ Provide new recreational fishing locations on PSR. ■ Improvement on current staging area i.e. improving public access to the area.
	Gertak Sanggul	RF2					✓			✓		✓	
	Tanjung Karang	RF3					✓			✓		✓	
	Pasir Belanda	RF4					✓			✓		✓	
	Sungai Batu	RF5					✓			✓		✓	
	Teluk Tempoyak Besar	RF6					✓			✓		✓	
	Batu Maung	RF7										✓	
	Pantai Sri Jerjak	RF8										✓	
Fish-Landing Point	Sungai Pulau Betung	F1											New fishermen jetties ■ New jetties for fishermen will be built.
	Gertak Sanggul	F2	✓			✓ (Sedimentation)						✓	
	Teluk Kumbar	F3	✓		✓								
	Sungai Batu	F4	✓		✓	✓ (Sedimentation)							
	Permatang Damar Laut	F5											
	Permatang Tepi Laut	F6	✓		✓							✓	
	Teluk Tempoyak Besar	F7											
	Teluk Tempoyak Kecil	F8											
	Batu Maung	F9											
	Sri Jerjak	F10											
Mangrove	Sungai Gertak Sanggul	M1											An offset programme in collaboration with the Forestry Department and FRIM can be conducted. The small and localised mangrove area adjacent to the proposed Project area can be enhanced by replanting programme. This programme can be organised by PPSN set up by the Project Proponent.
	Sungai Teluk Kumbar	M2											
	Sungai Batu	M3											
	Sungai Bayan Lepas	M4											
	Bayan Lepas Main Drain	M5											
	Teluk Tempoyak Besar	M6											
	Teluk Tempoyak Kecil	M7											
Human	Fishermen		✓			✓	✓	✓	✓				a) Compensation/*Ex-gratia* ■ Compensation/*Ex-gratia* for loss of fishing ground. ■ Formula for compensation/*ex-gratia* to be paid shall be according to the parameters and recommendations in this EIA report. ■ Provision of public housing for eligible affected parties. ■ Establish an initial contract for the public housing with the affected parties. b) *Pusat Perkhidmatan Setempat Nelayan* (PPSN) ■ Continuous engagement with the local fishermen. ■ Offer fishermen exit plan to those needed. ■ Disseminating information and latest updates on the Project. ■ Job-registration for fishermen. ■ Answering public queries on the potential impacts they might face in the future. ■ Organise community services to ensure good relationship. ■ Two PPSN (Permatang Damar Laut and Gertak Sanggul) are already in operation. d) Conserving/restoring the fishery and ecosystem ■ Deployment of Fish Aggregating Device (FAD), pillars and artificial reefs that are consistent with the Penang Artificial Reef Plan. ■ Fish stocking/releasing of fish fry at strategic locations (sea ranching). ■ Monitoring of the released and natural stocks to assess the impacts. ■ Mangrove replanting programme. d) Social proactive measures ■ Improving local education status by providing scholarships (priorities to fishermen's children) and tuition centres. ■ Other commitments which include four fisherman's jetties and beach enhancement.
	Local community									✓	✓	✓	a) Employment opportunities ■ Construction works targeted to engage 30% of local workers. ■ Labour requirement to be partly recruited from locals. ■ Appropriate skills training programme for locals. b) Community development ■ Continuous community engagement to foster good relationship. ■ Marginalisation could be overcome by direct participation of locals in the development. ■ Add local amenities, schools, services and health facilities to cater for increased population. c) Noise Control ■ Restriction on night works at specific area closest to residential area.
	Business operators									✓	✓	✓	

Note: 1: Current Speed, 2: Water Level, 3 Wave Heights, 4: Bed Level Changes, 5: Sediment Spill Dispersion, 6: Water Quality, 7: Footprint, 8: Noise, 9: Air Quality, 10: Aesthetics, (✓) indicates 'has impact'
The proposed P2M2 for impacts from Pre-dredging Phase: Construction of Workers' Quarters is described in *Section 8.3.3.1*.

8.3.1.1 Combination of Perimeter Bund and Silt Curtain

a) Construction of Perimeter Bund

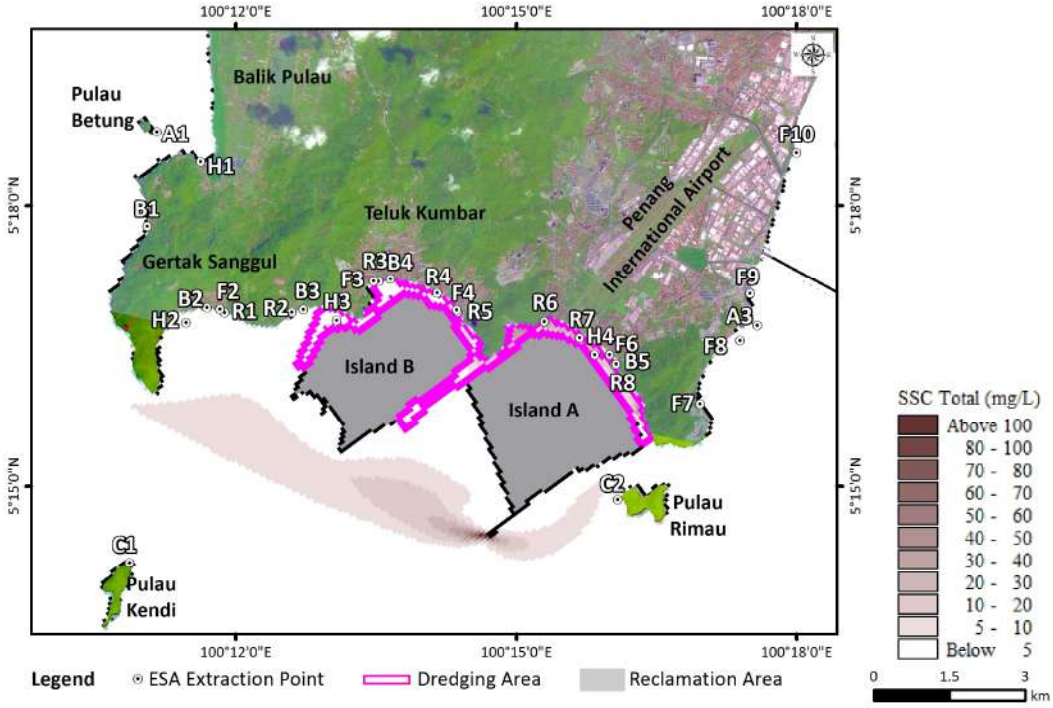
Perimeter bund can be constructed first prior to reclamation filling process as an effective way in managing sediment plume. The perimeter bund will act as a physical barrier in filtering the fine material suspended in the water column generated during the filling process from dispersing to the surrounding area. As discussed in *Chapter 5: Project Descriptions*, two types of perimeter bund will be used for this Project namely rock bund and temporary sand bund. For sand bund that is expected to be exposed to wave or current actions, i.e. without silt curtain protection, for more than two weeks, the sand bund needs to be protected using geotextile and/or geobags. Both measures are done to protect the sand bund from being eroded away. F8.1 shows an example of a reclamation project that uses perimeter bund.

F8.1 Example of perimeter bund

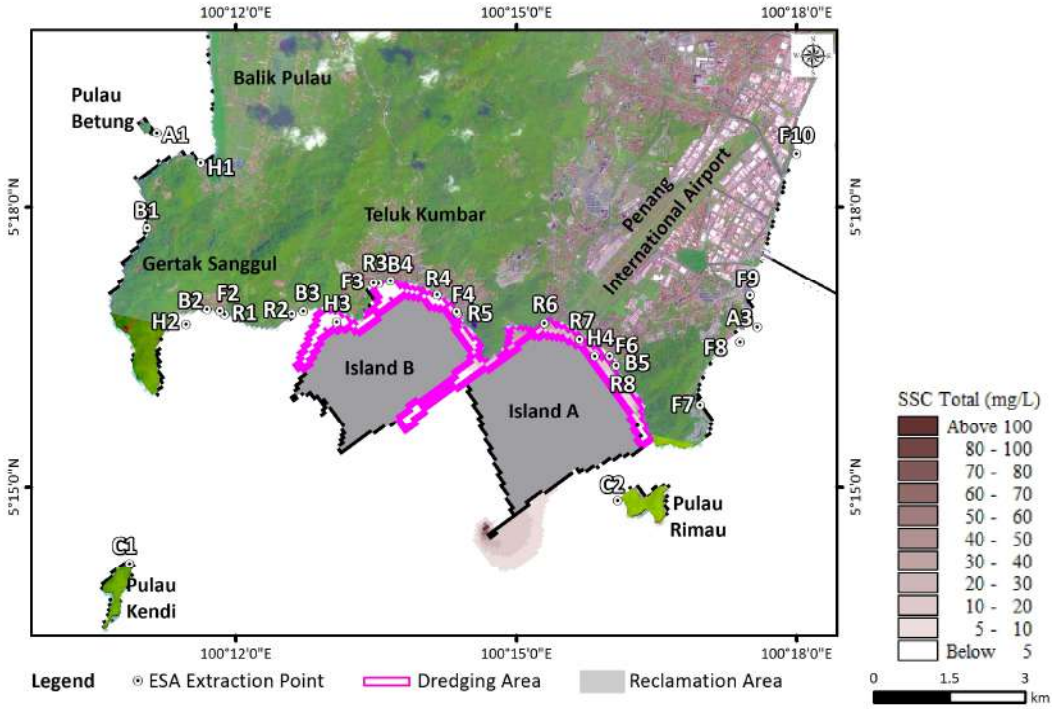
It should be noted that for Island A, bedding layer for the rock bund construction at the south eastern edge, which is the closest section to Pulau Rimau, shall be made using small rocks instead of sandy material. This is done in order to minimize the spread of plume at this area which may affect the coral located at Pulau Rimau because it is considered that the fines contained in small rocks are insignificant. As such, the plume generation modelled for this mitigated condition will come from the construction of the sand bund at approximately 150 m away from the inner end of the rock bund.

The effectiveness of this method can be demonstrated using hydraulic simulation for sediment dispersion. Similar simulation for Scenario 3 was conducted as described in *Section 7.3.5* of *Chapter 7: Evaluation of Impacts* and findings between the unmitigated and mitigated condition are compared. It should be noted that the comparison simulation was conducted only for Scenario 3 in order to emphasise on the impact of sediment plume to coral at Pulau Rimau, which only occurs during this scenario.

The comparison for mean and maximum excess suspended sediment concentration during pure tide condition for unmitigated and mitigated condition are illustrated in F8.2 and F8.3 respectively. Meanwhile, F8.4 and F8.5 show the differences of percentage of time exceedance for 5 and 10 mg/L between the unmitigated and mitigated conditions respectively.

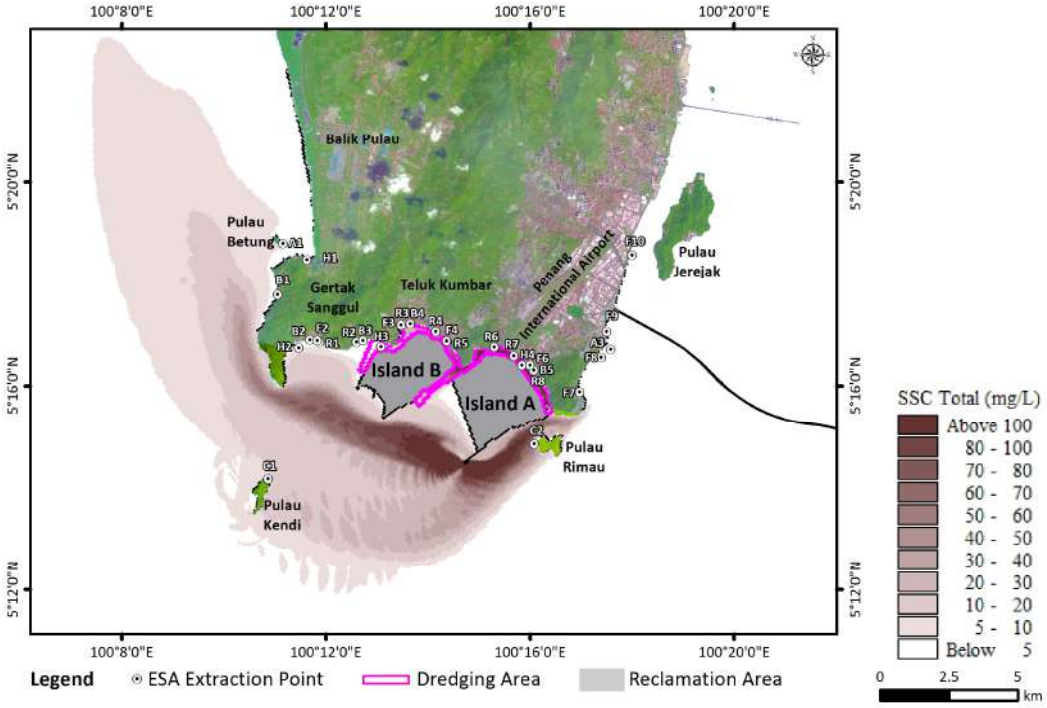


a) Unmitigated

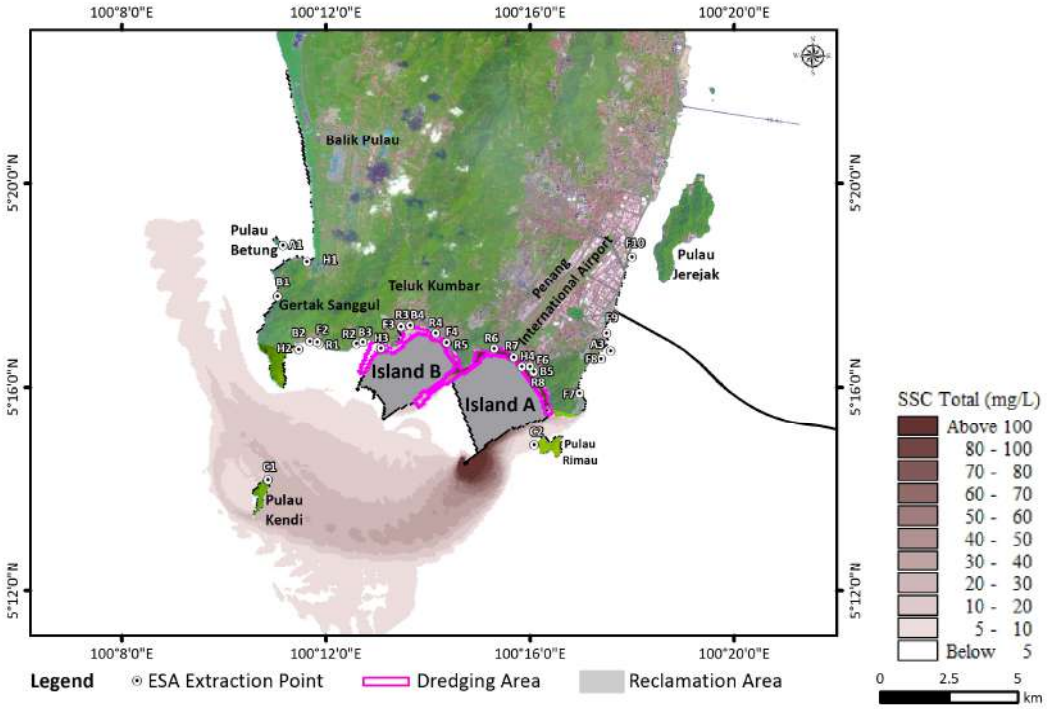


b) Mitigated

F8.2 Mean excess suspended sediment concentration for Scenario 3: Unmitigated vs. mitigated condition (small rocks instead of sand at Island A)

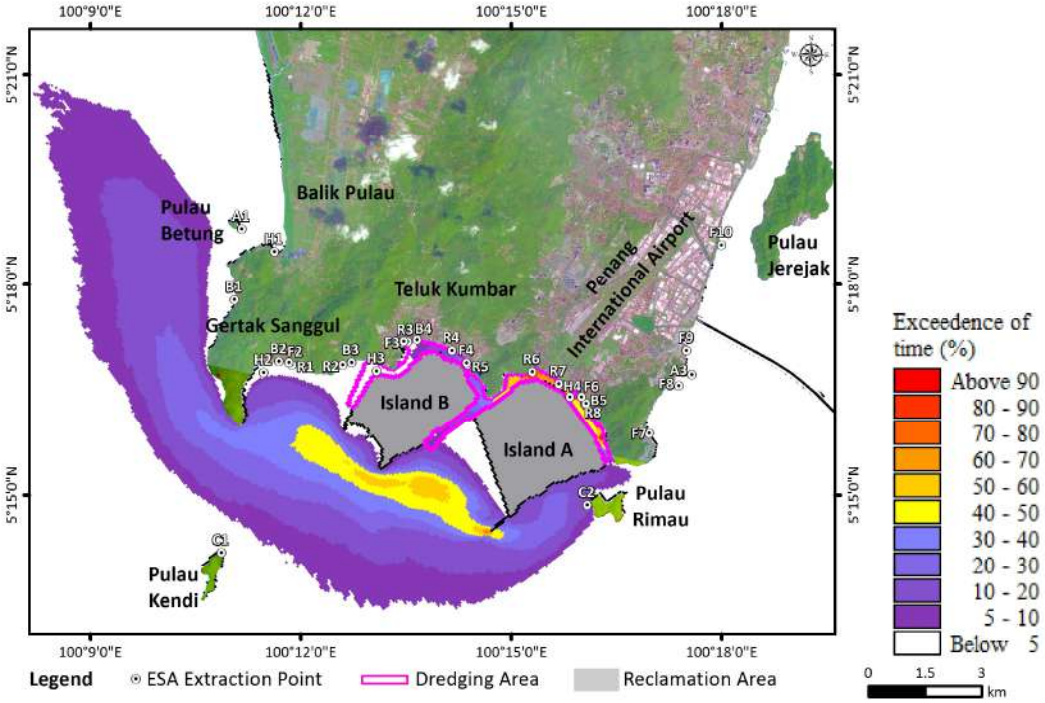


a) Unmitigated

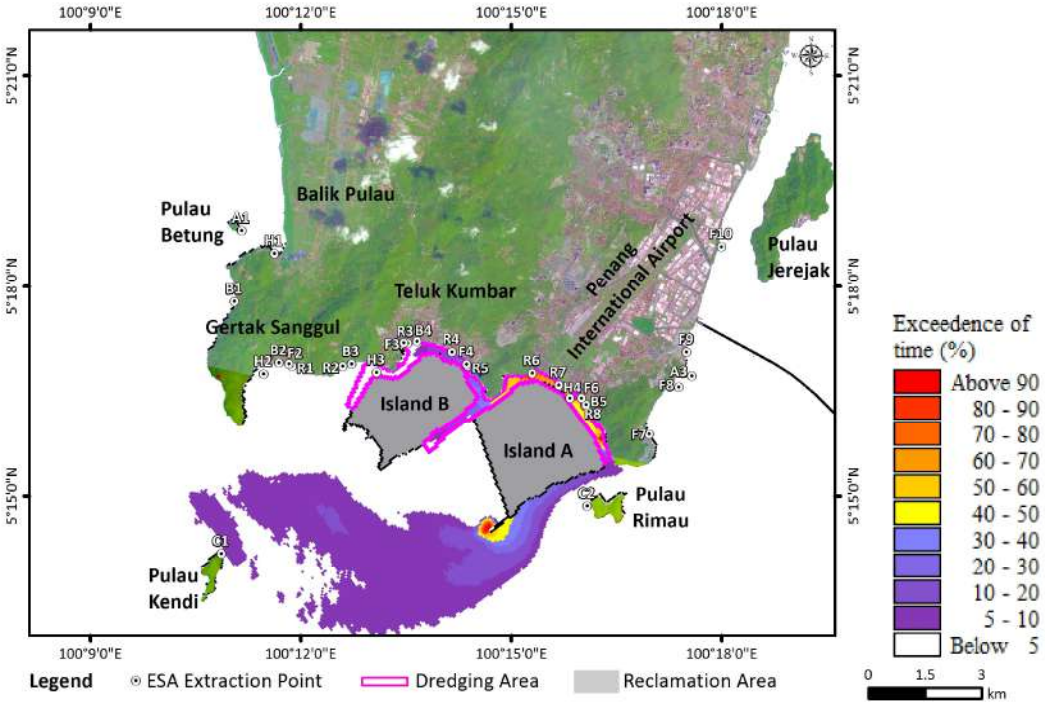


b) Mitigated

F8.3 Maximum excess suspended sediment concentration for Scenario 3: Unmitigated vs. mitigated condition (small rocks instead of sand at Island A)

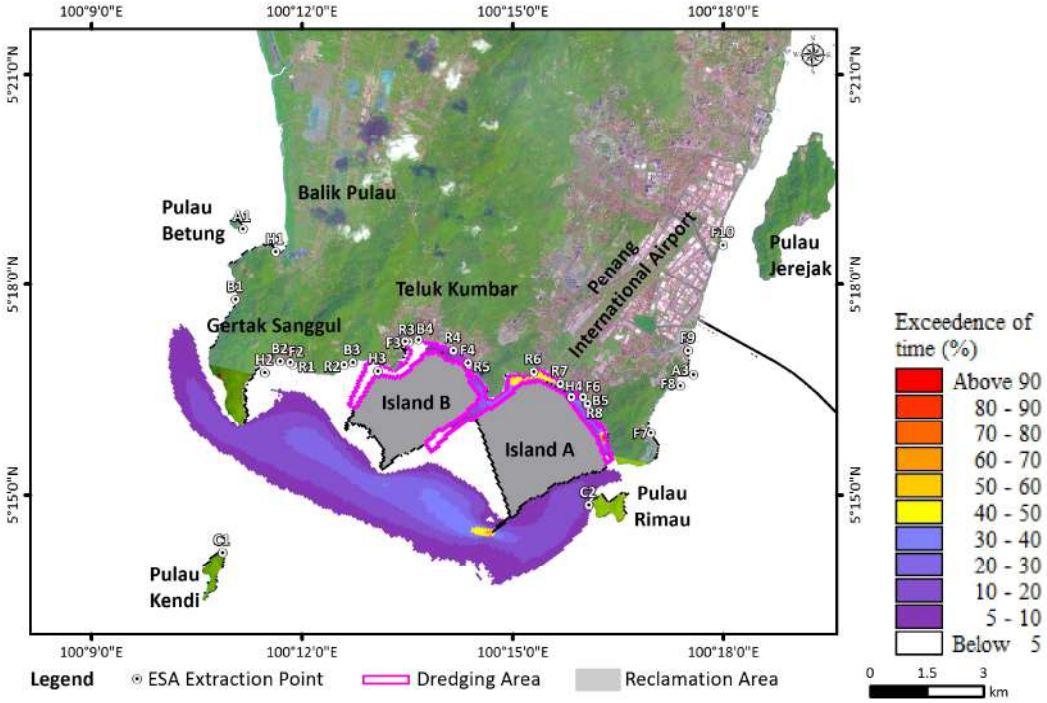


a) Unmitigated

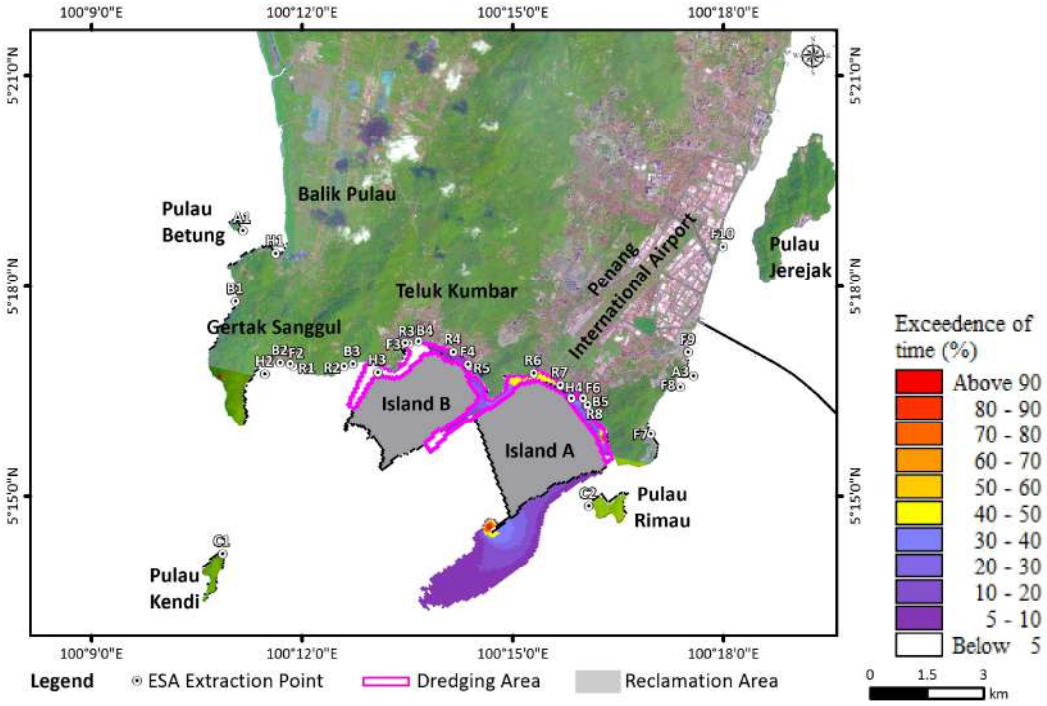


b) Mitigated

F8.4 Percentage of exceedance of suspended sediment concentration above 5 mg/L for Scenario 3: Unmitigated vs. mitigated condition (small rocks instead of sand at Island A)

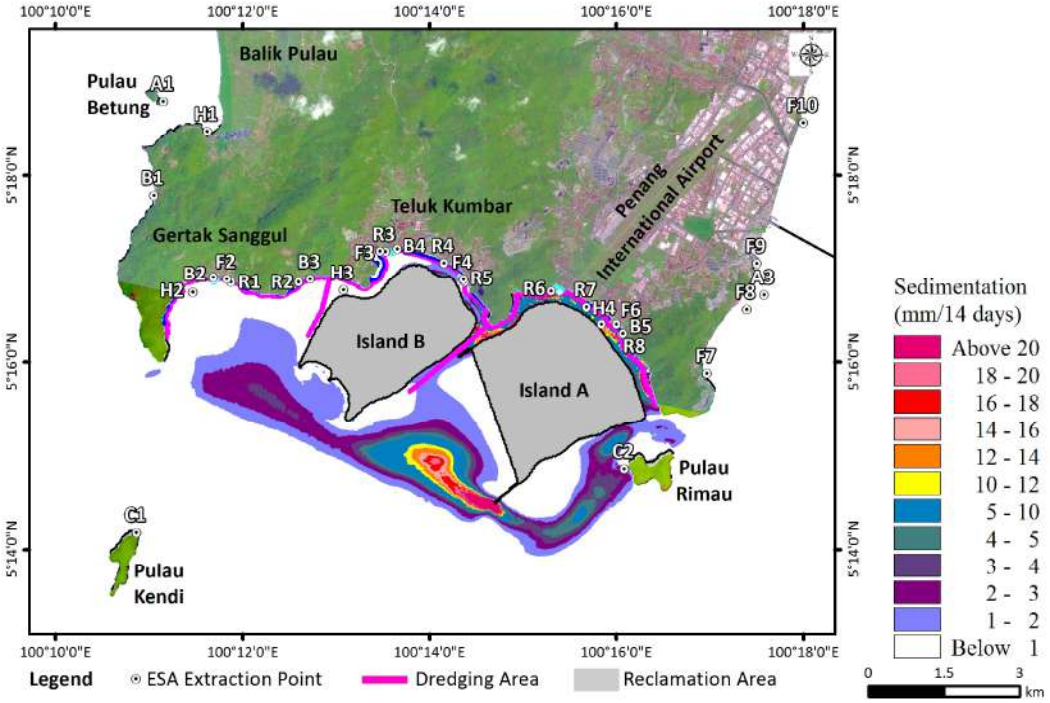


a) Unmitigated

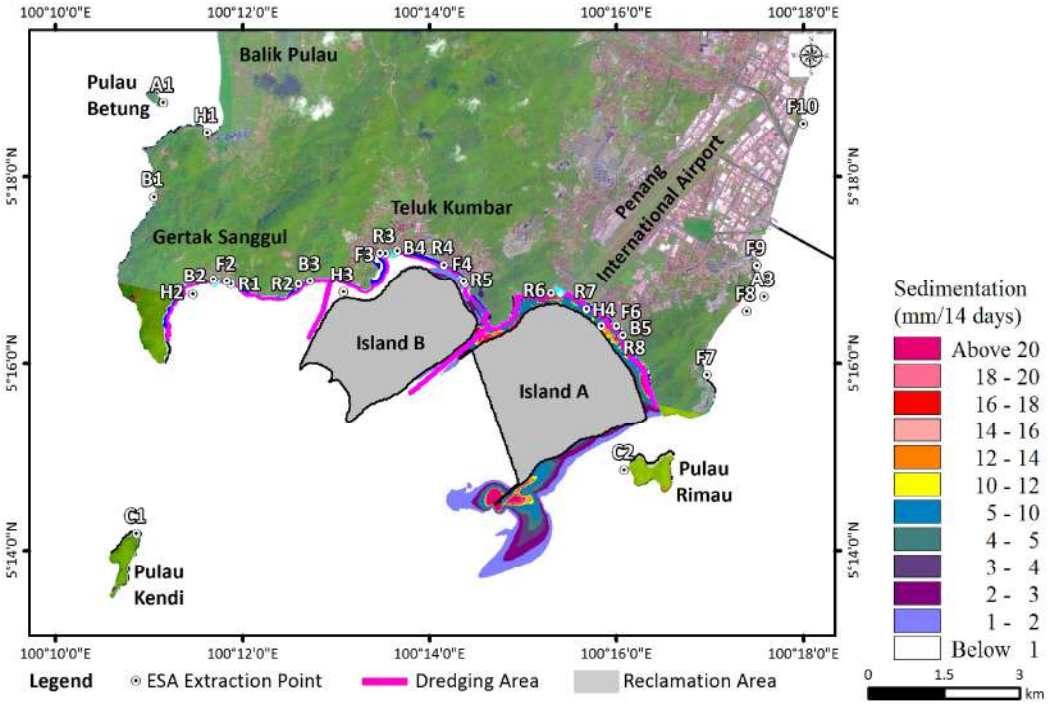


b) Mitigated

F8.5 Percentage of exceedance of suspended sediment concentration above 10 mg/L for Scenario 3: Unmitigated vs. mitigated condition (small rocks instead of sand at Island A)



a) Unmitigated



b) Mitigated

F8.6 Sedimentation of suspended sediment for Scenario 3: Unmitigated vs. mitigated condition (small rocks instead of sand at Island A)

Mean and maximum excess suspended sediment concentration levels were extracted at the coral of Pulau Rimau, which are presented in T8.2. The results show that there is significant reduction in both mean and maximum excess suspended sediment concentrations at Pulau Rimau. It is thus concluded that this P2M2 will help in alleviating the impact to coral at Pulau Rimau.

Condition		Excess Suspended Sediment Concentration (mg/L)	Remarks
Mean	Unmitigated	2	By using small rocks instead of sand at Island A, there is a significant reduction (89%) in maximum excess suspended sediment concentration
	Mitigated	0	
Max	Unmitigated	47	
	Mitigated	5	

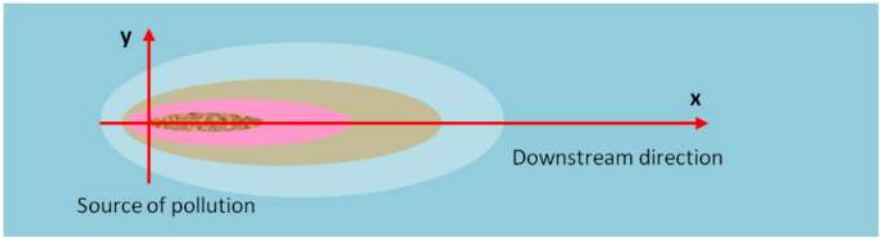
T8.2
Comparison on mean and maximum excess suspended sediment concentration at Point C2: Pulau Rimau for Scenario 3: Unmitigated vs. mitigated condition (small rocks instead of sand at Island A)

b) Silt Curtain

A silt curtain is typically simple in design, comprising of a geo-textile sheet attached to floats that are weighed down to the sea floor and anchored in place. The expected result is to prevent the transport of sediment out of the work site and into the surrounding environment by diverting the flow under the current as shown in F8.7.

a) Without silt curtain

b) With silt curtain



c) Flow of sediment plume in direction of current

F8.7
Silt curtain physical function

The use of silt curtain is very much dependent on the hydrodynamic conditions of the area, which are current/wave/tidal actions. Silt curtains are suited to shallow water environment, with water depth typically less than 10 m and subjected to minimal wave actions. As for currents, it is generally recognised that silt curtains are only effective under currents speed of less than 0.5 m/s.

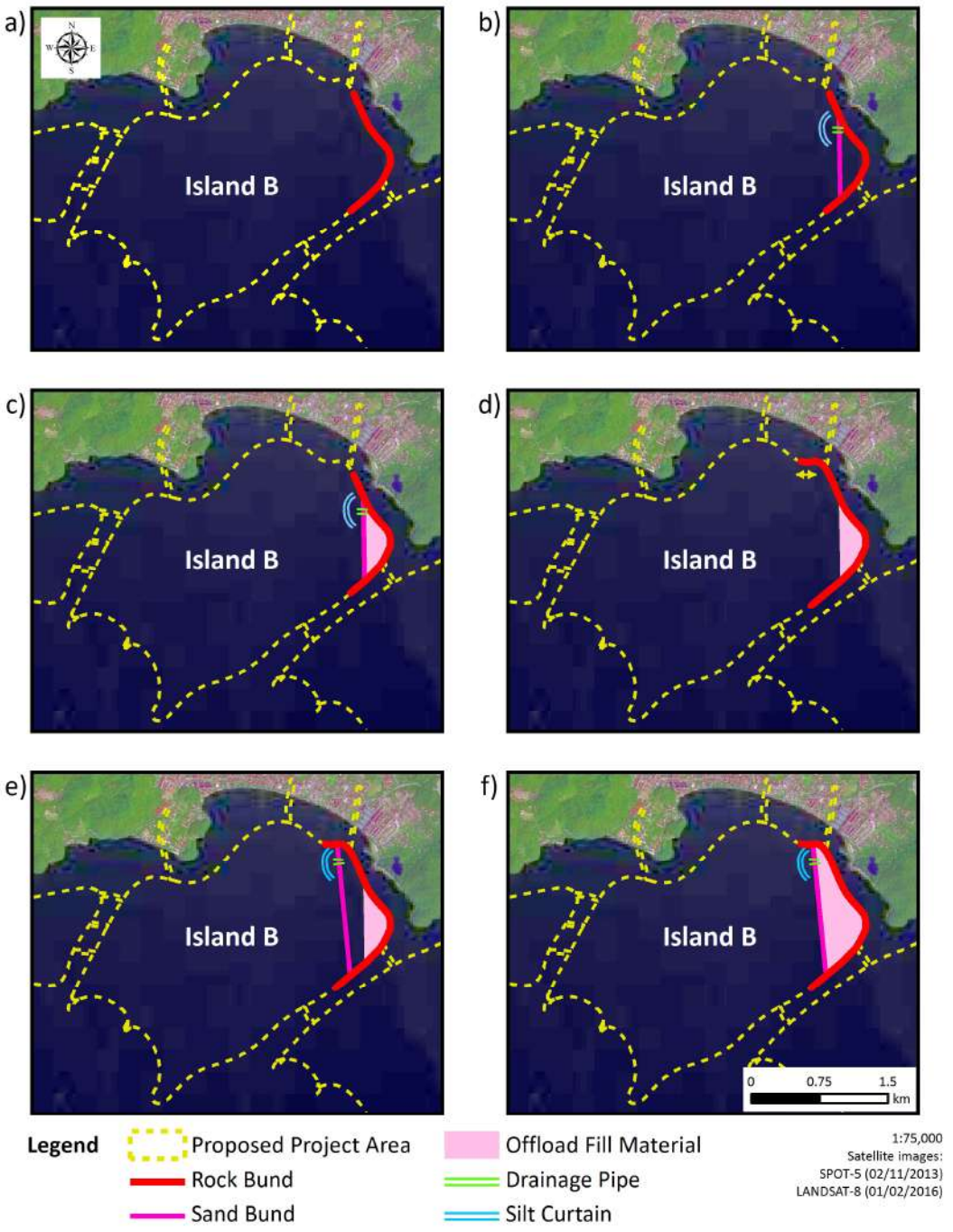
Incorrect installation of silt curtain may not only be ineffective in containing the sediment plume, but can also further exacerbate the problem. For example, the loading applied to a silt curtain structure during exposure to a current typically causes the structure to deform due to the opposing anchoring, buoyancy and current forces (USACE, 1978). Where buoyancy forces are sufficient, these cause the screen to flare, generating a gap between the bottom edge of the screen and the seabed, thus reducing the effective depth and permitting water exchange near the seabed as shown in F8.8. This phenomenon is particularly apparent in silt curtains where the bottom edge of the screen is kept in place with ballast rather than fixed to the bed by direct anchoring. As for waves, they generate additional and more complex loading forces including heave and surge. Under certain wave conditions, the performance of a silt curtain can be compromised, allowing the uncontrolled exchange of water. The combination of heave and surge can cause turbulence around the base of the curtain, prompting the re-suspension of fine material that may have settled on the seabed.

Taking into account of the above, silt curtains for this Project will be deployed in conjunction with the temporary sand bund focusing on the active work area. This is done to ensure maximum efficiency in containing the sediment dispersion. As discussed in *Chapter 5: Project Descriptions,* the silt curtain will be mobile following the progression of the reclamation work, as illustrated in F8.9. The specifications of the silt curtain are shown in T8.3 while the typical cross section of a double-layered silt curtain and its installation sequence are shown in F8.10 and F8.11 respectively.

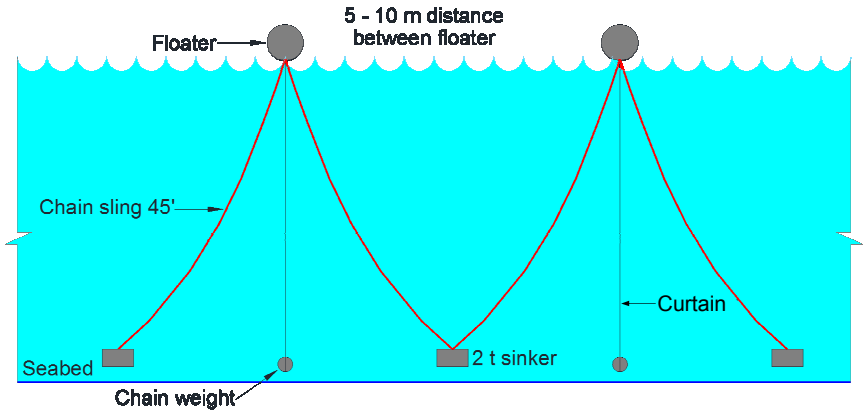
F8.8 Flaring silt curtain

T8.3 Properties of silt curtain (Geotag Turbidity Curtain SC150)

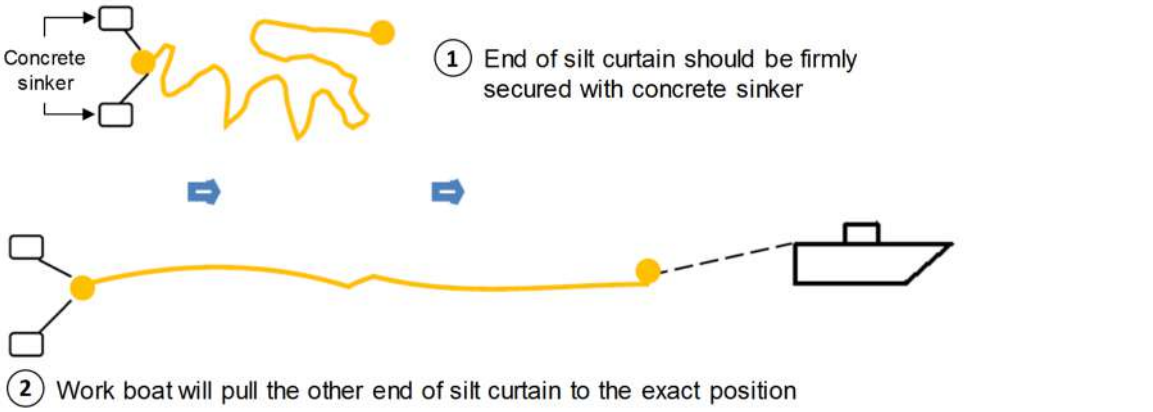
Properties	Test Method	Unit	SC150
Mass per unit acre	ASTM D5261	g/m^2	600
Thickness	ASTM D5261	mm	1.1
Mean wide width tensile strength (warp and weft)	ASTM D5261	kN/m	150
Mean tensile extension at maximum load (warp and weft)	ASTM D5261	%	15
Shrinkage under seawater	ISO 7771: 1985	%	0.2
Seawater permeability	ASTM D5261	cm/sec	1.4×10^{-3}
Apparent opening size	ISO 12956	mm	0.10
Tensile strength retention after 90 days exposure to sunlight	ASTM D5261	%	80



F8.9 Schematic illustration of reclamation sequence



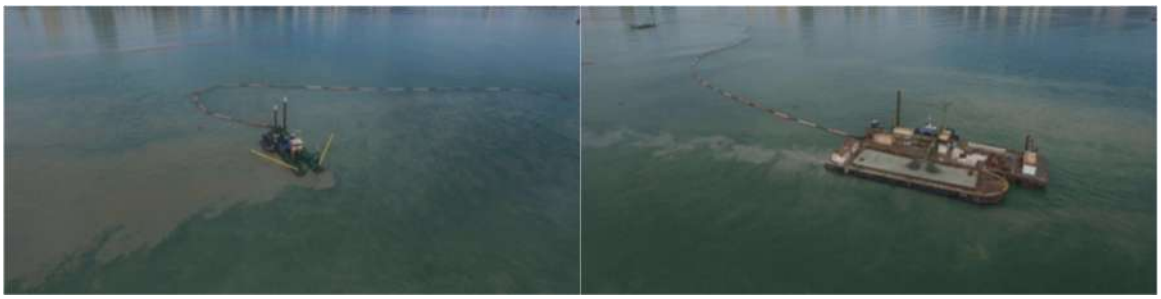
F8.10 Typical section of a double-layered silt curtain



F8.11 Overall sequence of double-layered silt curtain installation

8.3.1.2 Controlled Dredging and Reclamation Operations

Sources of sediment plume during dredging operation include seabed disturbances around the dredge head and spillage overflowing from hopper barges (F8.12).



F8.12 Plume generated from hopper barges during dredging

In areas where current speed is expected to exceed 0.5 m/s, it is almost impossible to maintain silt curtains in a working condition as explained above. An alternative is to reduce dredging works or overflowing from the hopper barges in the event that TSS level exceeds 50 mg/L above ambient. For this method to work, an equipment measuring TSS level in real-time must be installed at site. Readings must be taken at selected ESAs such as coral reefs at Pulau Rimau.

An automated, continuous, 24-hour monitoring system should be installed to monitor the levels of Total Suspended Solids (TSS) and turbidity generated by the dredging and reclamation activities. An example of a TSS real-time monitoring system is a submersible laser-diffraction based particle size analyzer called the LISST-200X (F8.13) which is designed to measure particle size and concentration in marine waters.

Source: http://www.sequoiasci.com/product/lisst-200x/

F8.13 LISST-200X

LISST-200X designed by Sequoia Scientific, Inc. is an example of the real-time monitoring system that is currently available on the market. It is able to make measurements in depth of up to 600 m. The optics cover the size range 1 to 500 microns in 36 size classes. It is small in size, easily handled and self-contained with internal programmable datalogger. The entire system can be installed without divers, allowing for complete serviceability from a small boat. The specifications of the LISST-200X are listed in T8.4.

Physical Size	100 mm diameter x 640 mm long
Weight	5.4 kg in air; 1.7 kg in water
Particle Size Distribution	1 to 500 micron in 36 size ranges
Depth	600 m maximum depth or 0.01 m resolution
Temperature	0.01°C resolution with response time of 2.5 seconds
Optical Transmission	0.1% resolution
Volume Concentration	0.1 µl/l resolution
Volume Scattering Function	0.036 to 13.8 degrees in water
Analog Output	Mean size and total volume concentration

T8.4
Specifications of LISST-200X

Applying a trigger value for suspended solids and turbidity in such areas is important because the sediment plume resulted from the reclamation works may stay in the water column for an extended period of time, depending on tidal conditions. This condition may be too late to be rectified if the DOE guideline's concentration of 50 mg/L is applied. Therefore, it is deemed appropriate to apply a lower TSS trigger value i.e. 30 mg/L that acts as a buffer before the plume exceeds the guideline's concentration limit.

8.3.1.3 Dredger Type

Alternatively, a different type of dredger can be used to reduce the sediment spillage. This can be applicable if the sediment dispersion issue cannot be managed properly at site. Unlike the CSD, the use of grab or clamshell dredgers operating from barges does not involve the pumping of dredged material that results in the mixture of dredged material with water and thus the need to overflow. The amount of sediment spillage will be vastly reduced with overflowing, thus alleviating the impact of sediment dispersion. This method can be effective for managing sediment plume at areas that are located very close to an ESA e.g. hatcheries' water abstraction point.

8.3.2 P2M2 for Reduced Flushing Capacity

As described in *Section 7.4.3* of *Chapter 7: Evaluation of Impacts*, with the presence of the newly-reclaimed islands, the flushing of pollutants from the rivers will be affected significantly. As a result, accumulation of pollutants along the navigation channel will occur, which in turn will cause further water quality degradation. There are two measures identified in order to alleviate this problem. The first measure is to reduce the pollutant load from the rivers in the vicinity of the Project area through the Green River Programme or Integrated River Basin Management while the second measure is to increase the navigation channel width.

8.3.2.1 Green River Programme/Integrated River Basin Management

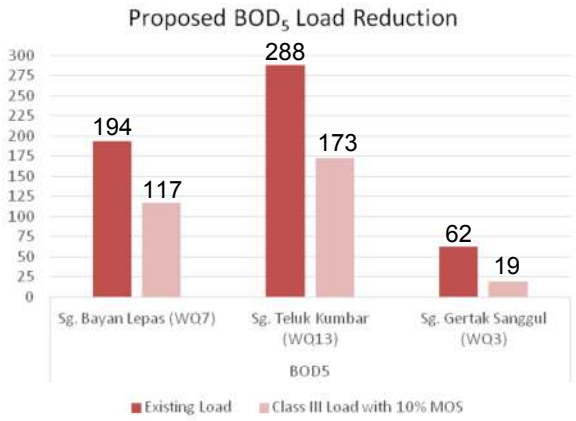
This measure entails pollution load reduction of sources contributing to rivers in the vicinity which subsequently reaches the coastal zone. To achieve this, a comprehensive study needs to be done, which quantifies all relevant sources followed by suitable waste load allocations (WLAs). River improvement study shall be initiated prior to commencement of development and Green River Programme will be implemented concurrent with reclamation works.

The baseline monitoring results show very clear degradation of river water quality, particularly for Sungai Gertak Sanggul, Sungai Teluk Kumbar and Sungai Bayan Lepas. As a preliminary indicator, T8.5 shows the amount of load reduction required to achieve Class III of the NWQS for selected rivers and parameters. Currently, most of these rivers were beyond the Class IV/V denotation. Overall, for BOD, a reduction of between 40 to 70% needs to be achieved, as illustrated in F8.14, whereas for NH_3-N the figure was more in the realm of 30 to 81%. Sungai Bayan Lepas and Sungai Teluk Kumbar were significant nutrient load contributors.

T8.5 Load reduction analysis for selected rivers relative to Class III of NWQS

Parameter	Location	Current (kg/m^3)	Class III Load with 10% MOS (kg/m^3)	Reduction Needed (kg/m^3)	% Load Reduction Needed
BOD_5	Sungai Bayan Lepas (WQ7)	194	117	78	40
	Sungai Teluk Kumbar (WQ13)	288	173	115	40
	Sungai Gertak Sanggul (WQ3)	62	19	44	70
Ammoniacal Nitrogen	Sungai Bayan Lepas (WQ7)	25	17	8	30
	Sungai Teluk Kumbar (WQ13)	138	26	112	81
	Sungai Gertak Sanggul (WQ3)	11	3	8	75
Phosphorous	Sungai Bayan Lepas (WQ7)	19	2	17	90
	Sungai Teluk Kumbar (WQ13)	45	3	42	94
	Sungai Gertak Sanggul (WQ3)	21	0	21	99

Note: MOS—Margin of Safety



F8.14
Required pollutant load reduction for BOD_5

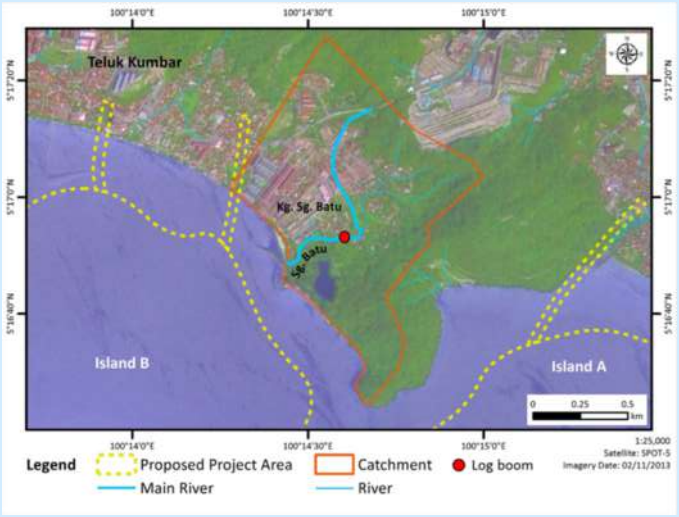
While this analysis was only limited to certain rivers and select parameters, it does give a preliminary indication of the amount of pollution load that needs to be reduced. In order to accomplish this, several measures can be implemented which are summarised in T8.6.

The recommended measures have been separated into short-term and long-term measures. The proposed measures are presented according to the five selected rivers that are significant contributors to the existing polluted water quality which are Sungai Bayan Lepas, Bayan Lepas Main Drain, Sungai Batu, Sungai Teluk Kumbar and Sungai Gertak Sanggul (T8.7). The phasing of the overall Green River Programme is shown in T8.8; while T8.9 shows the prioritising of rivers in implementing the programme.

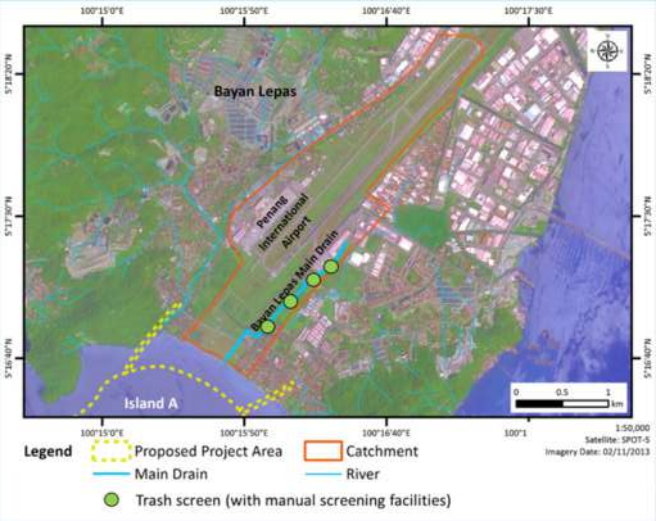
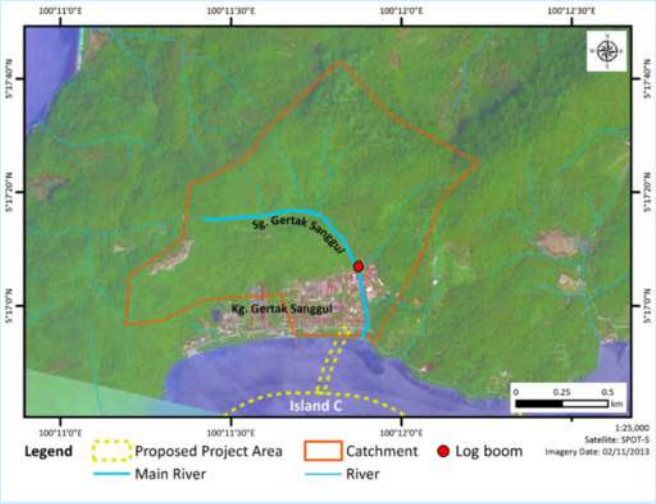
T8.6 Recommended measures for Green River Programme

Short/ Long-term	Structural/ Non-structural	Solution	Aesthetics	Water Quality
Short-term	Structural	Install additional communal debris collection bins and centralised collection for large items	✓	✓
		Introduce floating aerators		✓
		Install Gross Pollutant Traps (GPTs)	✓	
		Install log booms	✓	
		Install trash screens with manual cleaning	✓	
	Non-structural	Establish long-term improvement plan	✓	✓
		Conduct a comprehensive hydrology and water quality review	✓	✓
		Manage of commercial and farming activities	✓	✓
		Enforce construction activities to follow MSMA guidelines on erosion and soil control (ESCP)		✓
		Ensure MSMA guidelines are followed		✓
		Establish water quality monitoring programme		✓
		Establish/enhance river care groups	✓	✓
		Introduce Corporate Environmental Stewardship Award	✓	✓
Long-term	Structural	Impose all properties along coastline to have communal STPs or connection to centralised STPs		✓
		Introduce connection of industrial discharge to STP		✓
		Pre-treatment of all industrial discharges and then discharge into local STPs		✓
		Install small package plants to treat untreated discharges from industrial and small properties		✓
		Install additional required GPTs	✓	
		Introduce sullage water treatment		✓
	Non-structural	Improve STP discharges to higher standards		✓
		Expand existing STPs for future growth		✓
		Develop a comprehensive solid waste management plan	✓	✓
		Review of local laws and by-laws.	✓	✓
		Review monitoring results over the long-term	✓	✓
		Establish protection zones	✓	✓
		Introduce River Water Quality Levy for businesses		✓
		Resettlement of squatters and relocation of polluting discharges out of commercial areas	✓	✓

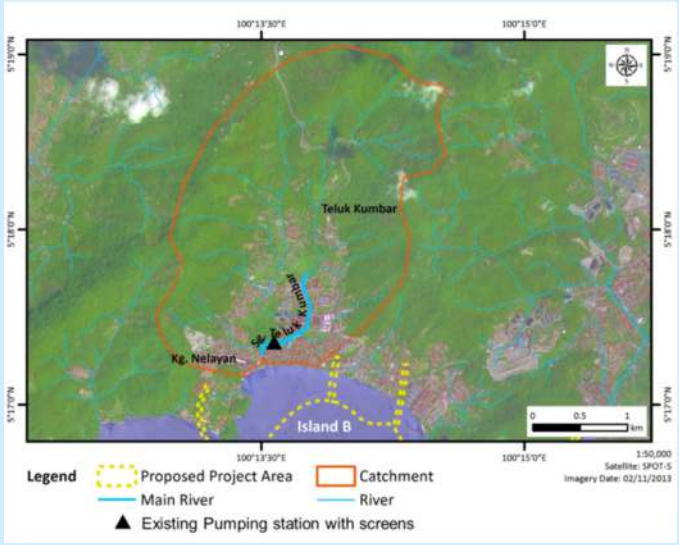
T8.7 Recommended measures for selected rivers at South Penang Island

River	Pollution Prevention and Mitigation Measures (P2M2)	
Sungai Bayan Lepas ■ "Slightly Polluted" (WQI, DOE) ■ Low DO and high ammoniacal nitrogen ■ Possible pollutants contributors: Wet markets, shops and factories		The proposed short term measures to mitigate debris are to install log-boom and GPTs. Aerators are also proposed to increase DO level and reduce ammoniacal nitrogen concentration. This can be in the form of physical drops (cascades) or spring aerators. However, the placement of the aerators will be determined once the point sources are identified. Further detailed assessment is required in identifying major polluters that discharge into the river directly. Pollutants from identified sources are proposed to be discharged into local sewerage system as a long term measure.
Bayan Lepas Main Drain ■ "Slightly Polluted" (WQI, DOE) ■ High ammoniacal nitrogen ■ Possible pollutants contributors: Industrial, treated sewage, landfill leachate and construction activities		The proposed short term measure for debris mitigation is to introduce trash screen with manual screening facilities along the Main Drain. It is also recommended that erosion control during the construction activities to be actively managed. As a long term measure, industrial sources of polluting flows should be pre-treated before being discharged into the local sewerage system. Further site investigation is required to ascertain the sewerage effluent discharges.

T8.7 Recommended measures for selected rivers at South Penang Island (cont'd)

River	Pollution Prevention and Mitigation Measures (P2M2)	
Sungai Batu ■ "Slightly Polluted" (WQI, DOE) ■ Low DO and high ammoniacal nitrogen ■ Possible pollutants contributors: Residential, commercial and shops		The debris mitigation proposed is a log boom to be installed in Sungai Batu. Aerators in the form of physical drops and springs are also recommended. Long term measure suggested is to install small package treatment facilities at suitable pollutant sources. Further detailed assessment is required to identify major polluters of the Sungai Batu.
Sungai Teluk Kumbar ■ "Polluted" (WQI, DOE) ■ Very low DO and high ammoniacal nitrogen ■ Possible pollutants contributors: Accumulation of pollutants from stagnant water at tidal gate		The existing pumping station at Sungai Teluk Kumbar acts as a debris mitigation measure. It is suggested that aerators are introduce at suitable locations along the river as short term measure in reducing ammoniacal nitrogen and increasing DO. Installation of small treatment facilities at identified pollution sources is also commended as a long term measure.

T8.7 Recommended measures for selected rivers at South Penang Island (cont'd)

River	Pollution Prevention and Mitigation Measures (P2M2)	
Sungai Gertak Sanggul ■ "Polluted" (WQI, DOE) ■ Very low DO, high ammoniacal nitrogen and high bacteria ■ Possible pollutants contributors: Illegal pig farms and cottage industries		Log boom is proposed as the debris mitigation to be installed in the river as a short term measure. It is also recommended to install regulated water containment or lagoons in the river and impose on to the pig farm operators to install a wastewater treatment facility for pig farm effluent as part of long term measures.

T8.8 Green River Programme implementation phasing plan

Phase	Description
1 (2 years)	a) Initial data collection and study: ■ Pollution source inventory ■ Water quality sampling at the upstream, midstream and river mouth/outlet (including volume and concentration of pollutants) ■ Water quality modeling b) Implementation of short-term measures*
2 (3 to 5 years)	Continue data collection due to dynamic catchment to update data from Phase 1
3 (5 years onwards)	a) Implementation of long-term measures** b) Establish monitoring points at upstream, midstream and downstream c) Include all structural and non-structural measures

*Short-term measures shall commence within 1st and 2nd year
**Long-term measures to target at source and prioritise big polluters

T8.9 Water quality implementation plan priority

River/ Catchment	WQI Status	T_{50} [hours]		Flow (m^3/s)	Blocked By/ Duration	Remark	Implementation Priority
		Without PSR	With PSR				
Sungai Batu (1.22 km^2)	Class III Slightly polluted (61)	2	8.5	0.07	Island B (0-7 years)	Very low flow; Slow flushing; Impacted first due to Island B	1
Sungai Bayan Lepas (7.43 km^2)	Class III Slightly polluted (75)	2.5	28.5	0.25	Island A (4-12 years)	Low flow; Very slow flushing	4
Sungai Teluk Kumbar (7.05 km^2)	Class IV Polluted (36.8)	2	8.5	0.37	Island B (0-7 years)	Low flow; Slow flushing; Impacted first due to Island B	2
Sungai Gertak Sanggul (1.34 km^2)	Class IV Polluted (49.4)	1.5	2	0.04	Island C (8-15 years)	Very low flow; Slight reduce in flushing; Impacted after 15 years	5
Bayan Lepas Main Drain (2.98 km^2)	Class III Polluted (56.1)	2.5	28.5	0.028	Island A (4-12 years)	Very low flow; Very slow flushing	3

A comprehensive implementation plan pertaining to all point sources in the region, contributing either directly or indirectly, needs to be done. Commitment on the part of the authorities to mitigate these sources is required. Otherwise there is very real risk of further degradation of water quality within the navigation channel due to reduction of flushing capacity.

8.3.2.2 Widening of the Navigation Channel

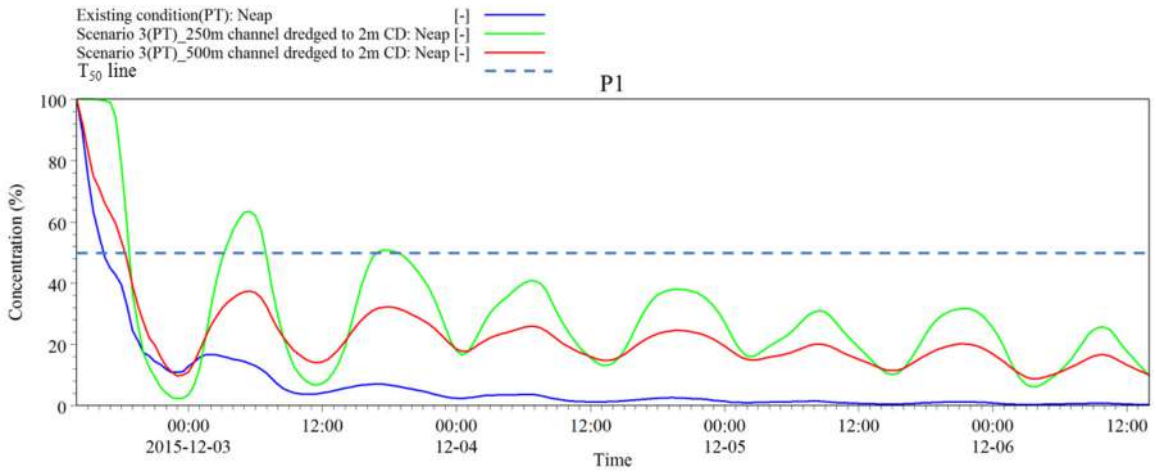
Prior to implementation of the Green River Programme, a detailed study shall be carried out. However, in the event that the Green River Programme is not feasible, it is recommended to increase the width of the navigation channels between the proposed reclaimed islands and the existing coastline of Penang Island.

A sensitivity test has been undertaken to determine the increase of channel width required between Island A and the coastline of Permatang Damar Laut in Scenario 3, where the retention time of T_{50}, is the longest among all locations in all scenarios. The T_{50} has been predicted to be 29 hours as compared to the existing condition of 2.5 hours under worst-case scenario (during pure tide and no wind). As shown in T8.10 and F8.15 below, the T_{50} is vastly improved for the 500 m wide channel to 4.5 hours.

Nevertheless, widening of navigation channel will improve the flushing capacity but not totally eliminate the river water quality problem, thus the Green River Program is still necessary.

T8.9 Comparison of retention time, $T_{50,}$ for existing, unmitigated and mitigated condition

Scenario 3	Dredged Level (m CD)	Channel Bottom Width (m)	T_{50} (hours)
Existing condition	N/A	N/A	2.5
Unmitigated condition	-2	250	29.0
Mitigated condition	-2	500	4.5



F8.15 Comparison of retention time, $T_{50,}$ for existing, unmitigated and mitigated condition

8.3.3 P2M2 for Wastes, Material and Pollutant Management

Measures for waste, material and pollutant management are mainly related to the activities during the dredging and land reclamation phase. For brevity, measures under this aspect is divided into three categories as follows:

a) Construction of workers' quarters;
b) Land reclamation and dredging; and
c) Transportation of dredged material.

8.3.3.1 Construction of Workers' Quarters

a) Land Disturbing Pollution Prevention and Mitigation Measures (LD-P2M2)

This section presents the Land Disturbance Pollution Prevention and Mitigation Measures (LD-P2M2) for the construction of workers' quarters. The aim of this section is to address erosion and sediment control aspects as part of the requirements of the EIA report.

The workers quarters will be progressively developed in five different phases in order to minimise the total area of exposed soils open at any time and thus the potential for erosion. The roads and building platforms areas will be surfaced with aggregate. For erosion and sediment control during the construction at the workers quarters, a sediment pond will be installed to trap construction-site sediments from being transferred into the marine waters. The required sediment pond area shall be constructed in the initial stage of the construction before any earthwork is carried out on-site.

All the rivers/drains proposed are designed to match the exact topography and streamlined as closely as possible. Therefore, no critical areas will face potential serious stormwater problems. Proposed BMPs are earth drain, silt fence and sediment basin as shown in F8.16. These BMPs have been included in the soil erosion and sediment yield analysis which will be further discussed in the following section.

Removed topsoil that will be used later shall be temporarily stockpiled at a designated area; properly covered and secured.

A detailed ESCP will be submitted for approval by DID prior to any land clearing and earthworks activities of construction of workers' quarters.

The total estimated sediment yield during earthwork-uncontrolled condition for all phases is 69.83 tonnes and reduced to 2.48 tonnes during earthwork-controlled condition. Therefore, a reduction of approximately 95% of sediment yield is expected after the implementation of the erosion and sediment control measures.

Post-development condition gives the least soil erosion and sediment yield with the comparison of earthwork conditions as the soil has been stabilised with the development of buildings and vegetation. From the prediction, both estimated soil erosion and sediment yield after the completion of the development is almost similar with the present condition.

The calculation of the soil erosion and sediment yield with all BMPs (Earthwork – controlled) and post-development is summarised in T8.11 and T8.12.

F8.16
Proposed Best Management Practices (BMPs) for erosion and sediment control

T8.11 Estimated soil erosion

Condition	Parameters	Phase				
		A	B	C	D	E
Earthwork-uncontrolled	R	16,000	16,000	16,000	16,000	16,000
	K	0.0168	0.0168	0.0168	0.0168	0.0168
	LS	5.1442	2.9243	1.5087	1.1680	1.9728
	C	1.00	1.00	1.00	1.00	1.00
	P	1.00	1.00	1.00	1.00	1.00
	A (ton/ha/yr)	1,384.3922	786.9791	406.0170	314.3288	530.9142
Earthwork-controlled (with BMPs)	R	16,000	16,000	16,000	16,000	16,000
	K	0.0168	0.0168	0.0168	0.0168	0.0168
	LS	5.1442	2.9243	1.5087	1.1680	1.9728
	C	0.1	0.1	0.1	0.1	0.1
	P	0.5	0.5	0.5	0.5	0.5
	A (ton/ha/yr)	69.2196	39.3490	20.3008	15.7164	26.5457
Post-development	R	16,000	16,000	16,000	16,000	16,000
	K	0.0168	0.0168	0.0168	0.0168	0.0168
	LS	1.5927	0.1756	1.0634	0.2705	0.8144
	C	0.25	0.25	0.25	0.25	0.25
	P	1	1	1	1	1
	A (ton/ha/yr)	107.1557	11.8156	71.5448	18.1990	54.7922

T8.12 Estimated sediment yield

Condition	Parameters	Phase				
		A	B	C	D	E
Earthwork-Uncontrolled	K	0.0168	0.0168	0.0168	0.0168	0.0168
	LS	5.1442	2.9243	1.5087	1.1680	1.9728
	C	1.00	1.00	1.00	1.00	1.00
	P	1.00	1.00	1.00	1.00	1.00
	V	122.194	104.718	14.883	92.084	147.476
	Qp	0.103	0.104	0.005	0.081	0.124
	Y (tonnes)	31.98	16.77	0.53	5.41	15.14
Earthwork-Controlled	K	0.0168	0.0168	0.0168	0.0168	0.0168
	LS	5.1442	2.9243	1.5087	1.1680	1.9728
	C	0.10	0.10	0.10	0.10	0.10
	P	0.50	0.50	0.50	0.50	0.70
	V	101.829	87.265	12.402	75.929	12.897
	Qp	0.085	0.087	0.010	0.067	0.103
	Y (tonnes)	1.30	0.68	0.04	0.22	0.24
Post-Development	K	0.0168	0.0168	0.0168	0.0168	0.0168
	LS	1.5927	0.1756	1.0634	0.2705	0.8144
	C	0.25	0.13	0.14	0.15	0.11
	P	0.50	0.50	0.50	0.50	0.50
	V	101.829	87.260	12.401	75.929	122.897
	Qp	0.086	0.087	0.010	0.067	0.103
	Y (tonnes)	1.01	0.06	0.03	0.08	0.28

b) Management of Biomass Waste from Land Clearing

Land-clearing activities will be conducted at the proposed workers' quarters site as well as the access road. This activity will generate biomass waste that must be disposed properly. Open burning of biomass is strictly prohibited.

Currently in Penang Island, the appropriate disposal site for biomass waste is located at Pulau Burung in Nibong Tebal. After clearing, the biomass waste shall be transported via covered lorries so that there will be no debris littering the road along the transportation route.

c) Management of Wastewater

The workers' quarters must be provided with toilets conforming to the requirements of the Ministry of Health and National Water Services Commission (SPAN). Direct discharge of sewage and greywater must be strictly prohibited. In addition, grease trap should be used to manage oily discharges from the kitchen.

It is expected that the workers' quarters will house approximately 500 workers. The wastewater generated will be treated using a proposed sewage treatment plant (STP). The effluent will be treated up to Standard A (Environmental Quality (Sewage) Regulations, 2009). A layout of the STP is shown in F5.39 and the design calculation is shown in T5.10 of *Chapter 5: Project Description*.

d) Management of Solid Waste

Waste minimisation concept shall be implemented on-site by introducing 3R recycle bins. Recyclable wastes with recycle value are to be segregated, stored in 3R recycle bins at designated area, labelled, maintained and collected by a licensed recycling contractor. Waste containers and storage areas shall be of sufficient capacity to contain all waste generated. Waste containers shall display labels to indicate the type of waste (i.e. construction waste or domestic waste).

Open burning of wastes shall be prohibited. Signage on the prohibition of open burning will be put up within the site.

All wastes shall be disposed at Pulau Burung landfill in Nibong Tebal or other approved landfill by Authority's licensed contractor.

It should be noted that material contaminated with oil and other chemical must be separated from the normal waste, as it may be considered as scheduled waste and thus requiring a different handling method.

e) Management of Scheduled Waste

Storage and handling of scheduled wastes will be carried out according to the Environmental Quality (Scheduled Wastes) Regulations, 2005, including the followings:

i) The wastes should be stored in sealed drums, labelled and placed in a proper scheduled waste storage shed.
ii) The shed should be concrete paved, bunded with a capacity to contain 110% of the largest container volume.
iii) There should not be any opening in the bund wall that may allow leakages and spills to flow off-site.
iv) Separate compartments should be provided for different groups of incompatible wastes.
v) Scheduled wastes should not be kept on site for more than 180 days or exceed 20 tonnes.
vi) An accurate and up-to-date inventory in accordance with the Fifth Schedule of the categories and quantities of scheduled wastes being generated, treated and disposed of will be kept.
vii) Scheduled wastes will be collected by DOE licensed contractors and managed according to the consignment note system of the Sixth Schedule.
viii) A competent person in Certified Environmental Professional in Scheduled Waste Management - CePSWAM shall be appointed to handle the scheduled wastes.

8.3.3.2 Land Reclamation and Dredging

a) Best Management Practice for Storage

Storage of fuel, oil and other chemicals on board a vessel must be done using correct Best Management Practice (BMP). Container tray, as illustrated in F8.17, must be provided for fuel and oil storage, as well as machineries that hold a significant amount of fuel and oil, for example generator set. It is also recommended for the designated drum holding area to be covered.

As for on-land storage, the area must be suitable, i.e. on stable ground and away from water bodies. The base must be constructed using impervious material such as concrete and it must be able to hold at least 110% of the volume of the largest tank/ container stored in the area. The storage area should be covered and properly labelled (F8.18).

F8.17 Spillage/drip tray provided at fuel/oil container

F8.18 Oil drum stored at designated covered area provided with tray

b) Management of Scheduled Waste

Ballast water, bilges, spent oil and other scheduled waste must be managed and disposed of according to the Environmental Quality (Scheduled Waste) Regulation 2005. A storage area according to the Guidelines for Packaging, Labelling and Storage of Scheduled Wastes in Malaysia published by the Department of Environment (DOE) must be prepared on land for temporary storage before disposal. Disposal of scheduled waste must be done by approved contractors at a designated premise according to the Environmental Quality (Scheduled Waste) Regulation 2005.

c) Management of Wastewater

For vessels equipped with toilet and kitchen, facilities to store and treat the wastewater such as septic tank and greywater tank must be provided. Direct discharge into the sea must be strictly prohibited.

d) Management of Solid Waste

A good system of solid waste management must be implemented on board of the vessels. Sufficient bins must be provided and regularly serviced. The collected solid waste must be disposed at a site permitted by the Local Authority. It should be noted that material contaminated with oil and other chemical must be separated from the normal waste, as it may be considered as scheduled waste and thus requiring a different handling method.

e) Vessels and Machineries Maintenance Schedule

It is advisable that a vessel maintenance schedule is prepared in order to anticipate and track any vessel maintenance work. The schedule should indicate the expected date for maintenance, location, type and amount of waste projected to be generated during the maintenance work.

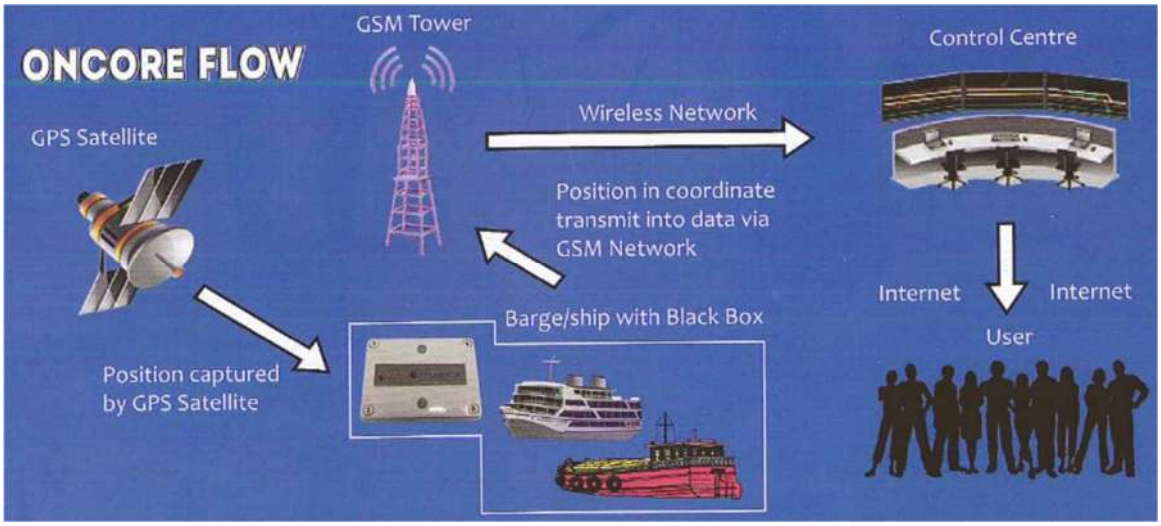
f) Preparation of Emergency Response Plan

A thorough Emergency Response Plan (ERP) which includes oil spill prevention and response must be formulated. It is recommended that an oil spill kit is kept at the Project site. In the event where spillage does occur, DOE must be alerted immediately and first clean-up response by the site personnel can be activated.

8.3.3.3 Transportation and Disposal of Dredged Material

a) Dredging and Disposal Monitoring System

All barges deployed for the disposal of dredged material must be equipped with a Dredging and Disposal Monitoring System (DDMS). DDMS will act as a tracking device that monitor the load of dredged material within the barge hopper and track the movement of the barge in real time. Strict monitoring is needed to ensure that the dredged material is dumped only within the boundaries of the approved site. DDMS can emit instantaneous alert if the system detects illegal dumping or leakage occurrence. An overview of how DDMS functions is illustrated in F8.19.



F8.19 Overview of DDMS

b) Transportation Procedure

The crew involve in transporting the dredged material to the disposal site must prevent "short dumping" from occurring. Overloading of barges must be prohibited to minimise the risk of spillage.

Vessels involved in the transportation of dredged material must be well-maintained and working properly. If leakage is observed to be caused by malfunctioning barges, rectification work must be done immediately. The barge must be fully repaired before it is allowed to resume work.

c) Subscription to Weather Information Service

Before embarking on a trip to the dumping area, the crew should check the current weather situation *en route* with a reliable weather information service. This is done to ensure the barge can safely sail to the dumping site. Inclement weather may jeopardize the safety of the barge, which may necessitate dumping of dredged material outside the designated area in order to maintain barge stability. This situation can be avoided by making sure the sea is safe for dumping operation before embarking on the journey.

8.3.3.4 Operational Phase (Topside Development)

While this study only covers the land reclamation and dredging activities, solid waste management for the topside development during the operational phase must be addressed . It is necessary to promote/enforce sorting at source, recycling and smart management of solid waste to minimize waste generation. Waste management station has to be built to compact solid waste before final disposal at Pulau Burung, which has sufficient capacity for another 20 to 30 years. Solid waste management to be adopted in the future will be evaluated based on the technology available at the time of implementation.

8.4 Marine Capture Fisheries

The mitigation measures proposed under this aspect will concentrate on artisanal fishermen and fish-landing points within south of Penang Island.

8.4.1 Fishermen

The Project Proponent is committed in implementing several measures to ensure the well-being of the fishermen communities. The measures proposed are designed specifically for them so that they can benefit from the Proposed Project and will not be left behind in the development along south of Penang Island. The Project Proponent has also set up a committee, called Fishermen Taskforce, to oversee the implementation of the proposed mitigation measures.

8.4.1.1 Compensation/*Ex-gratia*

Suitable compensation/*ex-gratia* will be provided for the fishermen. Compensation/*Ex-gratia* will be considered via eligibility criteria and quantum based on severity of Project impact to the fishermen's fishing operation. Generally, the *ex-gratia* quantum shall be not less than the Penang Second Bridge Project or North Butterworth Container Terminal (NBCT) Project or Jelutong Expressway Project. The eligibility criteria will include essential parameters based on records with Department of Fisheries and will be studied in detail by a subcommittee headed by the State Government along with relevant government department including the Department of Fisheries.

The parameters that determine the quantum of compensation/*ex-gratia* is the prerogative of the Penang State Government. The Fishermen Taskforce is assigned to this task and has pledge that all comments received from the EIA process will be taken into account.

8.4.1.2 Housing Provision

The Project Proponent has planned several housing provision measures for eligible affected parties. Firstly, 30% public housing units will be allocated as part of PSR's topside development which then further complemented by units build by other developer to fulfil State Government's requirement. The housing units will be offered to eligible buyers, in which priority will be given to the fishermen.

8.4.1.3 Setting Up of *Pusat Perkhidmatan Setempat Nelayan* (PPSN)

Pusat Perkhidmatan Nelayan Setempat (PPSN) is a one-stop centre for fishermen and local villages that was set up by the Project Proponent as a proactive measure in managing the impact of the proposed Project to the local fishermen. This facility also provides a place for continuous engagement with the local communities, disseminating latest information about the proposed Project as well as entertaining public queries. PPSN is also a centre that offers fishermen exit plan to those needed. Besides that, PPSN acts as a venue for activities organised by the Project Proponent.

Currently, there are two PPSN operating at Permatang Damar Laut (F8.20) and Gertak Sanggul. The Project Proponent intents to open another two PPSN at Sungai Batu and Teluk Kumbar. One of the activities that was conducted at PPSN is job registration for fishermen and general public who are interested in taking up employment opportunities that will be offered during Project implementation stage (F8.21). As of September 2016, a total of 425 job registrations was received by PPSN which will be considered to fill approximately 1,100 job opportunities (T8.13) once the Project commences.

F8.20 PPSN cabin at Permatang Damar Laut

F8.21 Job registration drive conducted by the Project Proponent

T8.13 Available jobs during reclamation works

	Job Category	Job Opening	Salary Range (RM)	Entry Level
Skilled workers	Managers, Engineers and Professionals	104	>3,000	Tertiary/college education Graduates
	Foremen			
Semi-skilled workers	Project Executive	18	1,500 – 6,000	Immediate entry (skill training provided)
	Site supervisor	129		
	Crew for work vessel	40		
	Boat and barge staff	73		
	Plant operator	99		
	Testing and monitoring	31		
	Structural works	57		
Site workers	Crew for work vessel	100	1,200 – 3,000	Immediate entry
	Transporter	53		
	Patrol/security	24		
	Construction worker	372		
Total		**1,100**		

8.4.1.4 Fishermen Exit Plan

The Fishermen Taskforce must formulate an exit plan for the fishermen by working together with LKIM, Department of Fisheries and Persatuan Nelayan Pulau Pinang. Several exit plans proposed are:

a) Aquaculture industry;
b) Deep fishing industry;
c) Recreational fishing;
d) Water taxi; and
e) Replacement of work from fishermen to other sector or industry:
   i) Fish processing;
   ii) Maintenance of boats and engines;
   iii) Entrepreneur; and
   iv) Industry.

8.4.1.5 Conserving and Restoring Fishery and Ecosystem Plan

The loss of fishing ground caused by the proposed Project footprint can be mitigated by replenishing the fish stock in the southern waters of Penang Island. Higher fish stock may contribute into higher catches for the fishermen. In order to achieve this, several measures can be taken as follows:

a) Deployment of Fish Aggregating Device (FAD), pillars and artificial reefs to:
   i) restore damaged habitat; and
   ii) contribute to biodiversity conservation.
   The above measures must be monitored periodically to ensure the enrichment occurred post-deployment.
b) Fish and shrimp stocking/Releasing fish fry at strategic locations (sea ranching);
c) Monitoring of the released and natural stocks to assess the impacts; and
d) Mangrove replanting programme and creating new habitat for fish spawning ground.

The proposed measures listed above can be considered as offset programmes devised to mitigate the environmental impact of the proposed Project. Details for each offset programme shall be discussed in *Section 8.7*.

8.4.1.6 Promotion for Tourism

Currently, southern Penang Island is a popular area for recreational fishing as well as obtaining fresh sea produce. The Project Proponent plans to capitalize on this by promoting this area as a place for recreational fishing. The Project Proponent will provide assistance to the fishermen who wish to venture into tourism business, e.g. by organising courses with the cooperation of the Marine Department and to assist them in obtaining boatmen *(Jurumudi)* license.

8.4.1.7 Social Proactive Measures

The Project Proponent has several measures planned in order to elevate and strengthen the fishermen community of south Penang Island. One of them is towards elevating the education level of the local communities. This can be achieved by upgrading education measures as well as including tuitions and scholarships. By increasing the level of education, especially for the fishermen's children, it is hoped that the younger generation will be empowered to move away from becoming traditional inshore fishermen.

8.4.1.8 Improvement on Standard of Living

Various development programmes has been planned to be conducted at southern Penang Island that will be implemented as part of the Project. These include:

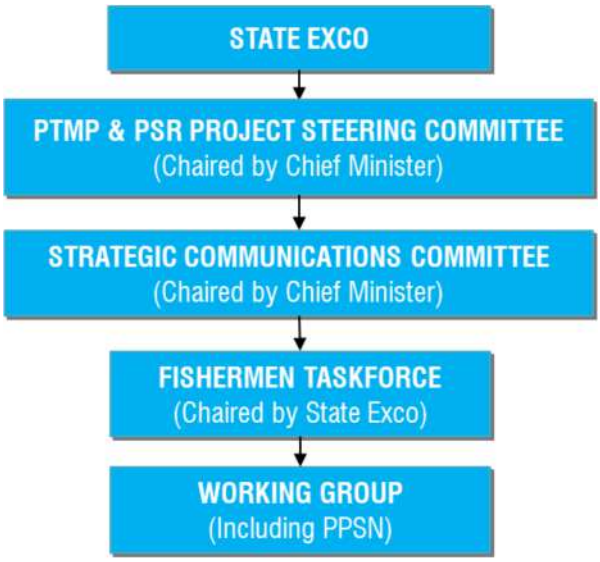
a) Flood mitigation programme;
b) River water quality improvement programme;
c) Fisherman's jetties;
d) Shoreline enhancement;
e) Village development and conservation; and
f) Roadworks.

8.4.1.9 Mechanism for Implementation of the Proposed Measures

a) Fishermen Taskforce

The Penang State Government (as the Project Proponent) has set up a "Fishermen Taskforce" to implement all mitigation measures and improve the livelihood of both the fishermen and local community. The Taskforce is headed by the *Exco Pertanian dan Industri Asas Tani Kerajaan Negeri Pulau Pinang*. It is parked under the Strategic Communications Committee which is chaired by the Penang Chief Minister.

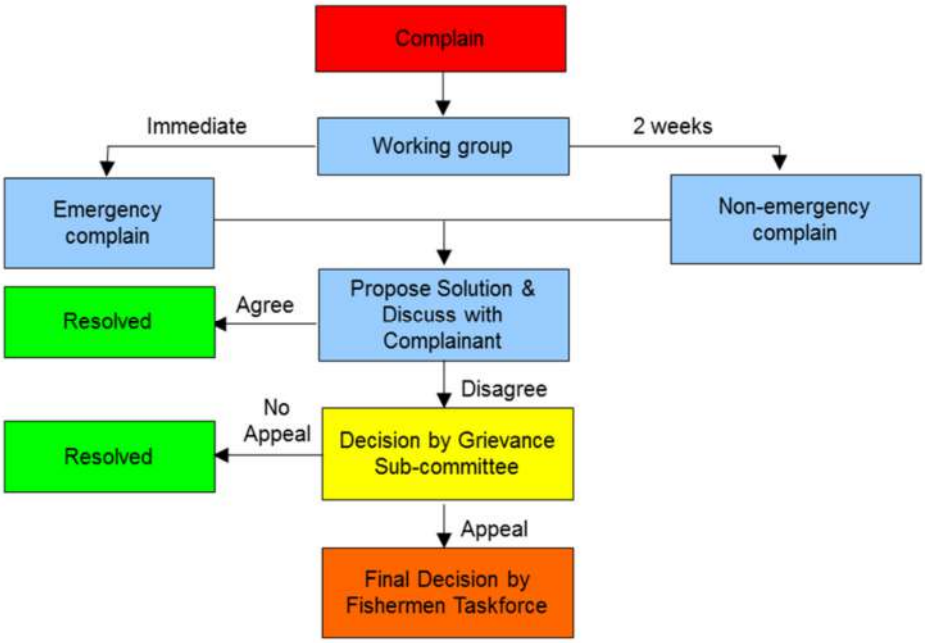
The Taskforce consists of representatives from *Bahagian Perancang Ekonomi Negeri* (BPEN), Department of Fisheries (DOF), *Lembaga Kemajuan Ikan Malaysia* (LKIM), District Office and the people's representative from relevant *Ahli Dewan Undangan Negeri* (ADUN). The overall structure of this organisation is presented in F8.22.



F8.22 Organisation chart for Fishermen Taskforce

b) Grievance Mechanism

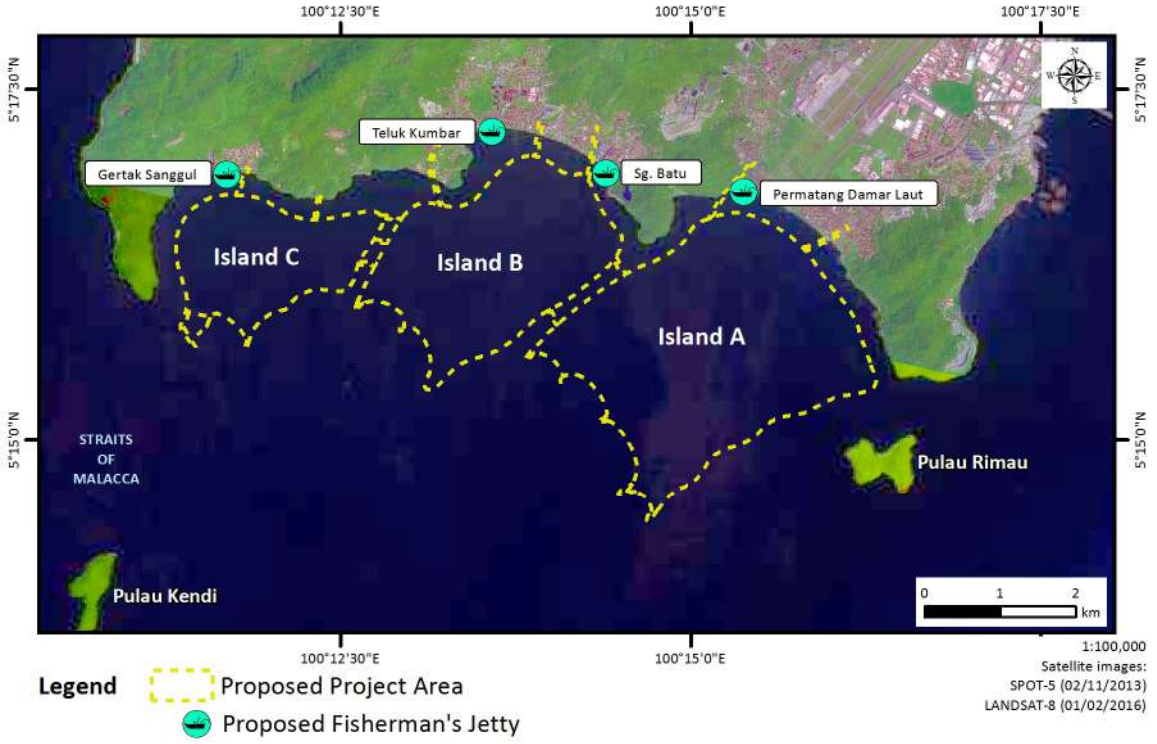
The Project Proponent will establish a grievance mechanism to ensure any complaint arising from the fishermen is handled in a constructive and professional manner. The grievances will be handled by the Grievance Subcommittee which is part of the overall Fishermen Taskforce. The proposed grievance mechanism is illustrated in F8.23.



F8.23 Grievance mechanism for PSR

8.4.2 Fish Landing Point

The existing jetties found along the coastline are run-down and under-utilised. In order to improve this situation, construction of new fishermen jetties will be a part of the proposed development. Fisherman's jetties are proposed to be constructed at Permatang Damar Laut, Sungai Batu, Teluk Kumbar and Gertak Sanggul (F8.24). These jetties will be sheltered by the reclaimed islands and will be accessible at all time via the dredged access channel. An artists' impression of the jetty is shown in F8.25.



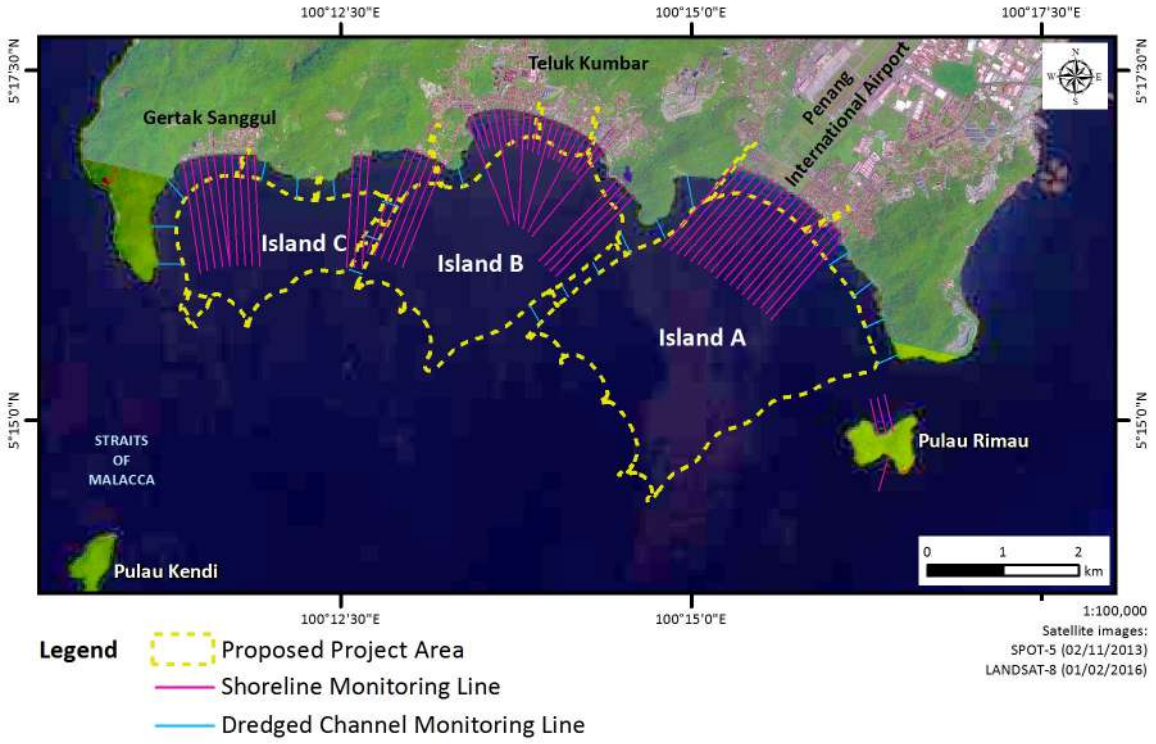
F8.24 Locations of proposed new fishermen's jetties

F8.25 Artist's impression of fishermen's jetty

8.5 Sedimentation and Erosion

Periodic bathymetric and nearshore monitoring surveys are recommended to assess beach and bed level changes during and after the implementation of the proposed development.

Monitoring surveys covering the beaches between Tanjung Teluk Tempoyak to Tanjung Gertak Sanggul and around Pulau Rimau are recommended. The survey shall extend 50 m landward of the High Water mark and sufficiently far seaward of the coastline. It is recommended that shore-parallel survey lines be taken at 100 m intervals as shown in F8.26.



F8.26 Proposed monitoring survey extent and intervals

Each survey campaign will be carried out at three months' interval during the construction phase. The report for each survey shall be submitted to the Department of Irrigation and Drainage (DID). The survey can be done at half-yearly intervals during the post-construction phase for up to three years or after receiving consent from DID to discontinue the survey. Information from the periodic survey can also be used to determine the need and extent of maintenance dredging required after the development is completed.

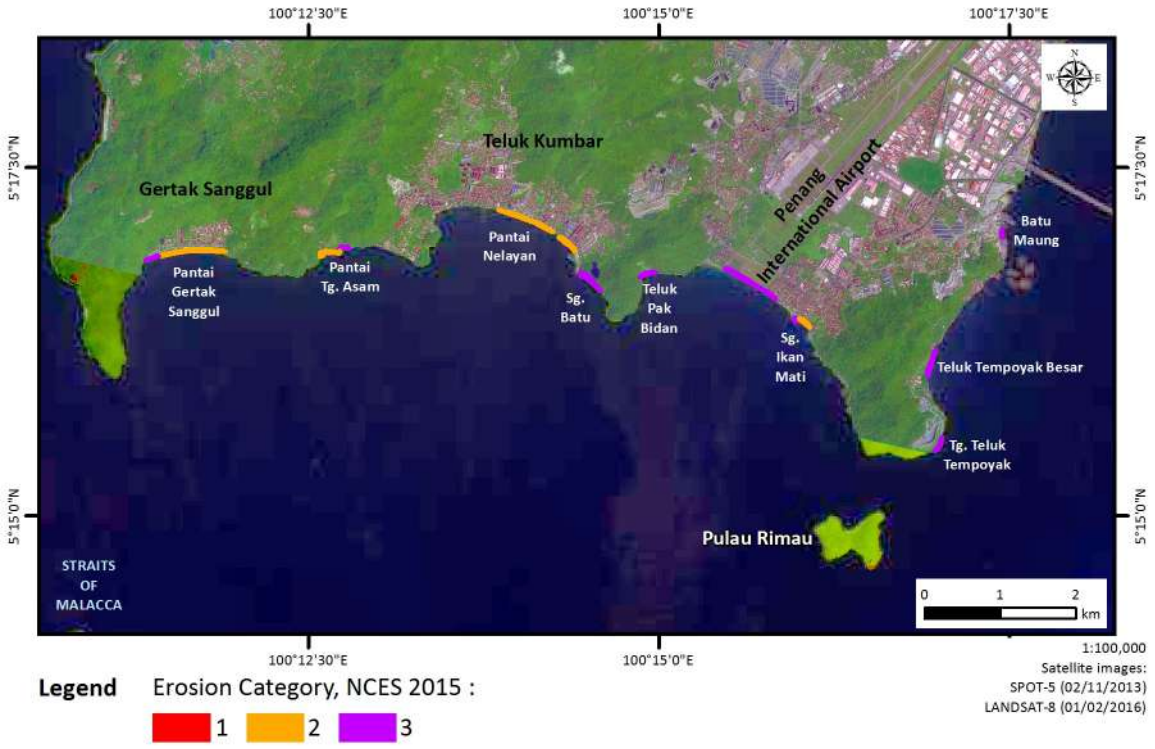
The survey shall include the conditions of the existing coastal defence structures. In the event there are damages to these structures due to the Project, the Project Proponent shall be responsible for the repairs of these structures.

In addition to the monitoring required by DID, it is recommended that the dredged channels are to be monitored at least on a yearly basis to ensure that the channels are sufficiently deep for safe navigation and effective flushing. The locations of the monitoring surveys of the dredged channels are also shown in F8.26.

8.5.1 P2M2 for Erosion

a) Shoreline Enhancement

As discussed earlier in *Chapter 6: Existing Environment*, several existing beaches namely Pantai Nelayan, Pantai Tanjung Assam and Pantai Gertak Sanggul are currently experiencing significant erosion (F8.27). The Project Proponent aims to alleviate this condition by conducting enhancement works for the existing shoreline, so that public properties along the critical erosion area is protected and the beaches can be maintained for the fishermen and public to use. This shoreline enhancement works at three areas mentioned before will be conducted during the initial stage of the Project implementation.



F8.27 Erosion category of southern coastline of Penang Island

b) Beach Nourishment

In the event that coastal erosion is detected from the monitoring surveys as an impact of the Project, beach nourishment will be required. The beach nourishment work involves the placing of sandy material on the beach slope, unlike the beach enhancement work explained in *Section 8.5.2(b).*

c) Scour Protection

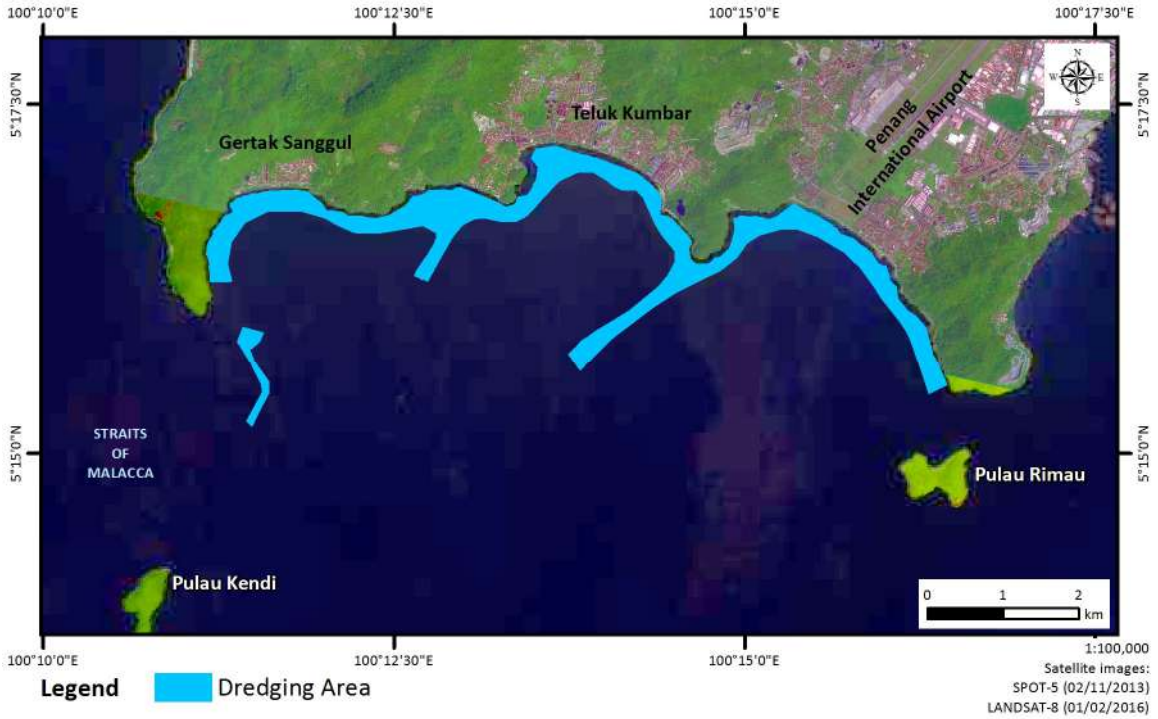
The design of the island edge protection and the artificial headlands of the reclaimed islands need to incorporate scour protection. It is particularly important for the artificial headlands as they induce high current speeds within their immediate proximity.

The modelling simulation results do not show potential erosion or scour at the existing beaches or coastal protection structures. In the event that the shoreline monitoring survey shows erosions caused by the Project, rectification works shall be undertaken by the Project Proponent.

8.5.2 P2M2 for Sedimentation

a) Maintenance Dredging

Based on the findings from sedimentation and erosion simulations discussed in *Section 7.3.4* of *Chapter 7: Evaluation of Impacts*, sedimentation is expected to occur along the navigation channel. The annual sedimentation rates at the dredged channels in Scenarios 2, 3 and 4 have been predicted to be 70,000, 125,000 and 150,000 m^3 respectively. Periodic maintenance dredging at 3 to 5 years intervals, to be informed by the outcome of monitoring surveys, would be required to maintain safe navigation and effective flushing in the dredged channels (F8.28).



F8.28 Maintenance dredging area

Given the relatively shallow water depths of the dredged channels, approximately 3.5 m at MSL, it is recommended to use either a clamshell or grab dredger or a small CSD. The latter is able to pump the dredged material to bigger hopper barges at deeper water. The production rate of a small CSD is approximately 100,000 m^3 per month. A clamshell/grab dredger is able to dredge approximately 70,000 m^3 per month.

Considering the dredging works are to be undertaken every 5 years, each maintenance dredging campaign will involve in the dredging of about 210,000 , 375,000 and 450,000 m^3 of material following Scenarios 2, 3 and 4 respectively.

In the event that the periodic monitoring survey shows high spots that affects safe navigation of the local fishing boats, it is recommended to use a clamshell or grab dredger to remove the high spots given the smaller volume and relatively faster mobilisation.

b) Beach Enhancement

Additional beach enhancement works may be required if the upper beach areas experience siltation of fine sediments. It is, however, expected that such siltation will mostly happen in the inter-tidal areas, which are mudflats at present.

8.6 Hatcheries

The affected hatcheries will be those located adjacent to the Project area which are Gertak Sanggul, Teluk Kumbar and Permatang Damar Laut. The proposed P2M2 for hatcheries aim to alleviate and manage the impact of water quality degradation and the reclamation footprint. It is recommended for a committee consisting of State Authorities and affected hatchery operators to be established to ensure the proposed mitigation measures can be specifically tailored according to the operators' comments and feedbacks.

8.6.1 P2M2 for Water Quality Degradation

a) Water Filtration System Upgrade

Apart from the P2M2 proposed in managing water quality as discussed in *Section 8.2*, the hatcheries concerned could be provided with an upgrade of the water treatment system to mitigate the loss of water quality values. Further discussions are needed with the hatchery operators to determine the specifics of the treatment system upgrade so that an effective solution can be developed.

8.6.2 P2M2 for Project Footprint

a) Relocation of Seawater Intake Pipe

Currently, the intake pipes ranged from 5 to 100 m from the shoreline (F8.29). If the seawater intake pipes for the hatcheries are located within the Project footprint, new suitable locations must be identified for the relocation of these pipes. The new locations proposed must take into account the water quality at that area and must be paired with an appropriate filtration system. The cost of relocation and constructing a new pipe shall be borne by the Project Proponent.

F8.29 Hatcheries seawater intake pipe found at the Project site

8.7 Offset Programmes

Offset programmes are developed in order to compensate for the impact on the services of various environmental components that cannot be fully mitigated or deemed to be a total loss. In other words, these programmes will act as a balance on the environmental trade-off incurred by implementing the proposed Project. As mentioned in *Chapter 7: Evaluation of Impacts*, ESAs that are classified as trade-off will be:

a) turtle landing sites;
b) coral reefs of Pulau Rimau (partial trade-off);
c) mudflat; and
d) fishing ground (partial trade-off).

Seeing that the trade-offs are marine-based and relatively linked to marine capture fisheries, the offset programmes developed are of similar nature. The planned programmes can be divided into two main categories as listed below:

a) Marine-based ESA:

   i) Provide grants of financial support for research related to:
      - turtle;
      - coral reefs; and
      - seagrass.
   ii) Mangrove replanting programme.

b) Marine capture fisheries:

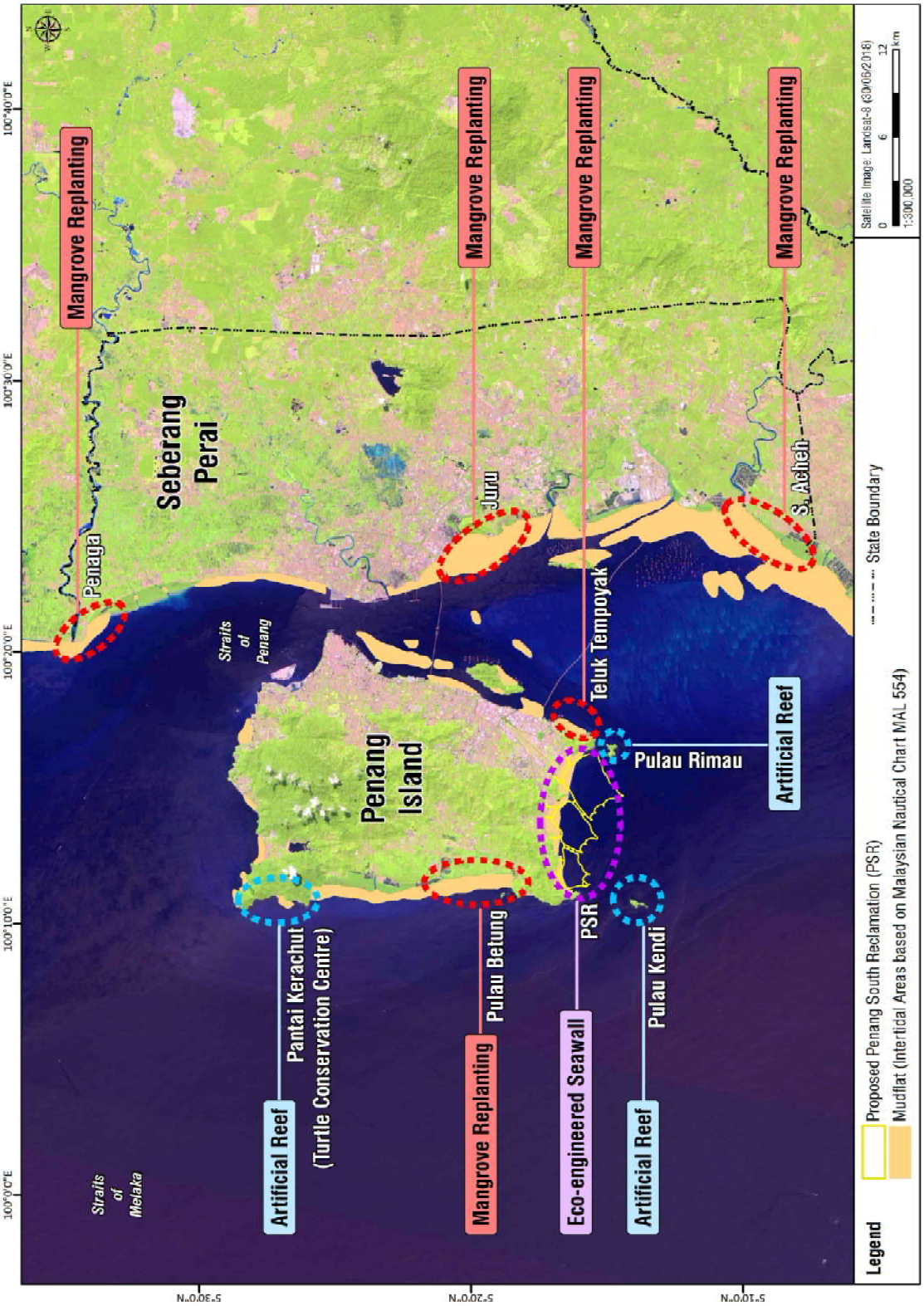
   i) Deployment of Fish Aggregating Device (FAD), pillars and artificial reefs to:
      - restore damaged habitat; and
      - contribute to biodiversity conservation.

      The above measures must be monitored periodically to ensure the enrichment occurred post-deployment.
   ii) Fish and shrimp stocking/Releasing fish fry at strategic locations (sea ranching);
   iii) Construction of eco-engineering structures on PSR;
   iv) Monitoring of the released and natural stocks to assess the impacts;
   v) Mangrove replanting programme; and
   vi) Provide grant or financial support for Fisheries Research Fund. This would include the study of post larval movements of the greasyback shrimp (*Metapeneaus ensis*).

The proposed offset programmes must be comprehensive to determine the most effective method of implementation. For example, for artificial reef, the comprehensive study should include:

a) baseline data for comparison;
b) site suitability and selection study in Penang;
c) target objective;
d) hydraulic study;
e) design of artificial reef; and
f) reporting on ecosystem rebound.

Then, it is proposed that each programme shall conduct a monitoring exercise (offset monitoring for artificial reefs) on the impact over the course of the implementation. Findings from the monitoring shall be compared with the baseline data to gauge the effectiveness of the offset programmes. Proposed locations of the offset programmes are shown in F8.30. However, the locations are still subject to further detailed study post-EIA.



F8.30 Proposed locations of offset programmes

8.7.1 Grants or Financial Support for Research

a) Turtle

Funds for turtle-related research or conservation efforts will be allocated by the Project Proponent as an offset to the loss of the turtle-landing site. Priority will be given to organisations that are located in Penang and have successful track record in their endeavour. Among organisations that can be selected for the support are:

i) Turtle Conservation and Education Centre at Pantai Kerachut (Penang National Park), Penang (managed by Department of Fisheries);
ii) Turtle and Marine Ecosystem Center (TUMEC), Rantau Abang, Terengganu (managed by Department of Fisheries); and
iii) SEATRU, Universiti Malaysia Terengganu (UMT).

b) Coral

The partial loss of coral at Pulau Rimau shall be compensated by funding in research or conservation efforts for coral reefs. Seeing that coral are not ubiquitous in Penang, most likely the funding will go to research and conservation efforts elsewhere in Malaysia. Deployment of artificial reefs can also become one of the offset programme for the coral partial loss at Pulau Rimau.

c) Seagrass

As an effort to conserve and enhance Penang's marine biodiversity, support on research and conservation effort for seagrass located at Middle Bank (Pulau Gazumbo) will be provided. Seagrass is an important marine habitat that serves a large number of other marine organisms. Thus, it is hoped that this programme will not only improve on seagrass vitality but also on the associated marine species.

d) Fisheries Research Fund

The Project Proponent shall make contributions to the Fisheries Research Fund to be utilised by Department of Fisheries and/or LKIM for the advancement of the fishing industry in the south of Penang Island.

The Project Proponent shall do research on greasyback shrimp population to better understand their presence, migration and seasonal pattern at the mudflats of the study area. It is recommended that the monitoring study be undertaken monthly (at least six months before dredging and reclamation work) and in collaboration with the Department of Fisheries.

8.7.2 Mangrove Replanting and Monitoring Programme

An offset programme should be undertaken by the Project Proponent to compensate for the impact on marine ecology. Previously, the Project Proponent carried out one replanting programme on 3rd September 2016 with Penang Inshore Fishermen Welfare Association (PIFWA) in Sungai Acheh, Nibong Tebal. This programme involved inshore fishermen from Southern Penang Island, Penang State Government and students from Sekolah Menengah Seri Nibong whereby 500 mangrove saplings were planted (F8.31).

Source: Altinagac *et al.*, 2010

F8.31 Mangrove replanting programme conducted by the Project Proponent

In future, the Project Proponent intends to continue this programme as well as working closely with the Penang Forestry Department in identifying new suitable locations ideally at degraded mangroves areas both on Penang Island and mainland. Based on discussion with the Department, the proposed locations for mangroves replanting will be either at Pulau Betung, Teluk Tempoyak, Sungai Acheh, Juru or Penaga (as shown in F8.30). The type of mangrove to be re-planted would depend on specific site conditions and sound geomorphological and hydrological understanding of the potential replanted sites. It is also recommended that the fishermen and the members of local communities be involved in the re-planting activity, as this would encourage them into taking care of the mangrove and allow them to be the stakeholders, stewards and custodians of the mangroves.

8.7.3 Deployment of Artificial Reefs

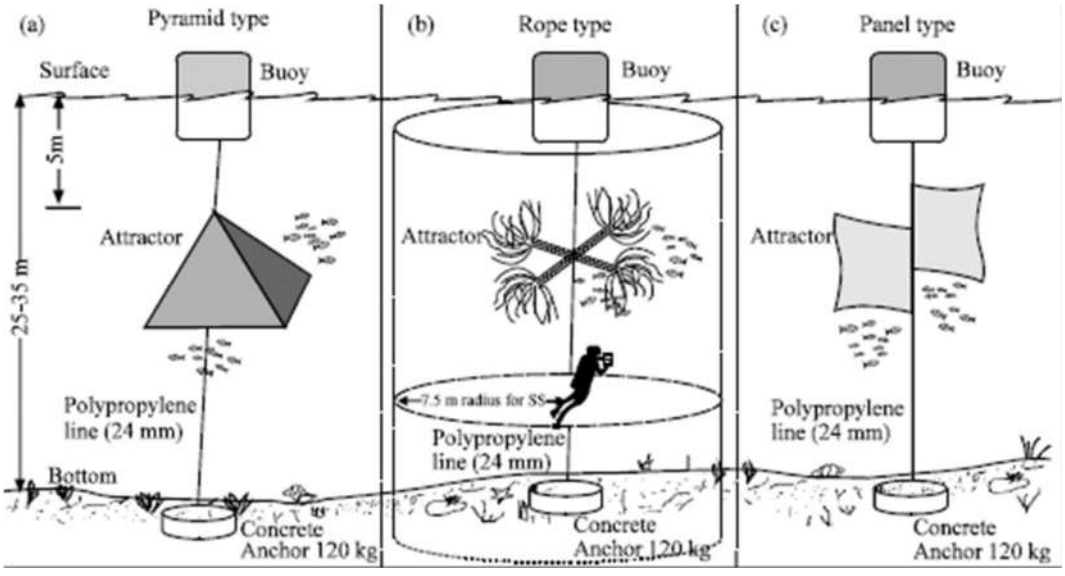
The Penang State Government has deployed artificial reefs at several locations near Pulau Kendi. These artificial reefs will act as habitat enrichment devices. According to Pears and Williams (2005), the benefits of these devices include:

a) Fishing enhancement (commercial, recreational or artisanal);
b) Science experimentation and research;
c) Conservation of biodiversity (e.g. provide or enhance habitat for re-establishment of depleted organisms);
d) Restoration of damaged habitats;
e) Protection of habitat or control of fishing mortality with artificial reefs as physical barriers; and
f) Tourism and recreational opportunity enhancement (diving, snorkelling).

The loss of the mudflat would lead to a decrease in catch for the fishermen. The artificial reefs would attract fish to aggregate in the water surrounding the proposed islands, thus reducing the cost of fishing. Ahmad *et al.* (2013) reported that, 76 species of commercial fish, 33 species coral fish, seven species of soft coral, six species of gorgonians, nine species of gastropods, eight species of bivalves, seven species of sea cucumber, four species of sponges and three species of echinoderms were recorded at artificial reefs installed along the east coast of Peninsular Malaysia.

8.7.4 Deployment of Fish Aggregating Devices (FADs)

The installation of Fish Aggregating Devices (FAD), known locally as *unjam*, would enable the aggregation of fish stocks, which in turn will make fishing easier and may help in reducing the cost of fishing. Since shallow water depth was recorded at the study area, the FAD systems can be a static type i.e. fixed to the bottom with an anchor. Examples for FADs that could be installed are shown in F8.32. However, the design and location of these FADs would need to be consistent with site conditions and are part of a separate study.



Source: Altinagac *et al.*, 2010

F8.32 Examples of FADs for artisanal and recreational fishing

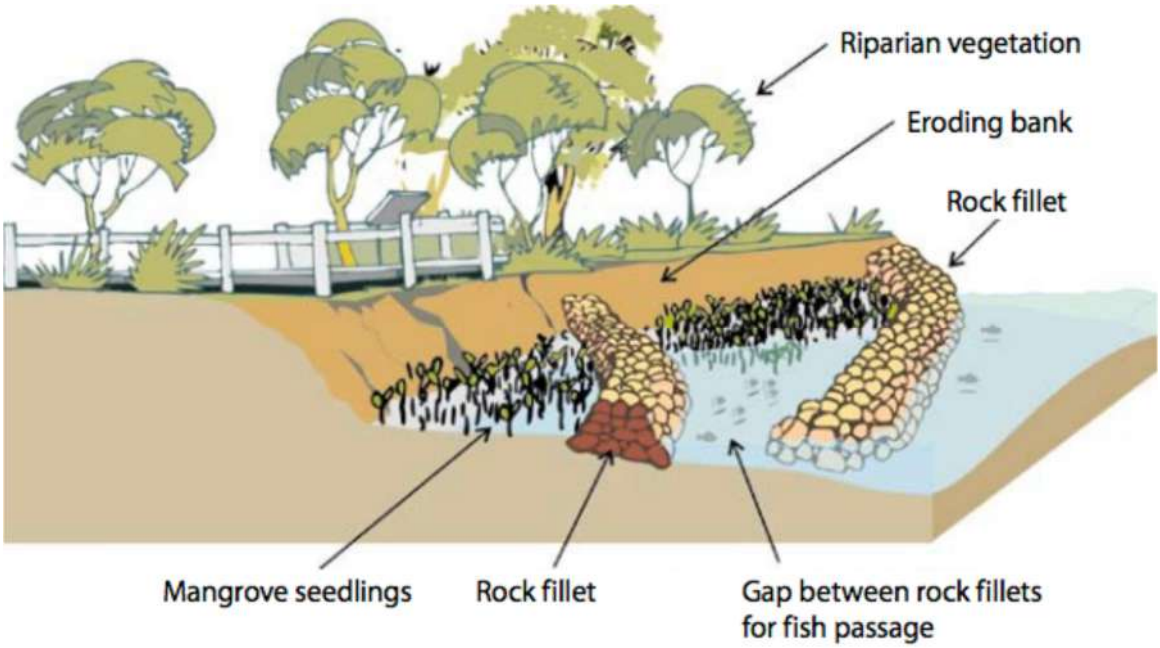
8.7.5 Sea Ranching

Sea ranching involves obtaining fish fry or fingerlings from hatcheries and releasing them into the sea. Sea ranching or fish stocking has been conducted effectively around the world and has been proven to be successful in supplementing the existing fish populations. For this Project, site selection is a priority and preferably to be done at strategic locations, such as Balik Pulau Forest Reserve or the mangroves of Sungai Acheh, in which the fry or fingerlings will have a sizeable chance to grow to a size at which they can be captured.

Further discussions with the Fisheries Research Institute in Batu Maung and LKIM will be done in order to develop an effective fish stocking endeavour.

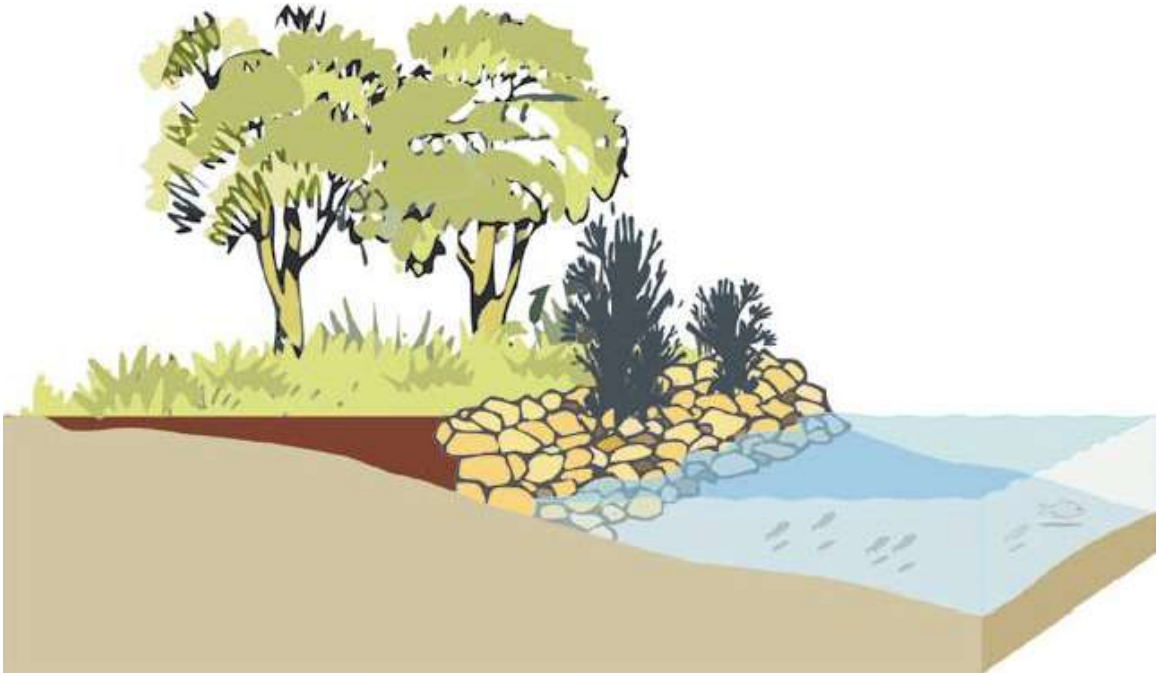
8.7.6 Construction of Eco-engineering Structures

Construction of modified seawalls surrounding the reclaimed area that enable the establishment of mangrove or coastal vegetation. There were several studies (Moosavi, 2017) that have come up with designs that shift from “coastal armouring” and hard engineered “defense systems”, to ecologically informed infrastructures (eco-engineered structures) that can perform beyond engineering goals and provide ecological and social benefits. Emerging studies determine the importance of ecological knowledge and landscape-based solutions in informing the design of coastal infrastructures; however, there are limited number of projects that demonstrate the most effective design approaches. F8.33 and F8.34 provide some conceptual drawings of such infrastructure. Details will be part of a separate study that would look at the matter in greater detail. Locations of the proposed areas for the construction of eco-engineered structures are as shown in F8.35. Examples of installation of eco-engineered structures are shown in F8.36. An example of a case study where eco-engineered structures, specifically geotubes, were employed in the degraded mudflat area at Sungai Hj. DOrani, Selangor (F8.36)



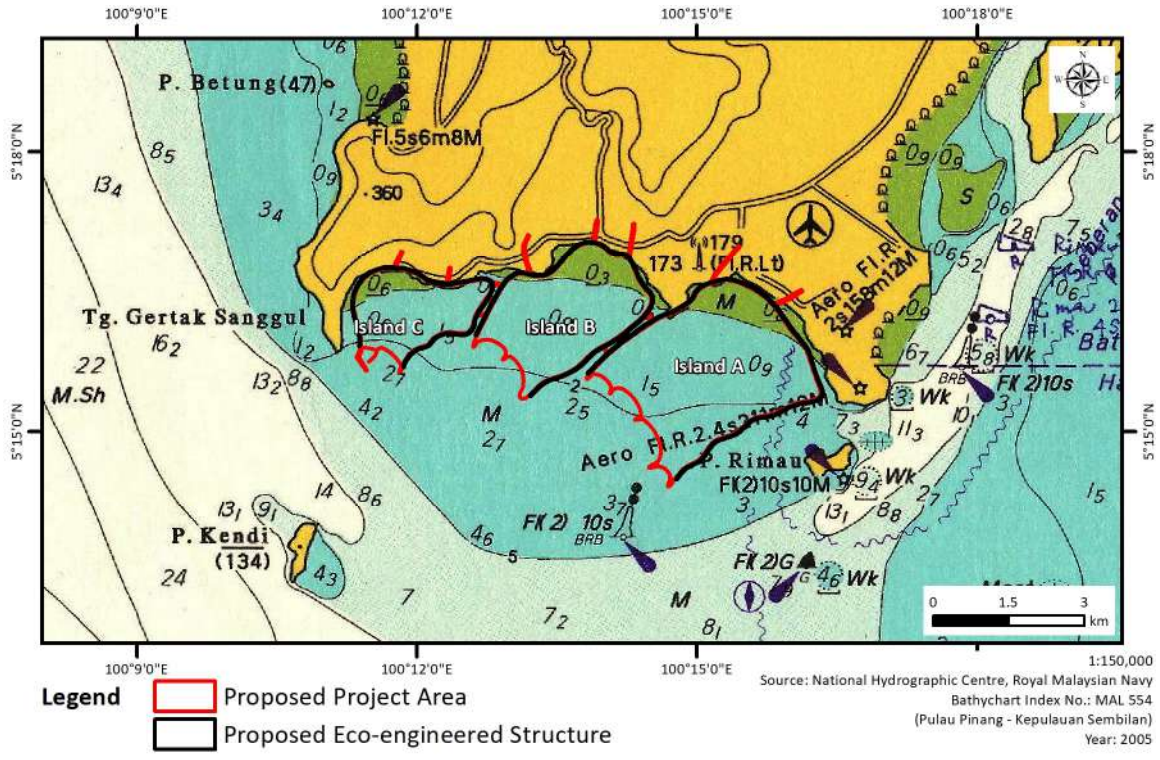
Source: DECC, New South Wales (2009)

F8.33 Examples of shoreline stabilisation by mangrove planting



Source: DECC, New South Wales (2009)

F8.34 Examples of shoreline stabilisation by coastal vegetation



F8.35 Location of the proposed areas for construction of eco-engineered structure

F8.36 Examples of eco-engineering structures

Mudflats at Sungai Hj. Dorani without mangroves

Stabilised mudflats at Sungai Hj. Dorani with replanted mangrove tress

Mangrove development behind geotubes at Sungai Hj. Dorani (after 7 years)

F8.37 Examples of eco-engineering structures installed at Sungai Hj. Dorani, Selangor

8.8 Noise

8.8.1 P2M2 during the Construction of Workers' Quarters

Although the noise impact from this activity is expected to be insignificant because of the secluded location, physical hoarding will still be built along the perimeter of the construction site. The physical hoarding will not only provide security to the construction site but also deflect any noise generated from the construction area.

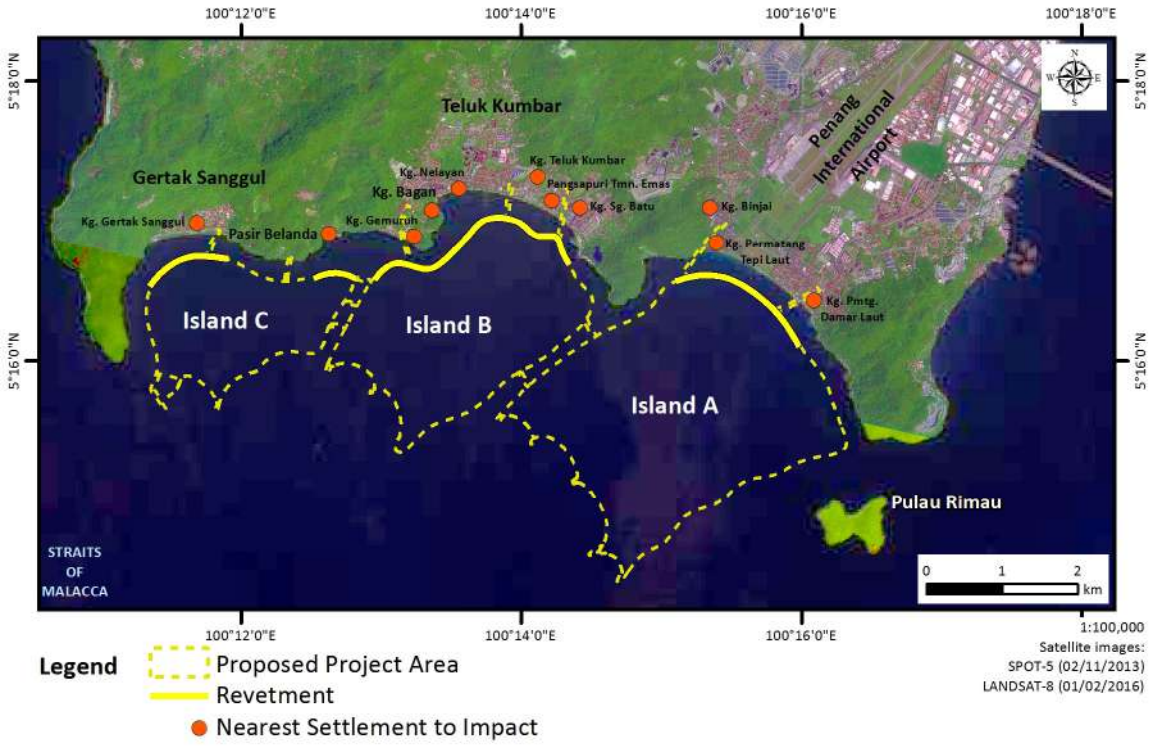
8.8.2 P2M2 during Land Reclamation

a) Best Management Practice for Noise Control

Ancillary plants, such as generators, compressors and pumps should be placed behind existing physical barriers. Plant, machineries and equipment used should be fitted with effective exhaust silencers and are maintained in good working order.

b) Restriction on Working Hours

Working hours for activities that may cause significant noise impact to sensitive receptors, such as piling and rock bund construction nearest to residential area, must be restricted from 7:00 am to 9:00 pm where practical. F8.38 shows the section of perimeter bund and revetment that should be given most attention because of the presence of residential areas nearby.



F8.38 Sections of perimeter bund/revetment that must be restricted from night activities

8.9 Air Quality

8.9.1 P2M2 during the Construction of Workers' Quarters

The access road for the construction of workers' quarters must be laid with crusher run so that dust generation will be minimal, especially during the dry season. In addition, tyre washing facility that consists of wash trough and water jet must be provided at the entry point of the access road.

8.10 Marine Traffic

8.10.1 P2M2 during Dredging and Reclamation

a) Marine Traffic Control Centre

It is recommended that a marine traffic control centre is established at site to monitor, manage and record the movement of all vessels deployed for the proposed Project. In order to be effective, the control centre must be sufficiently equipped with appropriate equipment such as VHF radio and Automatic Identification System (AIS). All self-propelled vessels must be equipped with AIS transponder to ensure continuous and real-time monitoring by the control centre.

b) Working Area Boundary Mark

A minimum of four lighted buoys must be installed around the Project site to mark the working area boundary. The location of the lighted buoys must be approved by the Marine Department and the lighted buoys must be constructed as per the Marine Department's specifications.

All fixed and movable structures such as floating pipelines, silt curtains and any other structures erected in the water ways must be well-illuminated by night and clearly marked so as to be highly visible by day.

c) Adherence to Penang Port Regulations

The movement of vessels coming in and going out of Port Limit Area must be reported to the Penang Port Authority. Pilotage may be required as stated in the prevailing law. The control centre may provide direct liaison between vessel operators and the Penang Port Authority.

d) Ensuring Vessels Seaworthiness

Vessels deployed for the Proposed Project must be in seaworthy condition. As a measure, all vessels must be inspected and obtain approval from the Marine Department before being allowed to operate. The vessels must also be manned by a competent crew that is aware of the operational regulations within the Penang Port Limit.

e) Dissemination of Information on the Latest Condition at Project Site

The Project Proponent must establish a close rapport with the local fishermen associations to ensure accurate and up-to-date information is transmitted to them. The fishermen must be made aware on the safety hazards on site and of precautions that they should take. The information will be continuously published through the PPSN.

8.10.2 P2M2 for Submarine Cables

8.10.2.1 P2M2 for Project Footprint

As the submarine cables are located within the reclamation footprint, the affected portion of the cables shall be realigned or relocated to new suitable locations. The Project Proponent must engage the cable owners to ensure the mitigation measures proposed will conform with the cable owners requirements. The cost of relocation and construction of the affected submarine cable segment shall be borne by the utilities' agency.

8.10.3 P2M2 during Operation

Areas with high current speeds are mostly at the artificial headlands. Whilst it is considered that the increased current speeds would still be manageable for fishing boats, the headlands are considered as navigation hazards that need to be marked.

8.11 P2M2 for Land Traffic

In order to cater for the additional trips generated from the proposed development, several mitigations measures are proposed to be implemented. The measures are listed as follows:

a) External connectivity;
b) External public transport network;
c) Internal public transport network;
d) Pedestrian lane provisions;
e) Bicycle lane provisions;
f) Car parking management schemes; and
g) Water taxis.

It is to be noted that these measures are complemented by some existing Federal and State Government's schemes, including Jalan Bayan Lepas/Jalan Teluk Kumbar/Jalan Permatang Damar Laut junction improvement, general road widening at Teluk Kumbar, Batu Maung flyover as well as the Penang Transport Masterplan (PTMP).

8.11.1 External Connectivity

The proposed development is proposed to be connected to the regional road network, linking the township to other matured centres/townships in Penang Island as well as the Seberang Perai regions. There are nine access and egress points proposed for the development.

Of these nine accesses, three are primary access/egress points and the remaining six (6) are secondary access/egress points. The proposed access/egress points are as follows:

a) Primary Accesses

   i) Pan Island Link 2 (PIL 2)

      PIL 2 will be constructed as two-lane dual carriageway road structure linking PIL 1 at the Relau Interchange/Jalan Teluk Kumbar/Jalan Pondok Upih to Island B. It would enhance the accessibility as well as serving as a major access road to the reclaimed islands;

ii) Pan Island Link 2A (PIL 2A)

The PIL 2A is being planned as an elevated two-lane dual carriageway road structure linking Jalan Permatang Damar Laut/LCE/Penang Second Bridge to Island A. It will provide a high standard, smooth-flowing route for traffic not needing to travel through the existing developed areas along the currently congested Jalan Permatang Damar Laut and Jalan Batu Maung to get to the Second Bridge;

iii) Jalan Tun Dr. Awang Link (JTDA Link)

The JTDA Link is also planned as an elevated two-lane dual carriageway road structure linking Jalan Teluk Kumbar/Jalan Tun Dr. Awang to Island B. The link will provide an uninterrupted flow for traffic to get to/from Bayan Baru in direct manner, skipping the signalised junctions along Jalan Teluk Kumbar

b) Secondary Accesses

i) An at-grade road bridge - Bridge 1 from/to Jalan Permatang Damar Laut to/from Island A;
ii) An at-grade road bridge - Bridge 2 from/to Jalan Permatang Damar Laut to/from Island A;
iii) An at-grade road bridge - Bridge 3 from/to Jalan Teluk Kumbar to/from Island B;
iv) An at-grade road bridge - Bridge 4 from/to Jalan Teluk Kumbar to/from Island B;
v) An at-grade road bridge - Bridge 5 from/to Jalan Gertak Sanggul to/from Island C; and
vi) An at-grade road bridge - Bridge 6 from/to Jalan Gertak Sanggul to/from Island C.

8.11.2 External Public Transport Network

It is planned that the reclaimed island will be provided with LRT system connected to Bayan Lepas LRT. This will provide external public transport linkage to Georgetown, as well as other public transport route to be developed under the Penang Transport Masterplan (PTMP).

8.11.3 Internal Public Transport Network

Good internal public transport network will be provided on the reclaimed islands. The options of electric buses and trams will be considered. In addition, feeder buses for the LRT system will also be provided to facilitate travelling from various locations on the islands to LRT stations.

8.11.4 Pedestrian Lane Provisions

Walking is to be encouraged within PSR through the provision of high quality public linkages which are direct, safe and aesthetically pleasing. Footways should be sufficiently wide for two pushchairs to pass (including behind bus stops or other street furniture), and illegal parking across footways will be prevented.

All pedestrian routes should be designed with personal safety and security in mind. In particular routes to be used at night should preferably be actively used by vehicles to allow users to feel safe walking. Routes should be lit where it is both safe and necessary to do so. In residential areas shared surfaces should be provided whereby priority is given to pedestrians rather than to motor vehicles, with a heavy emphasis on traffic calming measures such as crossing tables and block-paving to slow vehicles and empower pedestrians, encourage community cohesion which allow children to play safely within the streets.

8.11.5 Bicycle Lane Provisions

Segregated cycle lanes are proposed to be provided so that cyclists are not vulnerable to vehicular traffic. High quality cycle storage facilities should be provided within buildings and the public realm so that cyclists can safely secure their bikes when not in use.

Cycle user groups should be set up to encourage a cycling community within the proposed development. Cycle hire facilities should be provided for tourists, visitors and occasional cyclists. A cycle trail will be established linking the three islands, and thus encouraging tourists and visitors to explore the area on bike.

8.11.6 Car Parking Management Schemes

The transport strategy for PSR aims to achieve high public transport use supported by measures that encourage walking and cycling, with a subsequent reduction in car use. However, there is also a need to consider and provide appropriate levels of parking to accommodate those that do drive to or within the site. Parking provision and access to parking is an integral part of the development and also a strong tool for managing demand for private car use. Parking should be designed to achieve a high degree of integration with the public transport and road network, and overprovision should be discouraged.

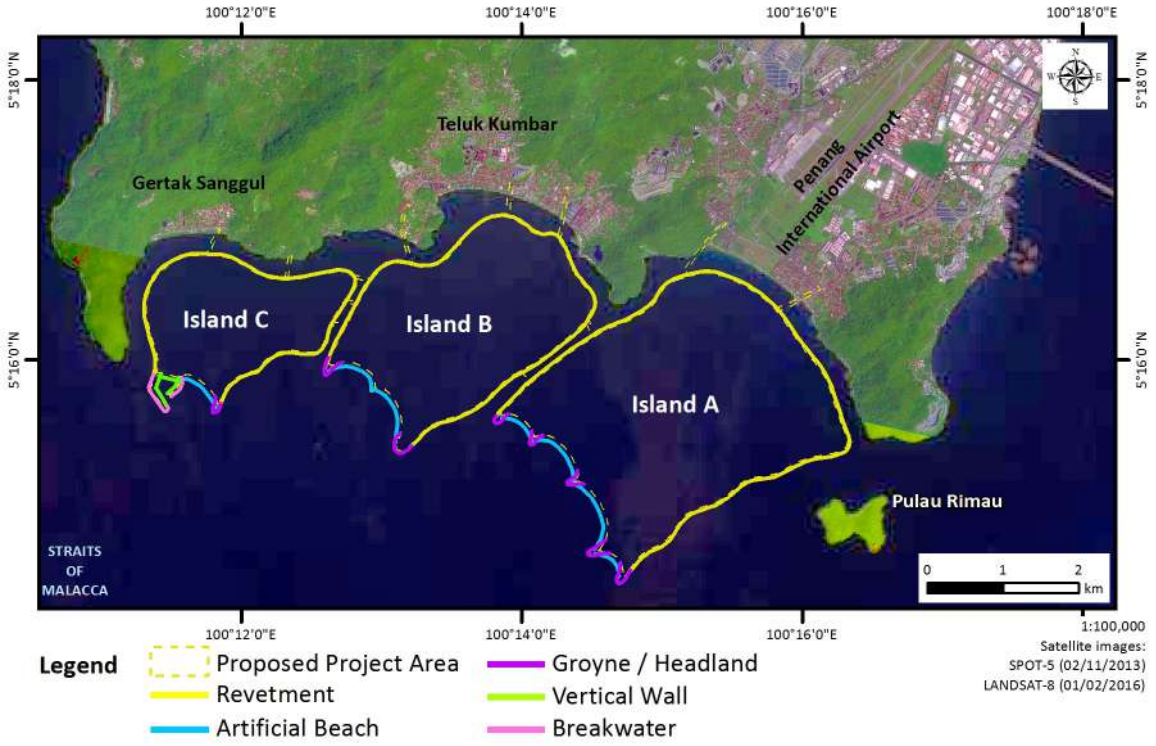
Local government planning mandates the provision of a predetermined amount of parking spaces for each type of land use. Parking has a distinct demand profile - office parking is generally full during the day and on weekdays but is empty in the evenings and during weekends, and residential parking is the inverse. Shared parking could be provided to cater for both commercial and residential land uses where residents and office-goers can maximise the use of parking space. This facilitates efficiency and offers an opportunity for cities to better satisfy residents and commuters without increasing supply.

8.11.7 Water Taxis

Water taxis will be provided around the perimeter of newly-reclaimed islands and along the navigation channel. Transportation by water would be both efficient and enjoyable for people living, working and visiting PSR.

8.12 P2M2 for Recreational Fishing

The proposed Project has been designed with rock revetment as part of the coastal protection structures, as shown in F8.39. Once the reclamation is completed, this structure usually attracts several species of fish that are sought after by anglers. As such, the topside development of PSR shall encourage recreational fishing by providing designated areas for anglers. This step may also help the southern Penang Island to become an attraction for recreational fishing. Findings from this study has shown that recreational fishing generates positive economic and social impacts. Spillover from the increase in recreational fishing activities at southern Penang Island will benefit the local communities as well as business and boat operators.



F8.39 Sections of rock revetment as coastal protection

8.13 P2M2 for Tsunami Impact

A key factor to prevent or reduce losses of lives during a tsunami event is via community educational programmes. This comprises of plans for vigorous promotion of coastal community preparedness and awareness. This is done by educating the residents and users of the coastal area i.e. increasing their knowledge on matters pertaining to tsunami readiness, response plans and local policies such as:

a) Implementing an early warning system based on networking with the relevant government agencies and other tsunami-prone nations;
b) Identifying early signals of an impending tsunami, for instance, by taking note of ground shaking which occurs greater than one minute;
c) Identifying signs of rapid recedence of sea levels;
d) Emergency readiness by taking heed of issuance of official tsunami warnings through various forms of communication systems, e.g. mobile phones, television or radio;

e) Preparation and dissemination of tsunami maps of tsunami risk zones; and
f) Perform constant review of tsunami preparedness plans through public involvement via the process of public hearings. These hearings would involve stakeholders from the younger generations right up to the older population to reflect preparedness on real community life.

The consideration for physical mitigation measures are generally only adopted in very high tsunami-risk areas. As such, no physical mitigation measures for tsunami impact is proposed for this Project.

8.14 P2M2 for Socio-economy and Human Environment

The mitigation measures proposed for the socio-economy and human environment will encompass both during Project implementation as well as the operation stage.

8.14.1 Housing of Foreign Workers at Workers' Quarters

The conditions of the base or workers' camps would have to fit into a certain decent living standard that provide well-ventilated space, basic amenities, proper sanitation and non-crowding.

The implication of social and cultural problems arising from accommodating foreign workers within one complex could be avoided if workers of different cultural backgrounds would be housed separately but sharing common facilities to promote social integration. Racial clashes and other social problems could be avoided if workers' interests are looked after, cordial relationship maintained and cultural understanding and tolerance inculcated. Fostering cultural tolerance among the multi-racial components of the workforce could diffuse the prospect of social conflict.

8.14.2 Labour and Employment

The boost in local employment during construction stage would only be effective if a portion of the labour required is recruited from within the local area. The inability to get a job due to their low educational status and thus having to revert to fishing, as raised by the fishing community during the survey and focus group discussion (FGD), are testimony to the fear that they will be left out. The Project will strive to have some local recruitment ratio for it to be relevant in the development of the area. Targets for the proportion of local recruitment may be set. Normally, this is set for at least 30% in projects of somewhat similar nature. The employment of locals will be monitored by the Employment and Training Sub-committee.

Also, recruitment of labour from among the locals would be most beneficial if taken from the unemployed source or new entrants to the labour market, and not pinching from other employments. To ensure that local content is included, contracting tenders would have to include it (at least 30% local workers including employment) as one of the prerequisites for tender award.

It should also be similarly applied to employing local contractors and sub-contractors who should be given priority in the selection process. Only then would the proposed Project be most beneficial and relevant to the local and nearby communities. Such an approach would not only fulfil the local expectations, but would also portray and boost the image of the Proponent in being socially responsible. It is recommended that some smaller contract package to be offered exclusively for locals.

For greater assurance of non-religious conflict and social stability, workers of similar religious background should be housed together to avoid open disrespect of the religious and social affinities of others. Also, there should not be free mixing with the locals to avoid untoward incidence of social and cultural conflict.

The Project Proponent has conducted a job registration drive for local fishermen and the public who were interested in the employment opportunities provided by this Project. As of December 2018, about 612 job registrations were recorded.

8.14.3 Health

The emergence and rise of new strains of diseases, which had been associated with foreign workers, could be checked and overcome by having proper recruitment procedures and health screening before permission to work is granted. Although such measure is currently already in place, a more foolproof procedure should be targeted.

8.14.4 Livelihood

The fishermen's fear of losing their livelihood will not be overlooked or left unheeded. Compensation/*Ex-gratia* will be given in various forms, according to the formula developed by the State Authority.

Whatever decisions taken regarding compensation/*ex-gratia* ought to be based on several considerations, such as claims from genuine cases, the type of inconveniences faced, and the duration affected etc. in order to arrive at the proper quantum of compensation/*ex-gratia*. Other aspects of payment such as its nature (in cash or in kind), frequency (one-off or over a period of time) and the paying agency should also be considered.

Although inshore fishermen using traditional equipment and small vessels are considered as being no longer productive and efficient in the modern fishing industry, they need space, time and other opportunities to be properly upgraded or considered. This is because fishing is still being considered a traditional vocation for at least one-fifth of the next generation fishing communities, as shown by the study. As such, efforts to improve artisanal inshore fishermen will focus on the younger generation through enhancement of the education level.

8.14.5 Tranquillity and Aesthetics

Although temporary in nature, matters that could cause nuisance to the public such as noise pollution and dust must be managed accordingly. P2M2 developed for noise and air quality are discussed in *Sections 8.8* and *8.9* respectively.

8.14.6 Psychological Well-being

Local fear and worry could be managed or overcome with greater rapport between the Project Proponent and the affected fishermen, especially in discussing the issues and striving for a two-way agreement or a win-win situation. In addition, dissemination of correct information in order to squash unfounded rumours will also play a part in maintaining psychological well-being of the local communities.

Other adopted measures that may have positive contribution in this aspect include compensation/*ex-gratia* and offset programmes developed to support the fishing activities in southern waters of Penang Island.

8.14.7 Income and Revenue

For the local area to reap the full benefit of the proposed Project economically should many opt to commute to work, a well-planned housing area to accommodate the working population had already been planned together with the supporting services. As such, the economic impact could be fully harnessed.

8.14.8 Demography, Housing and Other Services

If population increase is expected (especially with the kind of development being offered), the most basic mitigation would be to anticipate the characteristics of the in-migrants so as to be proactive in formulating plans in meeting the needs of the different ages and genders of the new communities.

Local accommodation impacts should not be a problem as these can be mitigated by either providing additional accommodation for the workforce or to encourage the use of unoccupied or under occupied accommodation into the impact zone, depending on the condition of the local housing and accommodation market, developer policy on site hostel and local authority's policies on housing, site hostel and the like.

Impacts on local services and local authority finance can be partially mitigated by the direct provision of certain facilities by the developer such as a (in-house) medical centre, fire-fighting equipment and recreational facilities for the workforce. This is particularly relevant to the industrial sector.

8.14.9 Socio-cultural

Problems of integration and clash of lifestyles may lead to failure and disappointment. These could be avoided if the residential areas created would not be exclusively enclaved, with equal opportunities being opened for all to participate in the everyday doings and regular happenings in the local area or impact zone.

The roles of the local authority and management body are crucial in seeing to the implementation of the events by involving all in whatever amenities provided and functions organised for the area. The creation of the feeling of oneness is important in determining that all members of the public would feel that they belonged. The latter is of utmost importance in a mixed society as it is.

With regards to the marginalisation of the locals, it could be mitigated by identifying deserving local manpower to be recruited and trained for specific skills required by the multifaceted development in the area. In so doing, the locals could take part and contribute to the development of their area.

The onus of this gesture should fall on the Project Proponent as a part of its social obligation to the community. Alienation could also be overcome by ensuring the integration of the surrounding population with the new development through the provision of proper access, infrastructures, and high level of connectivity within the area.